IJEMBM EMERGING MARKETS: BUSINESS AND MANAGEMENT STUDIES JOURNAL

SIX SIGMA DMAIC APPLICATION ON SMALL BUSINESS PERFORMANCE: A CASE STUDY ON INDONESIAN'S TOBACCO COMPANY

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Article Information

Received: 17 March 2020
Accepted: 27 May 2020
Published: 6 July 2020
DOI: 10.33555/ijembm.v7i2.119

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ISSN 2338-8854
eISSN 2620-9918

ABSTRACT

This study is aimed to examine the company's production performance in the quality control department by implementing the Six Sigma DMAIC Method. Research is conducted on small tobacco business namely CV SUUD for its specific cigarette product called SKM 88 Golden Taste. The cigarette production data are collected for the period of March 22, 2019 to April 22, 2019 while the data are then analyzed using Six Sigma DMAIC Method (Define, Measure, Analyze, Improve, Control). Using the descriptive method, the results show that the SKM 88 Golden Taste cigarettes produced during the period of observation contains defect such as deflated, porous, and non-sticky glue. The production performance of SKM 88 Golden Taste cigarettes in the research period is at the level of 11.353 Defects per Million Opportunities (DPMO) or equivalent to 3,78 Sigma. This finding indicates that CV SUUD lost its revenue by 25% to 40% cause by the defect in the production which is important for small company like CV SUUD to improve its quality control by refining its standard procedure as suggested by the Six Sigma evaluation.

Keywords*: Small Business Performance, Six Sigma, Quality Control, DMAIC*

1. Introduction

The tobacco industry is one of Indonesian industrial sectors that make a significant contribution to the national economy by providing high state customs revenues. State revenues from the customs sector shows increasing figure from year to year. According to data from the "Badan Pusat Statistik (BPS)", the total state revenues from the customs sector in 2007 was Rp 44.68 trillion and continued to reach Rp 205.5 trillion in 2018. Among several types of customs subject, tobacco's customs dominate the state revenues. The Director General of Custom stated that in 2018, state revenues from tobacco's customs amounted to Rp 153 trillion which is equivalent to 96% of the total state customs tax (Gerintya, 2017; Sukmana, 2019). The high proportion of state revenues from tobacco's customs shows that the tobacco products industry holds large market in Indonesia. While the cigarette company is one of important players. The small and medium cigarette industry plays a role in this field. SME has an important role in Indonesia's economic development. SME is a source of employment opportunities and a place for regional economic development in rural areas. The data of small-medium business is presented in table 1.

Table 1. The Data of Small-Medium Business Source: Indonesian Ministry of Cooperatives and SMEs

Type	2017	2018
Small Business	757.000	783.132
Medium Business	58.627	60.702

Six Sigma method is a quality control method that can be employed to measure the performance of small business. Six Sigma is mainly aimed to control the defective product, saving production time and reduce production costs. Six Sigma is also a comprehensive strategy, a discipline strategy, and means to achieve business success (Heizer and Render, 2015:249). The stages of controlling defective products used in Six Sigma are Define, Measure, Analyze, Improve, and Control (DMAIC). Define stage is the first stage in DMAIC which is started by defining the character of defect type, determining the purpose of improvement and determining the customer's response. Measure stage is started by measuring the process in order to determine the performance that occurs during observation. Analyze stage is started by analyzing and determining the problem root that cause the defective product. Improve stage is used to improve the process by eliminating the defective products. While lastly, Control is the closing stage in DMAIC which is completed by controlling the repairs that have been constructed previously (Foster, 2017: 342).

CV SUUD is a cigarette manufacturer located in Tamanan District, Bondowoso Regency. The company started producing cigarettes in 2016 and categorized as Small-Medium Business. The company produces two types of products, namely Red SKT 88 and SKM 88 Golden Taste. This research focuses on the SKM 88 Golden Taste since it dominates the production output. The average number of production of SKM 88 Golden Taste is 8.606.888 cigarettes per month. Meanwhile, the production defective products are divided into 3 criterias of defects including deflated, porous, and non-sticky glue. The percentage of defective products is currently in the range of 1-7% per day. This makes the company's revenue reduced to deal with production defects.

The company's revenue is presented in table 2.

