IMPLEMENTATION SIX SIGMA TO IMPROVE PRODUCT QUALITY IN XYZ

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ABSTRACT

PT XYZ is a provider of pesticide maklon services. The problem faced by the company is the quality of products in the production process does not meet the standards that result in the product needs to be reworked and dispose of. Therefore the company needs to make improvements in the quality of products in the production process. The method that can be used to improve the quality of products in the production process approaches the six sigma method. During six months of production, the data collection results showed the product SPR 480SL packaging one liter has the highest percentage of defects among other products with a product defect percentage value of 1.32%. The average weight of Sigma is at the level of 3.24-sigma. The production process of SPR 480SL packaging 1 liter consists of 6 main processes: mixing, labeling, filling, capping, plus induction seal shrink installation and packing. The data obtained by analysis using the Pareto diagram showed that shrink defects in the shrink installation process are the highest defect in the production process, with 49%. The cause-effect diagram’s analysis is known to affect the type of shrink defects, namely, humans, machines, methods, and materials. The way can make proposed improvements to the problems faced by the company of 5W - 1H. After the repair process in the following month there is an increase in the value of Sigma from 3.24-sigma to 3.52-sigma this indicates the increasing quality of the product, the proposal provided not only fix one of the factors causing the type of defect but give a suggestion to all factors that cause the type of product defect.

Keywords: quality, six sigma, reworked, pareto diagram

I. INTRODUCTION

Nowadays, competition in the industrial world is getting tighter, and intense competition demands the company always do the changes to survive and compete in running its business. Companies must be good at seeing the needs and wants of consumers so that the products produced can compete in the market. This makes the company encouraged to create quality products at affordable prices and create better products to meet the wishes and satisfaction of consumers. Providing products according to the wants and satisfaction of consumers is the key to the company’s success. Efforts to meet the joy of the company’s customers need to focus on controlling production quality to produce output by consumer expectations.

Product quality control is a control system carried out from the early stages of a process to the finished, even to the distribution of products to consumers. Quality control is an activity carried out to maintain the quality of products and services produced to comply with market demands. This activity is one of the ways that companies can minimize defective products that can occur. Efforts in quality control can use the six sigma method.

Six Sigma is a comprehensive and flexible system for achieving, supporting, and maximizing business processes that focus on understanding customer needs using facts, data, and statistical analysis and continuously paying attention to setting up, improving, and reviewing business processes. And Stevenson and Choung explain that six Sigma is a business process to improve quality, reduce costs, and improve customer satisfaction. Also,
Montgomery and Woodwall explained that applying the six sigma method appropriately is expected to increase the sales volume of products.

The six sigma implementation stage for quality control consists of five steps using the DMAIC method or define, measure, analyze, improve, and manage. The DMAIC methodology is key to solving Six Sigma’s problems, including successive remedial steps, each of which is critical to achieving the desired results. The purpose of the DMAIC concept, the six sigma method, seeks to create a zero-defect level (Dr & Dr, 2020; Ozarkan & Dogan, 2020; Ouazzani et al., 2020; Gumus et al., 2020).

PT XYZ maklon service provider company, the characteristic of the maklon company, is the raw materials and design specifications, and the amount of production is guided by customers. The company only provides production services. SPR product production process consists of 6 processes: mixing, labeling, filling, capping, shrinking, and packing. The most common problem is the occurrence of defective products in the production process. Production data are listed in table 1.

<table>
<thead>
<tr>
<th>Product</th>
<th>Total Production</th>
<th>Reject</th>
<th>Reject Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPR 480SL 1 liter</td>
<td>547,500</td>
<td>7212</td>
<td>1.32%</td>
</tr>
<tr>
<td>SPR 490SL Gold 1 liter</td>
<td>250,000</td>
<td>2194</td>
<td>0.88%</td>
</tr>
<tr>
<td>SPR 480SL 500 ml</td>
<td>50,000</td>
<td>424</td>
<td>0.85%</td>
</tr>
<tr>
<td>SPR 490SL Gold 500 ml</td>
<td>14,964</td>
<td>97</td>
<td>0.65%</td>
</tr>
<tr>
<td>SPR 480SL 20 liter</td>
<td>239,360</td>
<td>196</td>
<td>0.08%</td>
</tr>
<tr>
<td>SPR 480SL 4 liter</td>
<td>271,584</td>
<td>146</td>
<td>0.05%</td>
</tr>
<tr>
<td>SPR HTR 480SL 20 liter</td>
<td>6,720</td>
<td>0</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

Based on table 1 research problems located in defective products that occur in the production process, the percentage of defects of spr 480 SL 1 liter packaging products in the production process is the highest at 1.32%, exceeding the target of product defects in the company’s production process which is a maximum of 1%. The large number of defective products that occur in the production process can increase costs and more excellent production time, resulting in the company’s losses. Therefore, the six sigma method can be used for problems faced by companies because six Sigma is considered to reduce process variations as well as defects in products or services outside the specifications by using statistical methods and problem-solving tools intensively [8].

