Quality Improvement of Herbal Sachet in filling Powder Machine Using Six Sigma Method

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Abstract. This paper discusses the search for problem-solving product defects herbal sachets powder that occurs in the herb filling machine, using Six Sigma method with the concept of DMAIC (define, measure, Analyze, improve and control). In this study, 15% defects are found, the magnitude of this defect becomes one of the causes of the loss of production costs due to defects caused to the herbal sachets cannot be repaired or reused. Therefore, this paper will try to reduce the defects of these products using the stages of DMAIC repair. The quality tools used to solve this problem is by using Pareto, FTA (Fault Tree Analysis) and 5W + 1H. Ultimately, this study was able to provide quality improvement results by calculating the sigma level of defects of the herbal sachet product powder. The results of the improvement are: reduced sachets defect less than 2% with an increase in the sigma level value from 3.25 to 4.375. The use of this six sigma method is the right method and able to find problems, find solutions and be able to improve the quality.

Keywords: Quality, DMAIC, Fault Tree Analysis

1. INTRODUCTION

Every production activity must be found the defect product, this is very reasonable happened. However, if the production defect is not well controlled then it will cause a considerable loss in the production activity. Therefore, in order to reduce or suppress the defect value of the product, a suitable method is needed to reduce the number of defects in the absence of rework or poor product quality. Six Sigma is needed for the organization to carry out the related improvement process and must be run systematically [1]. The stages or steps of improvement process using DMAIC (define, measure, analyze, Improve, and Control). The DMAIC model in Six Sigma, is a concept to reduce process variability [2] This Six Sigma method has a purpose to know the current level of Sigma and ultimately improve the existing sigma value, while also improving productivity [3]. The problem faced is the discovery of defects in the production process in the packing section, especially the primary packaging of the filling sachet, with a defect percentage of nearly 15% of the total sachets available. Defects that occur on the packaging this makes a loss in this production activity due to many sachets that cannot be used anymore. To find the core problem of this defect, in this paper also uses Fault Tree Analysis, Fault trees are one the most commonly used method to analyse causal relations together with the measurement and operational data, as well as use and load profiling. At the top of the fault tree structure is a selected unwanted event. It is called the top event. The fault tree structure below the top event defines all the possible series of events which can lead to the top event [4]

The focus of this research is to try to improve quality with minimum achievement of defect reduction result of 2%. Finally, the paper is concluded in Section 6.
2. THEORY

2.1. Quality
Quality is the overall feature or characteristic of a product or service in purpose to meet customer needs and expectations [5].

Quality Price, Overall cost of these qualities include: [6]
1. cost of achieving good quality
2. costs of poor quality

Quality Control Definition
Quality control is an effective control system to coordinate the efforts of quality maintenance and quality improvement for the groups in the organization and production[5].

So that to obtain a very economical production as well as satisfy the needs and desires of consumers.

2.2. Six Sigma
Six Sigma steps: [7]
1. Define: at this stage team implementation identifies the problem, defines the customer specification and defines the goal (defect reduction, cost and target time).
2. Measure: Stage to validate problems, measure / analyze problems from existing data.
3. Analyze: Determine the factors that most affect the process, which means looking for one or two factors that if it is fixed will improve the process dramatically.
4. Improve: This stage is discussed ideas to improve system based on the results of the previous analysis, experimenting to see the results, if well made standard procedure (SOP).
5. Control: This stage should make the plan and the measurement design to be good Improvement can be sustainable. In this stage, a kind of matrix is created to monitor and perform corrective actions when it starts to decline or to make repairs again.

Definition of six sigma [9]
- The Defect is any event, where the product fails to meet customer requirements,
- Defective is any unit with one or more defects,
- yield is the number of units handled correctly through the process steps,
- Defect Per Opportunities (DPO) is a measure of failure calculated in the Six Sigma quality improvement program, and is calculated by the formula:

$$ DPO = \frac{Number\ of\ Defect}{Number\ of\ Unit\ \times \ Number\ of\ Defect\ Opportunities\ per\ units} $$ \hspace{1cm} [1]

The dimensions of this DPO when multiplied by the 1,000,000 constant will get the formula:

$$ DPMO = DPO \times 1,000,000 $$ \hspace{1cm} [2]

Defect per Million Opportunities (DPMO) is a measure of failure in Six Sigma improvement programs, which show failure per million opportunities.

3. RESEARCH METHOD

3.1. Data Collection and Processing
activities which conducted at this stage are as follows:
1. Define Stage (Definition)
This is the first step in the six sigma phase. The steps to be performed are as follows:

a. Determination of CTQ (Critical to Quality)

b. At this stage can know the order of CTQ based a level of the number defect.

c. Goal Setting.