Table 2. Company's Revenue

Year	Production	Defect	Revenue
2016	82.626.120	13.220.179	Rp. 37.594.700.000
2017	78.494.820	13.344.119	Rp. 35.289.800.000
2018	76.139.964	15.227.993	Rp. 32.994.00.000

This figure requires company to further reduce its production defect so that its production level will be more efficient.

Six Sigma has been successfully implemented in large business companies as indicates in previous study by Dubey (2016) and Rochman (2017). Dubey (2016) showed that Six Sigma analysis in the precast industry was at the level of 3 Sigma with the defect criteria for crack, dimensional deviation, and chip off [5]. Rochman (2017) showed that Six Sigma analysis in musical instrument industry was at level 4 Sigma or equivalent to 4639 Defects per Million Opportunities (DPMO). However, Six Sigma implementation in small business companies is still rare. The novelty of this study is to implement Six Sigma method to improve the performance of small businesses, especially in the tobacco industry. Therefore, this research has three important objectives which are (1) determine the company's production performance during the period of March 22, 2019 to April 22, 2019, and (2) develop plans to improve production performance improvements. Main contribution of this study is able to be used as a company reference to improve production performance using Six Sigma DMAIC in the small business company.

2. Literature Review

2.1 Quality

Quality is the overall features and characteristics of goods or services that is promised and implied (Heizer and Render, 2015:244). Quality is a dynamic link between products, services, people, processes, and environments that meet or exceed expectations for superior value (Knowles, 2011:10). Quality ought to be associated with the achievement of expectations, fulfillment of actual requirements not set by the customer, but once offered is the choice of everyone (Knowles, 2011: 11). There are eight quality dimensions that can be used to analyze the quality of a product, such as performance, feature, reliability, conformance, durability, service ability, aesthetic, and perceived quality (Nasution, 2005:4).

2.2 Cost of Quality

Quality costs are the costs incurred to acquire a criterion of quality (Nasution, 2005:172). This cost is intended as an evaluation of investment in the quality. This cost is divided into cost of achieving good quality and cost of poor quality. (Russel and Taylor, 2011:83-85).

Cost of achieving good quality is the cost spent to get good quality. This category is classified into two categories, prevention costs and appraisal costs. Prevention costs are costs incurred for efforts to prevent poor quality. Appraisal costs are costs incurred for measuring, testing and analyzing the process to ensure the achievement of specified quality specifications (Russel and Taylor, 2011:83-85).

Cost of poor quality is the cost that comes out to correct mistakes that occur. These costs are classified into two parts, internal failure costs and external failure costs. Internal failure costs are costs incurred to correct quality errors that occur before the product is received by the customer. External failure costs are costs that come out when customers receive goods of poor quality (Russel and Taylor, 2011:83-85).

2.3 Quality Control

Quality control is the process of identifying

and managing activities needed to achieve organizational goals that adapted from the customer's desires (Gryna et al., 2007: 19). Quality control is a process to ensure that an activity meets the established requirements (Pyzdek and Keller, 2013: 20).

2.4 Six Sigma

Sigma can be referred to statistical notation that indicates standard deviations while Six Sigma can be defined as "six times the difference of standard deviation" (Smetkowska and Mrugalska, 2018: 591). Six Sigma has two meanings in Total Quality Management. First, Six Sigma in the statistical sense, reflects processes, goods, or services with very high capabilities or equal to 99.9997%. Second, Six Sigma is a quality control method that aims to control the defective product, saving production time, reduce production costs, and increase customer satisfaction. Six Sigma is also referred as a comprehensive strategy, a discipline strategy, and means to achieve success in business (Heizer and Render, 2015: 249). As quality control method, Six Sigma includes 5 important stages of evaluation known as DMAIC. DMAIC itself can be defined as a systematic process and quality improvement approach to help companies or organizations solve problems and improve their processes (Kishore et al. :2016). DMAIC has the advantage of eliminating the causes of failure that occur in the production process and can be used as a tool for continuous improvement (Kwak and Anbari, 2014). DMAIC can be applied for small business and small organizations. Six Sigma is very appropriate for smaller companies. The results are usually quicker and more visible in smaller companies than large one (Antony, 2008).

