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Research Article

Quality Improvement of Floor Cleaner Packaging Using Six Sigma and Continuous Improvement

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Abstract.
There was a product defect in the 700 ML Lemongrass Refill Floor Cleaner packaging, which was 26,236 units from June to December 2021. The cost overrun was Rp. 15,085,700. This study aimed to improve the quality of the 700 ML Lemongrass Floor Cleaner packaging. The research method used was quantitative, and examined the quality of product packaging with Six Sigma and Continuous Improvement methods. The results of research conducted for the DPMO value before any improvement was 65,121 with a sigma level of 4.51. Then improvements were made so that the DPMO value became 12,517 with a sigma level of 5.26, resulting in a decrease in waste in the production process. So it can be concluded that we can provide solutions by replacing spare parts that are no longer suitable for use, making sure the machine is set correctly, making the standard materials used without defects and maintaining their shape, arranging the pouch arrangement as neatly and efficiently as possible, checking the pouch at the supplier, adjusting the machine settings, making sure it is neatly organized and performing regular machine maintenance according to the SOP.

Keywords: continuous improvement, floor cleaner packaging, six sigma, quality

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1. Introduction

With the growing manufacturing industry in Indonesia, and the pressure of industry owners to improve the company's progress and be able to compete with others, the quality of a company is very important and needs to be considered in market competition.[1] So that quality itself can be considered in a company, which can improve the company's reputation, product quality and, quantity [2].

From the results of the company's production must maintain good quality in order to meet the needs expected of consumers [3]. Quality products will increase customer satisfaction while increasing consumer trust and loyalty to the company [4]. A company that wants to have a balanced line of work must reduce waste because basically, effective manufacturing uses materials, and of course it can cause a lot of waste in

the production process [5]. Waste is any activity that does not add value. Therefore, companies need to reduce waste that can disrupt production because waste can increase additional costs [6].

There are still many industrial companies encountered during the production process such as what Kurniawan did at PT. Cakra Guna Cipta, Malang is the production of kretek cigarettes in his research to prove before the repairs obtained DPMO 9823.7 and sigma level 3.84. After the repairs were made, the DPMO value was 4403.2 and the sigma level was 4.12. With a proposal to improve the scrapper tool for flattening tobacco [7].

The same thing is also proven by Utami research that sigma can provide improvements in the manufacture of bonding belts at PT. Pindad, there are 93,000 possible failures, the probability of failure is 10,445 with a sigma level of 3.81, so it is still far from six sigma. So the proposed improvements are kanban card design, modification of assistive devices, and warning signs [8].

Referring to previous research, there are still production defects, so this research is very necessary in order to improve the quality of the 700 ML lemongrass floor cleaner packaging so that it can reduce waste. Exploring the problems that occur, the researcher uses a control mechanism as a tool to carry out routine supervision and inspection at each work station so that the purpose of this research is to find out what factors cause product packaging to fail so that it can affect production.

This will cause losses both small and large scale. The product is said to have failed if the product does not meet the requirements set by the company. If the product does not comply with the provisions, the packing material will be discarded, the failed product will result in waste in the form of assembly material that has been used in the filling process from the production department. The more failed products produced will have a negative impact on the company due to the higher cost. The pouch variants in the Lemongrass Floor Cleaner packaging are in table 1 below:

Table 1: Lemongrass floor cleaner production packaging

NO	Product Packaging	Total Production Period July-December 2021 (Units)	Number of Defects (Units)	Percentage (Units)
1	*Floor Cleaner Lemongrass Refill 350ML*	382.300	19.750	5,1661
2	*Floor Cleaner Lemongrass Refill 700ML*	401.250	26.236	6,538567
3	*Floor Cleaner Lemongrass Refill 1500ML*	352.700	20.154	5,714205

Based on Table 1, there are 3 pouches, which are packaged in 350 ML, 700 ML, and 1500 ML. The most produced packaging is Floor Cleaner Lemongrass Refill 700

ML during the period July – December 2021, the data is taken based on the planning of the production. However, at the time of production, there were several problems with the 700 ML Floor Cleaner packaging where there was a damaged pouch due to failure to fill during the production process with a percentage of 6.538567%. As for the 350 Ml package, the percentage of defects is 5.1661% and for the 1500 Ml package the percentage of defects is 5.714205%. So the researchers took the research with the highest percentage of defects, namely the product packaging of Floor Cleaner Lemongrass Refill 700Ml.