2. Measure Stage (Measurement)

DPMO Measurement (Defect Per Million Opportunity):
At this stage initial DPMO measurements or before repairs.

3. Analysis (Analysis)

a. The largest defect analysis using FTA
   To find the main defect that will be handled first

b. Causes Defect Occurrence
   Based on the results of defect analysis using FTA then obtain the main defect that will first handle.

4. Improvement

a. Interpretation of the results is in the form of calculating DPMO on the process after repair.

b. The Searching process to reduce defect causes
   In this process, The observation process using 5W + 1H method to reduce or eliminate activities that can cause defects.

c. Evaluation of improvement results by:
   make a charts/tables to see the decrease in percentage defects.

5. Control
To maintain the improvement in order to continue, this research will be presented some proposed to controls so that improvement process can run stable and sustainable.

4. COLLECTION AND DATA PROCESSING

4.1. Data Collection
Based on the results of quality control tests on the process of packaging herbal sachet powder that obtained data production as follows:

1. Data Number of Product defect Powder in sachets from January to May 2017:

| No | Months | Number of defects | Batch | Number of Sachets | Percentage (≤15%) |
|----|--------|-------------------|-------|-------------------|-------------------|
| 1  | January| 164381            | 16    | 1100000          | 14.94            |
| 2  | February| 145571           | 14    | 962500           | 14.91            |
| 3  | March  | 163842           | 16    | 1100000          | 14.89            |
| 4  | April  | 140279           | 14    | 962500           | 14.57            |
| 5  | May    | 141269           | 14    | 962500           | 14.67            |
| Total|       | 753342           | 74    | 5087500          |                  |

Table 1 shows the percentage of defects close to 15%.
2. Data on the number of defects herbal Products sachet powder from January to May 2017.

| No | Item Problem | Qty Defect | Percentage (%) |
|----|--------------|------------|----------------|
| 1  | Leakage      | 527337     | 70             |
| 2  | Pieces       | 150670     | 20             |
| 3  | Visual       | 39778      | 5.28           |
| 4  | Weight       | 35557      | 4.72           |
|    | Jumlah       | 753342     | 100            |

4.2 Data Processing

DMAIC steps consisting of:
A. Define
In the process of identifying the problem will describe the kinds of defects that can lead to the occurrence of repair/rework because it is not in accordance with standard specifications. Here are the steps in the defined process:

- Determination of CTQ (Critical to Quality)
  Based on the results of observation and data retrieval In Table 2, there are various kinds of defects that can lead to Rework, namely:
  1. Uniformity of weight
  2. Pieces of sachet
  3. Visual (Sachet Color, Sachet Print & Codification)
  4. Leakage
  Then it can be determined the number of CTQ as much as 4 in the packing process

- CTQ sequence based on the number of defects.
  At this stage use the Pareto diagram as a tool to identify it.

  Figure 1 Pareto Defect Diagram January - May 2017 (Before Repair)

From Figure 1, the most common defect in the process of powder filling machine is leakage with 70% percentage value.

- Goal Setting
  With the determination of CTQ, the goal to be achieved in this study is to improve quality by lowering the number of defects in the product. With a minimum defect reduction result of 2%

B. Measure
- Defect Per Million Opportunity (DPMO)
This DPMO calculation is obtained from the formula [2]

\[
\text{DPMO} = \frac{753342}{5087500} \times 4 \times 1000000 = \frac{37019}{2035000} \times 1000000 = 37019
\]

Based on sigma table conversion value DPMO 37019 ~ sigma 3.25 ~ 95.99 % yield.

C. Analysis

Figure 2. FTA Diagram Sachet Defect

From Figure 2. There are 4 causes of sachet defects occurring on the powder filling machine of the four causes of almost all of the major causes of this defect due to unsuitable performance. Many activities are deviant in the implementation of production activities.
• **Cause of Defect Occurrence**
  To focus on the problem solving in order to maximize, the handling of the defect problem that will be done first is the defect caused by Leaking. Due to the leakage defect is a more common defect can be seen from the pareto diagram (figure 1)

![Figure 3. Failure Tree of Sachet Leaked](image)

From Figure 3, the error factor that causes leakage defect consists of 3 factors, namely method, Man, and machine

D. Improve

- **The Search process to reduce defect causes**
  This stage is the stage to define actions taken for quality improvement by presenting improvements and controls derived from the interpretation of measurement and analysis results. Using the 5W + 1H method for tracing in reducing the cause of the defect, reducing or eliminating activities that may cause defects.