2.5 Six Sigma Tools

In order to applied the Six Sigma properly on this study, there are some tools that be used. The six sigma tools are in the following:

a. Pareto Chart

Pareto diagram is a tool used to identify and prioritize problems to be solved. This diagram can be used to display problems according to the frequency of their appearance (Foster, 2017:278-280).

b. P-chart

P-chart is a process chart used to graph the proportion of defective production items. Effective P-chart is used to determine the shift in proportion to a particular product or service (Foster, 2017: 340).

c. Cause and Effect Diagram

Cause and Effect diagram is a structured approach to analyze the factors that cause problems, gaps, and mismatches (Nasution, 2005: 166-167).

d. FMEA

FMEA (Failure Modes and Effect Diagram) is a tool used to identify all potential failures that may occur in a product or process, prioritize according to risk, and eliminate or reduce the probability of occurrence (Goetsch and Davis, 2010: 385).

3. Methodology

This research uses quantitative method approach and can be classified as descriptive research. Descriptive research is a study that aims to describe data that corresponds to variables, circumstances, facts, and phenomena that occur when the study takes place (Subana and Sudrajat, 2005:30). Data employed in this study are secondary data which is collected for the period of March 22, 2019 to April 22, 2019. Data of SKM 88 Golden Taste includes the number of cigarette production as well as the number of defective products.

In order to obtain the goals of this specific research, those data are then analyzed using the DMAIC phases of Six Sigma which includes 5 steps as follows:

a. Define, this step started by defining the character of defect type in the production department and then determining the purpose of improvement,
b. Measure, this step is started by collecting production data for the period of March

22, 2019 to April 22, 2019 and then measuring it using p-chart tool. After that, data will be measured using DPMO formula and the result of DPMO will be converted to Sigma Level.

c. Analyze, this step is started by converting production data using Pareto Diagram to prioritize the defective product by its occurrence frequency. After that, each defect type will be analyzed using Cause and Effect to breakdown the cause of the defect.
d. Improve, this step is started by converting the cause of the defect that was found on the previous stage using FMEA techniques. The output of FMEA is used to prioritize the proposed improvements.
e. Control, this stage is to standardize the proposed improvements that have been found in FMEA.

4. Findings and Discussions

Since the main tools applied in this study is DMAIC, then the findings and discussion are also presented according to the steps used in that method.

4.1 Define

a. Defining the characteristic of defect
The characteristic of defective product of cigarette is presented in Table 3.

Table 3. The Characteristic of Defective Product

No	Defect Type	Detail
1	Deflated	The contents of tobacco and clove cigarettes less congested.
2	Porous	Tobacco and cloves on the tip of the cigarette fall out, so that the tip of the cigarette is not completely filled.
3	Non-sticky glue	The glue does not stick perfectly to the cigarette shaft

It can be seen that for SKM 88 Golden Taste cigarettes, defect can be classified into three major categories which were observed during production process. The three major categories of defect will be used for the basis of data collection.n

b. Determining the purpose of improvement
This research was intended to reduce the level of defect in the production of SKM 88 Golden Taste cigarettes. Thus, the purpose of improvement analyzed by DMAIC is also to increase production process efficiency through reducing the percentage of defective cigarettes products.

4.2 Measure

a. Data collection on the number of defects
The production data of SKM 88 Golden Taste is presented in Table 4 which include the number of defective cigarettes for each category.

Table 4. SKM 88 Golden Taste Production Data

Date	Production	Defect			Total Defect
		Deflated	Porous	Non-sticky glue	
22/3	199.500	7.381	7.990	14	15.385
23/3	412.650	14.417	8.105	16	22.538
24/3	273.500	12.442	5.855	11	18.308
25/3	546.000	8.477	14.437	9	22.923
26/3	583.800	16.692	11.600	16	28.308
27/3	556.500	9.864	11.583	15	21.462
28/3	611.100	7.082	15.061	11	22.154
29/3	562.800	6.312	10.293	10	16.615
30/3	550.200	7.069	8.307	9	15.385
31/3	541.800	7.069	9.492	16	17.923
1/4	560.700	10.662	11.553	15	22.230
2/4	450.450	7.076	7.368	17	14.461
4/4	315.150	2.110	1.883	7	4.000
5/4	292.950	2.327	1.890	14	4.231
6/4	310.800	1.387	1.210	18	2.615
7/4	373.800	2.117	1.794	12	3.923
8/4	195.300	4.880	5.492	13	10.385
9/4	352.800	5.075	4.144	12	9.231
10/4	311.850	3.821	4.476	11	8.308
11/4	721.350	11.436	7.936	13	19.385
12/4	392.700	8.476	6.127	12	14.615
13/4	598.500	9.246	8.512	11	17.769
14/4	787.500	8.595	10.931	12	19.538
15/4	960.750	16.999	15.064	14	32.077
16/4	452.550	7.013	7.589	13	14.615
18/4	346.500	6.202	8.556	11	14.769
19/4	277.200	5.922	5.681	12	11.615
20/4	382.200	10.561	6.193	15	16.769
21/4	312.900	7.820	4.784	11	12.615
22/4	669.900	11.628	7.741	16	19.385
Total	13.903.200	241.510	231.647	380	473.537