This research aims to identify the problem of high defect products in the production process of SPR products and find solutions for corrective actions to overcome product defects in the production process that can ultimately increase profits for the company.

II. LITERATURE REVIEW

A. Quality Control

Vincent Gaspersh’s control is “Quality control is the operational techniques and activities used to fulfill requirements for quality.” While quality is a measure to assess that goods or services have had a valid value as desired, or in other words, goods or services are considered to have quality when functioning or have a practical matter as expected [10]. Sofjan Assauri quality control is an effort to maintain the Quality or Quality of the goods produced. Quality control is an effective control system to coordinate quality care efforts and quality improvement of the group in the production organization so that production is obtained that is very economical and can satisfy the needs and desires of consumers.

B. Six Sigma

Six Sigma is a statistical concept that measures a process related to defects at the six Sigma level. There are only 3.4 defects out of a million opportunities. Six Sigma is also a management philosophy that focuses on removing blemishes by emphasizing understanding, measuring, and improving processes. Six Sigma can also be defined as a method of improving business processes that aim to find and reduce defective factors, reduce cycle times and production costs, increase productivity, meet customer needs, achieve optimal machine utility and get better results in production and service.
C. Basic Aspects Of Six Sigma

According to Gaspersz (in Achmad, 2012:7), if the six sigma concept will be established in manufacturing, there are six aspects to note which are:

1. Identify product characteristics that satisfy customers (as per customer requirements and expectations).
2. Classify all of those quality characteristics as individual CTQ (Critical To-Quality).
3. Determine whether each CTQ can be controlled through material control, process machine work, and others.
4. Determine the maximum tolerance limit for each CTQ desired by the customer (determine the UCL and LCL values of each CTQ).
5. Specifies the maximum process variation for each CTQ (sets the ultimate standard deviation value for each CTQ).
6. Change the product design or process in such a way as to be able to achieve the target value of Six Sigma.

D. The Quality Control Stage With Six Sigma

In applying quality control using the six sigma method, there are five steps called DMAIC (Define, Measure, Analyze, Improve, Control). The DMAIC steps are as follows:

1. Define
2. This stage is the initial stage of DMAIC. Define is the phase of determining the problem that aims to identify the problem that occurred and determine the priority of the problem.
3. Measure
4. The measuring stage is the second phase of the DMAIC cycle, where key indicators are identified, and data is collected, compiled, and presented.
5. Analyze
6. At this stage where the details of the process are carefully examined for improvement opportunities. In this phase, the data is investigated and verified to prove the root cause of the problem and strengthen the problem statement. The analysis carried out includes reviewing the process map for value-added or not value-added activities.
7. Improve
8. The fourth phase in the DMAIC cycle, where solutions and ideas are creatively created and decided. Once a problem has been identified, measured, and analyzed, a potential solution can be determined to solve the problem statement and support the goal statement.
9. Control (Pengendalian)
10. This stage is the last stage of the DMAIC method. The fifth stage, where after the solutions are estimated, the improvement is supervised and controlled to be continuous. The purpose of progress can be maximized in minimizing process or business errors that adversely affect the company.

III. METHODS

Research methodology is the steps that will be taken in the research to achieve the desired goals. The research methodology can be seen in Figure 1.
The method of data retrieval at PT XYZ is done by direct observation in the field by observing and conducting interviews in one part of the company’s production. The data is then processed using a lean six sigma approach using define, measure, analyze, improve and control (DMAIC) methods.

1. Define

At this stage, problem identification is carried out through information from the flow of the production process and data collection of both quantitative and qualitative data to know the type of product damage produced in the production process.

2. Measure

At the measuring stage, identifying the type of defects that occur in the production process, then the processing of the P-control map and calculating the sigma level.

3. Analyze

At this stage will be analyzed the type of dominant defects in the production process of SPR products are then searched for the root cause of the problem using Pareto diagrams and cause-effect diagrams.

4. Improve

In this stage, corrective actions are carried out by taking measurements, providing recommendations for improvement reviews, and analyzing disciplinary actions.