Seeing these problems, researchers are interested in conducting production research on the 700 Ml Lemongrass Floor Cleaner packaging product during the period July to December 2021. In during a period of 6 months there were 26,236 packaging units wasted during the production process. Therefore, repair steps are the only way to reduce wasted pouches, and avoid waste during the production process. The following is the data for the July-December 2021 period in 3 shifts (Table 2):

Table 2: Data on the number of wasted pouches for the period of July-December 2021..

Month	Number of Production (Units)	Defective Pouch Type (Unit)				Total Defective Pouch (Unit)	% Defective Pouch
		A (Units)	B (Units)	C (Units)	D (Units)		
July	66333	998	1110	1107	1209	4424	6,7
August	65243	1008	897	909	1229	4043	6,2
September	67001	1112	986	1001	1308	4407	6,6
October	67231	1009	809	1003	1441	4262	6,3
November	66989	1013	908	1221	1456	4598	6,9
December	68453	987	1011	1003	1501	4502	6,6
Amount	401250	6127	5721	6244	8144	26236	

Based on Table 2, there are 4 types of product defects, namely: A = Tilt Press, B = No Batch, C = Leaky Packaging, D = Wasted Pouch. Table 2 is a form of problems that occur during the production packing process. One of them is the occurrence of errors from the materials used, the use of tools, and other factors, especially machine operators in operation, causing several obstacles such as tilting press, packaging leakage, no batch number, and wasted pouches, so that researchers can analyze the causes and consequences of the occurrence. waste that occurs and provides recommendations for improvement related to these limitations.

Seeing these problems, researchers are interested in conducting production research on 700 ML Lemongrass Floor Cleaner product packaging during the period July to December 2021. During a period of 6 months there are 26,236 packaging units wasted

during the production process. Therefore, corrective action is the only way to reduce wasted bags, and avoid waste during the production process.

2. Methodology

So that the collection method used in this study is to make direct observations on the company which is the object of research conducted by means of interviews, observation, and documentation [9]. To obtain the data analysis method used by the researcher, the DMAIC (Define, Measure, Analyze, Improvement, Control) flow is a tool that helps the calculation of six sigma and continuous improvement [10].

2.1. Data Analysis

The following is an explanation of the stages of research conducted based on the DMAIC cycle.

2.2. Define

In the initial identification is the first step in conducting research on a problem that is owned by the research subject, the data collection stage can also be considered as the initial definition stage which is very important to consider various things in research preparation.

2.3. Measure

At this stage, the calculation of the quality limit value of DPMO, sigma level, and process capability will be carried out. The first step in the measurement stage is to calculate the production quality limit using the control chart (P).

The calculation of the DPMO value is formulated as follows:

$$\text{DPMO} = \frac{Defect}{number\ of\ units\ inspected \times CTQ} \times 1.000.000$$

Description:

DPMO: *Defects Per Million Opportunities*

CTQ: *Critiqal to Quality*

Next is the calculation of the sigma level or sigma value with the help of the Microsoft Excel calculation application. The calculation of the sigma level in Microsoft Excel can be formulated as follows:

$$\sum = NORMSINV\ ((1000000 - DPMO)/1000000)\ + 1.5 \quad (1)$$

Description:

$$\sum : Sigma\ Level$$

2.4. Analyze

The analysis phase is the stage that needs to be carried out to analyze the causes of defects and determine the types of defects that are a priority for improvement.