Total production amount recorded during the period March 22, 2019 to April 22, 2019 was 13.903.200 cigarettes and 473.537 of them were defective products or around 34.06% from the total production. For a month of observation, this amount is substantially high which might have impact on company revenues.

b. P-chart analysis

Further step in measurement stage is presenting the data in the P-chart. The P-chart analysis for the production data measured previously is presented in Figure 1.

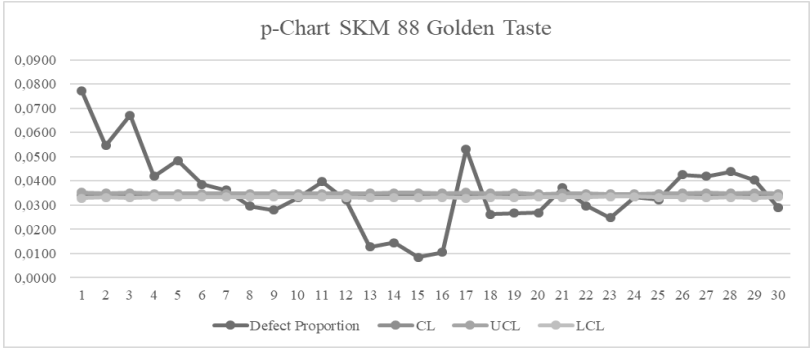

Figure 1. P-chart of SKM 88 Golden Taste

It can be seen in Figure 1, the fluctuations in the percentage of defective cigarettes product is considered high as it varies above and beyond the p. In other word, the defective product is uncontrollable. Therefore, it is an indicative that the company should maintain the production process as well as reduce the occurrence of defects in its production immediately.

c. Calculation of DPMO and Sigma Level values

The results of the DPMO-Sigma Level calculation show that the company's performance is at the level of 11,353 defects per one million opportunities (DPMO) or equivalent to 3.78 Sigma. The DPMO level of 11,353 illustrates that in the production process carried out by company, the probability of the occurrence of defective products on each production amounted to 11,353 occasions. While the Sigma Level of 3.78 can be used by company as a benchmark to improve production performance in order to achieve a higher Sigma Level. In addition, this value indicates that the company is in the industry average class with cost of poor quality of 25% to 40% of total revenue. This indicates that the company lost its revenue by 25% to 40% to repair defective products produced. This value is quite large, so the company needs to make improvements to the production of SKM 88 Golden Taste cigarettes.

4.3 Analyze

A. Pareto Diagram

The first step in the Analyze stage is developing the Pareto Diagram to show the number of defective cigarettes in detail for each type. This diagram can be presented in Figure 2.