| Table 3. Improve 5W + 1H |
|--------------------------|
| **Cause** | **Sub Cause** | **What**       | **When**      | **Where**  | **Who**      | **Why**                                      | **How**                                      |
| Machine      | spare part    | Filling machine not working properly and consistent | January 2017 | Filling sachet room | Maintenance | No preventive maintenance machine, because no minimum stock spare part | Start to arrange TPM program and minimum stock spare part to preventive periodically |
| Man Qualification | Still found operators of filling machines do not fit the qualifications to operate of machine | January 2017 | Filling Sachet room | Filling Machine operator | HRD department should be able to provide workers in accordance with the qualifications needed by the production department | RD section should be more selective by making personnel specifications |
|-------------------|------------------------------------------------------------------------------------------|----------------|---------------------|--------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------|
| Training          | the absence of training related to the operation of a good filling machine                | January 2017   | Filling Sachet Room | Operator                 | Less awareness of the importance of training and not realizing that management training is one of the efforts to establish sustainable quality | The Maintenance section should provide training to the filling machine operator |
| Method            | Lack of intensity of inspection of filling machine results                                 |                | Filling Room        | QC (IPC)                 | Lack of inspection intensity may be the cause of the escape of unmatched products | Improved inspection method by closing the intensity of the examination |
| SOP Inspection    | Lack of intensity of inspection of filling machine results                                 |                |                     |                          | Set up used are not quite right                                                  | SOP revised                                                   |
| SOP Operation     | SOP is used in languages that the operator lacks                                          |                |                     |                          |                                                                                |                                                                 |
| Machine           |                                                                                         |                |                     |                          |                                                                                |                                                                 |

E. CONTROL

In this research will be presented some form of control for the repair process can run smoothly, as follows:

1. Periodic evaluation of the performance sachet powder filling machine operators.
2. Conducting Total Productive Maintenance (TPM) to maintain and improve product quality through the maintenance of equipment.
3. HRD Department ensures in every department, especially production to keep briefing running before starting work, at least once a week.
4. Evaluation of sampling method so that the samples taken can represent the existing population.
5. Periodic evaluation of the SOP machine and other related for the operator or officer to use the machine according to the SOP that has been made.
6. Require commitment from top management to make continuous improvement

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5. RESULT

Based on analysis before session obtained results after the improvement, can be seen in table 4

**Table 4. Number of defects after August Improvement - December 2017**

| No | Months | Number of defects | Batch | Number of Sachets | Percent (≤ 2%) | Number of CTQ |
|----|--------|-------------------|-------|-------------------|---------------|---------------|
| 1  | August | 17261             | 16    | 110000            | 0.95          | 4             |
| 2  | September | 9963         | 20    | 117500            | 0.72          | 4             |
| 3  | October | 7324             | 18    | 122000            | 0.59          | 4             |
| 4  | November | 1961           | 10    | 69500             | 0.22          | 4             |
| 5  | December | 841             | 11    | 75600             | 0.11          | 4             |
| Total |        | 29950             | 75    | 5156250           |               |               |

Seen from Table 4 after the repair process, the product defect decrease value less than 2%. this value exceeds the expected target

- DPMO value after repair:

\[
\text{DPMO} = \frac{29950}{5156250 \times 4} \times 100000 \\
= \frac{2990}{2062500} \times 1000000 \\
= 1452
\]

Based on sigma table conversion value DPMO 1452 ~ sigma 4.375 ~ 99.79 % yield.

- Decreased defect Sachet

**Table 5. Defect Total Data August - December 2017**

| No | Item Problem | Qty Defect | Percent (%) |
|----|--------------|------------|-------------|
| 1  | Leakage      | 14216      | 47.46       |
| 2  | Patch        | 8246       | 27.54       |
| 3  | Visual       | 6563       | 22          |
| 4  | Weight       | 925        | 6.08        |
| Total |          | 29950      | 100         |

Table 5 shows a decrease in the defect, leakage defect from 70% (figure 1) to 47.46%. Decrease by 22.54%

**Table 6. Comparison of DPMO and Sigma Value Before and After Repair**

|                | Before Repair | After Repair |
|----------------|---------------|--------------|
| DPMO           | 37019         | 1452         |
| SIGMA          | 3.25          | 4.375        |
Table 6 shows the DPMO comparison results before the improvement and after the improvement, the DPMO difference is 35567. While for the Sigma value has a difference of 1,125

6. CONCLUSION

Based on the results of research then it can be concluded several things, namely:
1. Can be known types of defects and find the most dominant defect in the process of packaging sachet powder herbal products
   a. The types of defects that occur in the product are the leakage of sachet, patch sachet, visual sachet as well as the uniformity of sachet weights.
   b. Based on the Pareto diagram the most dominant defect is the leakage of sachet
2. The results of this study using the DMAIC method, be able to reduce the number of defects that were previously 15%, the average fell to less than 2%, although focused on the reduction of leakage defects but indirectly also affect the number of other defects.

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