2.5. Improvements

At the repair stage it is carried out by determining the priority of repair based on the RPN value in the FMEA table. Risk priority number (RPN) is a measure used when assessing risk to help identify “Critical Failure Modes” related to a design or process.

2.6. Control

In making the control mechanism aims to control the quality of the production process in PT. XYZ and anticipate the occurrence of defects in subsequent production processes [11].

3. Result and Discussion

In solving the problem of packaging defects for this 700 ML Lemongrass Floor Cleaner product, it is carried out using the Six Sigma method because Six Sigma is one method for quality control that can determine the cause of quality problems that occur and can provide corrective solutions. Six Sigma Method.

3.1. Define

Based on the observations that have been made at PT. XYZ types of defects that most often occur are in the product packaging such as Leaks C1, Press tilted C2, No batch C3, and Pouch wasted C4.

3.2. Measure

At this stage, the P-Chart Control Diagram Analysis is calculated, and the DPMO and Sigma level before improvement values are calculated, in Table 3.

DPMO and Sigma Level Before Improvement.

Based on Table 3, it is known that the DPMO is 16343 and the Sigma value is 3,64 before improvement.

TABLE 3: DPMO value and sigma level data before improvement.

No	Month	Number of Production (Units)	Total Defective Products (Units)	DPMO	Sigma Level
1	July	66.333	4424	16673	3,628
2	August	65.243	4043	15492	3,657
3	September	67.001	4407	16444	3,633
4	October	67.231	4262	15848	3,648
5	November	66.989	4598	17160	3,616
6	December	68.453	4502	16442	3,633
Amount		401250	26236	98059	21,815
Average		66875	4373	16343	3,64

3.3. Analyze

This analysis uses six sigma tools, one of which is by using a fishbone diagram.

Fishbone Diagram Analyze.

This method is used to analyze which parts cause product defects.

From Figure 1, it can be seen that the packing material is not good and the way of placing the pouch is not appropriate and does not comply with the given procedure which causes a lot of damaged packaging quality due to wasted pouches.

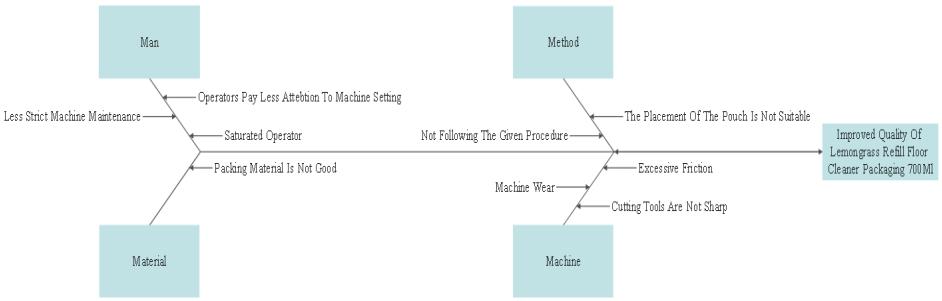

Figure 1: Fishbone diagram.

3.4. Improve

After the sources and root causes of quality problems are identified, it is necessary to establish an action plan to implement Six Sigma quality improvement (Table. 4).

3.5. Control

DPMO And Sigma Level After Improvement.

Based on Table 5, it can be seen that the DPMO is 11701 and the Sigma value is 3,77 after improvement.

Based on this research, the recommendation given by the researcher is that companies need to carry out quality control of packaging with suppliers to ensure the materials used are of good quality and carry out control of the production process based on company SOP. The researcher proposes a control system to inform the company that improvements in the quality of the 700 ML Lemongrass Floor Cleaner packaging can be carried out so that it can achieve the target. In making the control system, it is hoped that there will be no repeated packaging of defective products, the control system is implemented by the improvement design proposed by the researcher, so that it can be used as a work standard for the production process. The control system can be seen in Table 6.