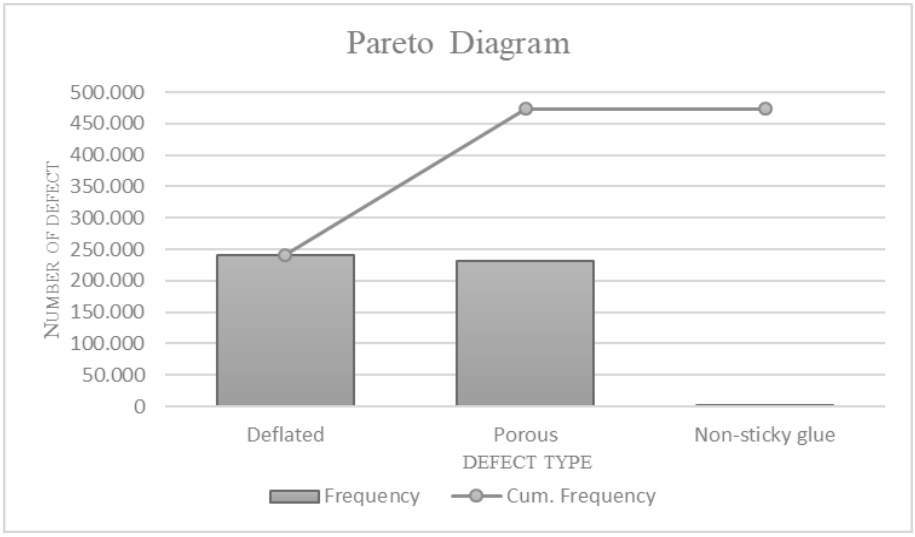

Figure 2. Pareto Diagram of SKM 88 Golden Taste

The figure 2 shows that the most dominant defect type during the observation period is "deflated" which is accounted for 241,510 cigarettes, followed by "porous" with 231,647 cigarettes, and then "non-sticky glue" with 380 cigarettes. This result suggests that the company may prioritize the improvement of quality control beginning with "deflated" type first which then followed by the rest of two types.

B. Cause and Effect Diagram

Cause and Effect Diagram is then presented after the Pareto Diagram which is employed to evaluate factors that cause problems, gaps, and mismatches for each defect type. Cause and Effect Diagram for each type of defect is shown by figures 3, 4, and 5 subsequently:

a. "Deflated"

Figure 3 shows that deflated cigarette is caused by several main factors including man, material, and machine. The dominant factors that cause type of defect is defined as "machine" and "material" factor.

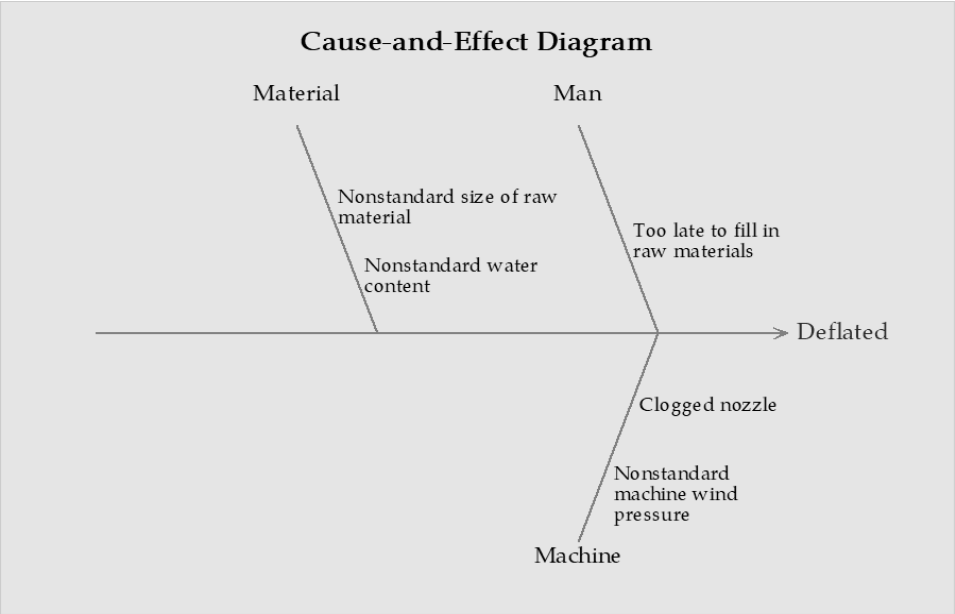

Figure 3. Cause and Effect Diagram for Deflated Cigarette

b. "Porous"

Figure 4 depicts that porous cigarette is caused by several main factors including man, material, machine, and method. The dominant factor for this type of defect is concluded as "material" factor.