5. Control

At the control stage is the control of improvement efforts, evaluating all actions that have been attempted to know the success of the steps that have been applied

IV. RESULTS AND DISCUSSIONS

A. Define Stage

The first step in implementing the improvement of the production process using the DMAIC method is to identify the symptoms that occur in the manufacture of SPR products. SPR product production data from September 2020 to February 2021 are listed in Table 2

<table>
<thead>
<tr>
<th>Product</th>
<th>Total Production</th>
<th>Reject</th>
<th>Reject Percentage</th>
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<tbody>
<tr>
<td>SPR 480SL IL</td>
<td>547,500</td>
<td>7212</td>
<td>1.32%</td>
</tr>
<tr>
<td>SPR-490SL Gold 1 liter</td>
<td>250,000</td>
<td>2194</td>
<td>0.88%</td>
</tr>
</tbody>
</table>
Based on table 1, SPR 480SL 1 liter packaging products become one of the products with the highest percentage of defects in the production process compared to 7 other products with a rate of product defects in the production process of 1.32%. With the percentage value, it is necessary to know the flow of the production process that can cause defects in SPR products ranging from the fulfillment of raw materials, production processes to products received by consumers using SIPOC diagrams. The Sipoc diagram is shown in figure 2.

![Fig 2. Sipoc Product SPR Diagram](image)

Figure 2, known to do the production process of SPR 480SL product packaging 1 liter, consists of 6 methods: mixing, labeling, filling, capping plus induction seal, installation shrink, and packing. After the product is finished in production, then the product is ready to be sent to consumers.

B. Measure Stage

At the measuring stage, identification of defects that occur in SPR 480SL products is carried out. Table 3 describes the types of defects that exist in the production process of SPR products.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Size</th>
<th>Bottle</th>
<th>Cap</th>
<th>Label</th>
<th>Shrink</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPR 480 SL</td>
<td>1 Liter</td>
<td>412</td>
<td>2912</td>
<td>579</td>
<td>3722</td>
<td>7625</td>
</tr>
<tr>
<td></td>
<td>500 ml</td>
<td>20</td>
<td>50</td>
<td>42</td>
<td>103</td>
<td>215</td>
</tr>
<tr>
<td></td>
<td>20 Liter</td>
<td>1</td>
<td>27</td>
<td>5</td>
<td>163</td>
<td>196</td>
</tr>
<tr>
<td></td>
<td>4 Liter</td>
<td>38</td>
<td>65</td>
<td>43</td>
<td>-</td>
<td>146</td>
</tr>
<tr>
<td>SPR 490 SL</td>
<td>1 Liter</td>
<td>71</td>
<td>903</td>
<td>198</td>
<td>1022</td>
<td>2194</td>
</tr>
<tr>
<td></td>
<td>500 ml</td>
<td>7</td>
<td>30</td>
<td>12</td>
<td>48</td>
<td>97</td>
</tr>
</tbody>
</table>

Based on table 3, the most common type of defect is shrinking defect type. After obtaining the type of defect in SPR 480 SL product packaging 1 liter, the next step is to decrypt the characteristics of defects that occur. The decryption of defect types is listed in table 4.

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Size</th>
<th>Bottle</th>
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<td>30</td>
<td>12</td>
<td>48</td>
<td>97</td>
</tr>
</tbody>
</table>

Tables 4. Identification of Defect Types
After the type of identification, defects are created, P-control maps existing conditions to know the defects of products produced in the production process are still within the limits of statistical control. P-control map existing shown in Figure 3

<table>
<thead>
<tr>
<th>No</th>
<th>Type of Defect</th>
<th>Explanation</th>
<th>Pictures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bottle</td>
<td>Defects in the bottle is a type of defect that comes from the supplier, in the form of visual defects in the bottle.</td>
<td><img src="image1" alt="Bottle Picture" /> <img src="image2" alt="Bottle Picture" /></td>
</tr>
<tr>
<td>2</td>
<td>Cap</td>
<td>Defects in the stamp can be caused by induction seal not installed properly</td>
<td><img src="image3" alt="Cap Picture" /> <img src="image4" alt="Cap Picture" /></td>
</tr>
<tr>
<td>3</td>
<td>Shrink</td>
<td>Shrink defects are caused by material defects from suppliers, resulting in shrinks not being usable</td>
<td><img src="image5" alt="Shrink Picture" /> <img src="image6" alt="Shrink Picture" /></td>
</tr>
<tr>
<td>4</td>
<td>Label</td>
<td>Label defects can be label placement and no batch is not precise</td>
<td><img src="image7" alt="Label Picture" /> <img src="image8" alt="Label Picture" /></td>
</tr>
</tbody>
</table>

After the type of identification, defects are created, P-control maps existing conditions to know the defects of products produced in the production process are still within the limits of statistical control. P-control map existing shown in Figure 3

![Control Map](image9)

**Fig 3 Control Map P – Product SPR 480SL packaging**

Figure 3 shows no data exceeding the control limit, and it shows that variations in defective shrink products are in a stable condition.
Based on table 5, the calculation of sigma levels for six months starting from September to February on SPR 480SL 20L x 1 products obtained an average sigma value of 3.2414 sigmas data shows the opportunity for defective products of 40800.25 DPMO. With the results accepted, there needs to be an improvement in making products SPR 480SL packaging 1 liter.