4. Conclusion

In this study, it can be concluded that prior to the improvement of the production process before improvement in the period July – December 2021, the DPMO value was 16343 and the sigma value was 3,64. So that the main priority of improvement on the material factor is poor packaging and the way the pouch is placed is not according to

TABLE 4: Action plan.

Failure of Mode	Cause of Failure	Suggestions for improvement
Wasted Pouch	Worn engine, wrong setting	Check the machine before use
		Replace machine spare parts that are no longer suitable for use
		Make sure the machine settings are done correctly
	Hot engine, poor material, excessive friction	Make a standard for the quality of the material used, there are no defects and the shape is still maintained
		Perform periodic checks on the engine temperature, and try to have good air circulation
	Wrong placement	Arrange the arrangement of the pouch as neatly and efficiently as possible
		Check the supplier's pouch on the machine, and make sure it's neatly arranged
Tilt Press	The sealing position is not right and the conveyor is too fast	Add a special workforce to monitor packaging so that the packaging position is always right with the nozzles
		Give the nozzle cantering plate so that the nozzle falls right in the middle of the package
		Adjust conveyor speed with nozzles
		Carry out maintenance on conveyor machines and filler machines according to the factory default SOPs
	The position of the Induxin seal is too far and the temperature is too low	Standardize the height of the induction seal
		Set the temperature of the induction seal at a level of 40 C˚- 42 C˚
		Standardize the height of the induction seal
		Carry out maintenance on conveyor machines and filler machines according to the factory default SOPs
No Batch	Operators are not careful with the ink replacement schedule	Make a regular ink management schedule
	Ink volume and dosage are not up to standard	Set up a manual or ink dosing SOP at the ink checker
	Wet packing material when printed	Make sure the room is not damp, and make sure the packaging is dry.
	Dirty inkjet ink	Make sure the print nozzle is not wet or still dirty after and before use
Leaky Packaging	Packing material is not good	Apply the acceptance sampling method
	Excessive friction	Make sure the machine is not worn and the placement is appropriate
	Incorrect engine temperature	Do a temperature check, make sure there are no items that cover the engine air circulation

the procedure, so it is necessary to supervise the operator. So that the sigma value

Table 5: DPMO value and sigma level after improvement.

No	Production Time	Total Production	Total Product Defect	DPMO	Level sigma (□)
1	April	68212	3262	11955	3,759
2	May	67274	3083	11456	3,775
3	June	66560	2878	10809	3,797
4	July	68053	3425	12582	3,739
Total		270099	12648	46804	15,07
Average		67524	3162	11701	3,77

Table 6: Control system mechanism.

Process	Work Instruction	Criteria	Control Tool	Control Period	Person Responsible
Sorting	Inspecting the quality of pouches from suppliers by applying the acceptance sampling method	The quality of the packaging purchased is according to specifications (not defective) and the supporting raw material checking form is filled in correctly	Manual	Every time something comes in	Warehouse clerk
Filling	Monitoring the packaging	Packs neatly arranged on a moving conveyor	Manual	Every production process runs	Filler Operators
	Adjust conveyor speed with Filler Machine	The nozzle drops/fills right at the pouch hole	Programmable Logic Controller	Before the filling process	Filler mechanic
	Perform routine maintenance on the filler machine	The maintenance mechanism is in accordance with the SOP from the factory and is preventive	Manual	Scheduled	Filler mechanic

is obtained after improvement in April-July 2022, with a DPMO value of 11701, and a sigma value of 3,77. So that continuous improvement can be done by providing solutions by replacing spare parts that are no longer suitable for use, ensuring that the machine settings are correct, making standard materials used without defects and maintaining their shape, arranging the arrangement of pouches as neatly and efficiently as possible, checking pouches with suppliers with make sure the machine settings are neatly arranged and carry out regular machine maintenance according to the SOP.

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