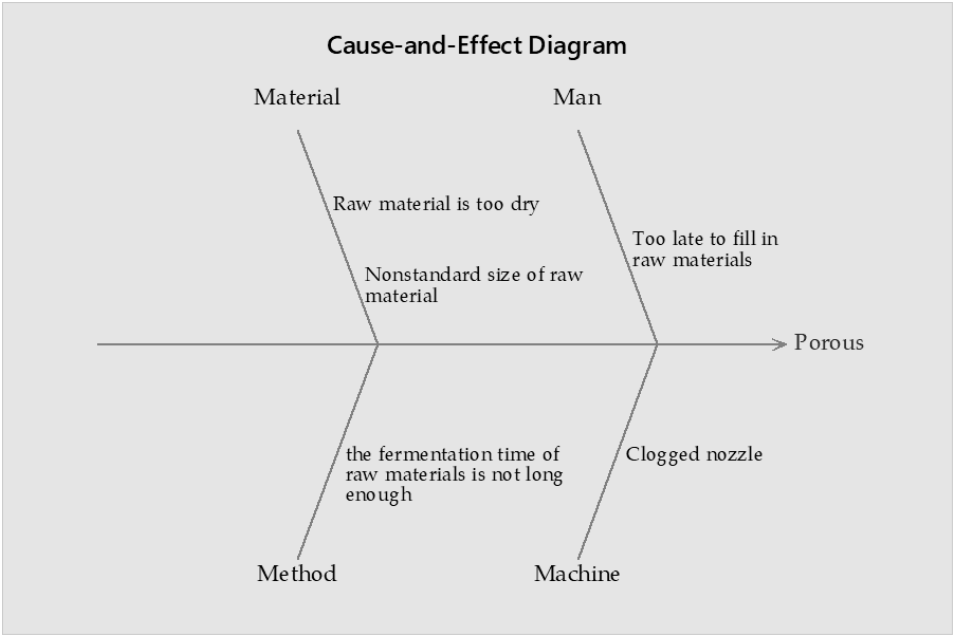

Figure 4. Cause and Effect Diagram for Porous Cigarette

c. "Non-sticky glue"

For the last type of defect, figure 5 shows that porous cigarette is caused by several main factors including man, material, machine, and method. The dominant factor of this type of defect is considered to be "machine" factor.

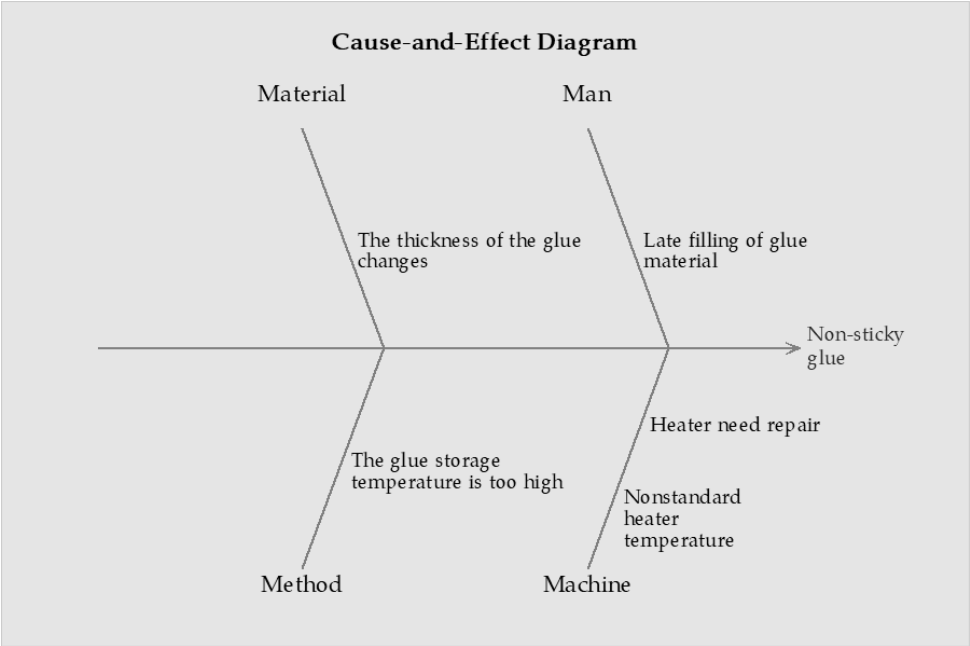

Figure 5. Cause and Effect Diagram for Non-sticky Glue Cigarette

4.4 Improve

In this stage, FMEA tools (Failure Modesand Effect Diagrams) is employed in order to identify all potential failures found on SKM 88 Golden Taste cigarettes. After that, it is necessary to prioritize them according to Risk Priority Number (RPN).