C. Analyze Stage

In the analysis stage, the analysis stage is carried out to determine the root of the problem that causes defects in the production process of SPR 480SL 1 liter products. Analysis in this phase using Pareto diagrams and cause-effect diagrams. Diagram Pareto defect product SPR 480SL packaging 1 liter is listed in figure 4.

Based on figure 4, indicating four types of defects contained in the production process of SPR 480SL products packaging 1 liter, shrink defects become the highest defects with a percentage of defects 49%, which causes almost 51% of defective products in the production process of SPR 480SL products packaging 1 liter. The significant percentage rate of shrink type defects indicates that it is a problem that the company must handle to minimize product defects in the production process is relatively high. The next step is to do a more detailed analysis of the root cause of the problem that causes shrink defects in the product using the cause-effect diagram. The cause-effect diagram is shown in figure 5.
Based on figure 5, five causes can result in shrink defects in the production process of SPR 480SL 1 liter packaging products, namely;

1. **Method**

   In the product production process SPR 480SL packaging 1 liter, Standard-setting parameters can not be used due to differences in raw materials and models. If there is a defective product, then the parameter setting will continue to be replaced until the defective product is produced a little. This is undoubtedly a waste for management if reviewed in terms of cost, raw materials, human resources, and production time.

2. **Raw Materials**

   There is a problem in the raw materials in the storage of moist raw materials, resulting in easy-to-tear raw materials and the storage of raw materials combined with natural materials with a pungent odor to the possibility of contamination of raw materials.

3. **Human**

   There is a problem in the shrink process production because the operator is wrong in setting the parameters of the shrink machine, so that there is a problem shrink is not appropriate.

4. **Machine**

   Currently, the maintenance of the machine used is only done when the device is damaged, while the age of the machine that is old can result in decreased engine performance.

**D. Improve Stage**

At the stage of improving the quality of the product, the improvement carried out is a significant problem improvement that arises from the cause-effect diagram. The corrective steps are carried out using the 5W – 1H method.

**Tables 6. Repair Defect Shrink product SPR 480SL**
The last stage in the DMAIC method is the control stage, and the control level is done by creating a counteraction plan.
Based on figure 6, the counteraction plan aims to control the shrink process to not produce defects beyond the company’s standards. Creating a counteraction plan is based on the cause of the defect, namely methods, machines, people, and materials. Control carried out on defect causal factors as follows:

1. **Method**
   - After the proposed corrective action, control is carried out regarding the setting of parameters that have been made during the production process, whether there are still many defective products produced after repairs.

2. **Machine**
   - After the proposed repair action, control of the machine is carried out whether there is still a damaged machine during the production process.

3. **Human**
   - After the proposed improvement, control is carried out during the production process, whether human factors still cause defects.

4. **Material**
   - After the proposed improvement, the supervision and evaluation of the quality of raw materials from suppliers, control are seen from reducing shrink defect products.

The last step in the control stage is to calculate the percentage of the defect rate and the value of the company’s Sigma each month to determine whether there is an improvement in the quality.

V. **CONCLUSION**

Based on the research results, the implementation of the DMAIC method successfully identified and analyzed the types of defects and causes of defects in the production process of products produced by PT XYZ. One product with the highest percentage of production process defects is SPR 480SL 1liter packaging with a product production process defect percentage value of 1.32% exceeding the company’s expected product production process defect target of under 1%. After analyzing the percentage of product production process defects, four types of defects occur in SPR 480SL 1liter packaging products, namely, stamp defects, label defects, shrink defects, and bottle defects. Shrink defects are types of defects that contribute significantly to the high percentage of defects in the product production process.

Based on the analysis of product production process defect factors, four factors can result in shrink defects, namely humans, machines, methods and raw materials, human factors caused by lack of training of operators, machine factors caused by the failure of machine maintenance periodically, method factors caused by the setting of shrink machine parameters are no longer usable or invalid and raw material factors caused by defects in raw materials from suppliers.
Once it is known the factors that cause product defects in the production process, the next step is to carry out the stage of action planning to improve the quality using 5W-1H. After the improvement process in the following month, there was an increase in the value of Sigma from 3.24-sigma to 3.52-sigma. This shows the increasing quality of products to achieve the expected goals by the company. The proposal provided needs to be controlled against each disability factor by calculating the percentage of disability rate and the value of sigma companies every month.

REFERENCES