The complete results of FMEA analysis on each type of defect can be presented in Table 5 which shows the priority order of improvement plans for each type of defect. The priority sequence is obtained from the calculation of the Risk Priority Number (RPN) in the FMEA. In overall, it is suggested that the company may prioritize repairment and maintenance of production machine as it indicates to have the highest level of RPN.

Table 5. FMEA Result According to RPN

Defect Type	Priority No.	RPN	Improvement Plan
Deflated	1	448	Periodic checking of engine pressure to maintain the stability of wind pressure and the provision of wind pressure sensors.
	2	294	Check and clean the nozzle regularly.
Porous	1	441	Paying attention to the process of handling raw materials, especially on the size of raw materials chopped.
	2	294	Check and clean the nozzle regularly.
Non-sticky Glue	1	108	Periodic control of heater temperature.
	2	84	Adjust the temperature of the glue storage room.

4.5 Control

The last step in conducting DMAIC is Control stage which is aimed to standardize the suggested quality control process in previous stage. It is previously observed that "repairment and maintenance" is the most significant activities that important to be executed soon in order to avoid uncontrollable defects in the cigarettes production. Standardization of this activities is a follow-up of proposed improvements that have been prepared with FMEA. Details of the proposed improvements needs to be conducted by the company are as follows:

a. Scheduling machine maintenance periodically
b. Controlling the engine settings periodically
c. Scheduling the use of raw materials by taking into account the maximum age of tobacco storage
d. Improving compliance with the standards for handling raw materials
e. Improving compliance with standard fermentation of raw materials
f. Conduct training for employees

From the overall analysis, it implies that the Six Sigma with DMAIC method are able to help small business such as cigarettes company to identify their main problem in regards of quality control performance. The first objective of this study is answered properly by providing information on defective product percentage which account for 1% to 7% for each type of defect.

This study is also able to achieve the second objective by providing standardized quality improvement activity which is mainly focused on the repairment and maintenance of production facilities. For small business, it is inevitable that one of its main obstacles is making regular replacement by adding new and advanced facilities since it requires large amount of investment.

Improvement proposals from the previous analysis are summarized to compile a standardization process. Details of the proposed improvements are periodic engine maintenance scheduling, periodic control of engine settings, scheduling the use of raw materials by taking care of the tobacco's age, improving compliance with standards for handling raw materials, improving compliance with raw material fermentation standards, and conducting training towards employees. Furthermore, the company can consider this standardized proposed improvement as a reference for further improvements to increase its the Sigma Level which in turns will improve its overall profit.

This research is in line with research conducted by Dubey (2016) and Rochman (2017) conducted in the precast industry and musical instrument industry. Six Sigma analysis can also be applied to small business in this study.

5. Conclusion and Limitation

5.1 Conclusion

The conclusion that can be drawn in this research is that the production process of SKM 88 Golden Taste cigarettes for the period March 22, 2019 to April 22, 2019 is as many as 13.903.200 cigarettes. The amount of production in that period produced defective products totaling 473.537 cigarettes with defective categories such as deflated cigarettes, porous cigarettes, and non-sticky glue cigarettes. The details of the number of defects according to their type are deflated as many as 241.510 cigarettes, porous as many as 231.647 cigarettes, and non-sticky glue as many as 30 cigarettes. The performance of SKM 88 Golden Taste cigarettes in that period was at the level of 11.353 defects per one million opportunities (DPMO) or equivalent to 3,78 Sigma. This value indicates that CV SUUD is at the industry average level with cost of poor quality of 25% to 40% of total revenue.

5.2 Limitation

The limitations of this research are that the results of the analysis on the Improve stage

have not been able to be applied to the production process of CV SUUD so that the Control stage is only done by converting the proposed improvements into several standardization process preparation points.

6. Suggestion

Based on the analysis that has been done in this research, the suggestion that are can be given for the company is to refresh the standardization process. This can be done by doing this following suggestions:

a. Scheduling the engine maintenance.
b. Controlling of the engine settings periodically.
c. Scheduling the use of raw materials by taking care of the tobacco's age.
d. Improving compliance with standards for handling raw materials.
e. Improving compliance with raw material fermentation standards.
f. Conducting training towards employees.

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