SIX SIGMA DMAIC PRACTICE IN CIGARETTE PRODUCTION PROCESS: CHALLENGES AND OPPORTUNITY

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SIX SIGMA DMAIC PRACTICE IN CIGARETTE PRODUCTION PROCESS: CHALLENGES AND OPPORTUNITY

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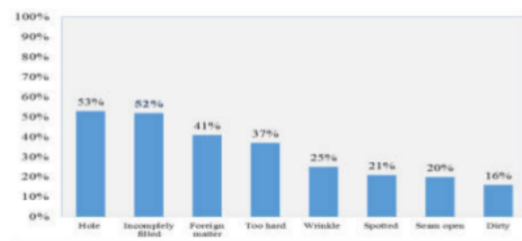
Abstract—The purpose of this paper is to explore the challenge of six sigma implementation to improve the quality of hand clove cigarette products. Systematic investigations are carried out to identify defects. The analytical tool used is SIPOC (Supplier Input Process Output Customer), Pareto analysis and Fishbone diagram. This is a qualitative exploratory study, a single case study research to demonstrate the use of Six sigma, DMAIC and the challenges in its application. Case study analysis shows that there are three defects that occur most in the cigarette production process, namely wrinkle, dirty and incomplety filled. Further analysis shows that incompletely filled defects are critical defects that often occur. After a process improvement has been done, the results are a decrease of 38% defect per million opportunity or from 4,474 to 2,777. The results showed that the use of Six Sigma DMAIC provides an opportunity for companies to reduce defects and produce savings in production costs, increase employee creativity in the production department in reducing the number of defects in the production process. Contribution of this study is the implementation of Six Sigma and DMAIC in a specific case for making hand-rolled cigarette (non machice) in Indonesia. Original values are also obtained by finding improvements to production tools to reduce incompletely filled defects which are critical defects that often occur.

Keywords—Six Sigma, DMAIC, Defect, Critical to Quality.

I. INTRODUCTION

Cigarette products are divided into 3 categories, namely: machine-made clove cigarettes, hand-rolled clove cigarettes and machine-made white cigarettes. Sales of hand-rolled kretek cigarettes since 2012 have decreased. The decline in sales of hand-rolled kretek products is a serious concern because hand-rolled clove cigarettes involve a very large number of workers. According to data from the Directorate General of Customs and Excise (2016), the hand-rolled cigarette industry involves 291,824 people and is a labor intensive industry. The decline in cigarette industry growth was caused by external factors and internal factors. External factors such as: regulation of cigarette restrictions issued by central and regional governments, increases in cigarette excise every year, increased public awareness of health, and anti-smoking campaignsInternal factors include decreasing the quality of cigarettes, especially hand-rolled clove cigarettes. This study focuses on internal factors, improving the quality of hand-rolled clove cigarettes through decreasing defects in the production process.



(Source: ICT 2016)

Fig 1. Survey of Customer Dissatisfaction with Defects

Figure-1 shows the results of a survey of customer dissatisfaction with a number of defects found. There are three defects that most affect customer satisfaction, namely holes, incompletely filled and foreign matter. The cigarette quality index is monitored every day by taking samples and comparing them to standard cigarettes.

The research was conducted in one of the third partly operations to produce one of the cigarette brands that has been widely known by the society. The purpose of this study is first, to identify the types of critical defects that occur based on the frequency of occurrence and the priority of hand-rolled kretek consumers This identification is done by using Pareto analysis and SIPOC (Supplier Inputs Processes Output CustomersSecond, identifying the root causes that cause critical defects by using a fish-bone diagram (cause and effect diagram). Third, finding a proposal for improvement and measuring the impact of improving the decrease in critical defect in the hand clove cigarette product process The practical implications which are also the benefits of this research are as a guide and input for practitioners in making decisions especially to reduce critical defects.

II. THEORETICAL BACKGROUND

A. Six Sigma DMAIC

Six sigma as a philosophy seeks to measure current performance and determine how desired or optimum performance can be achieved. (D. A. Desai, Antony, & Patel, 2012). Six Sigma as a method was introduced within the past 30 years. It quickly rose in prominence in the manufacturing, financial, retail, and service sectors (LeMahieu, Nordstrum, & Cudney, 2017). Six Sigma approach is gradually being adopted by organizations all over the globe in an attempt to increase market share, bring down production costs, increasing process yields through reduction of waste and scrap thereby increase profits by improving the quality of their products and services.(Sharma & Chetiya, 2012). Development and implementation of an effective quality strategy is a critical factor in long-term business success. Six Sigma is a disciplined, project-oriented, statistically based approach for reducing variability, removing defects and eliminating waste from products, processes and transactions. (Gijo, Antony, Kumar, McAdam, & Hernandez, 2014). Implementing Lean Six Sigma variables in all Jordanian Pharmaceutical Manufacturing organizations can improve their business performance. (Alkunsol, Sharabati, AlSalhi, & El-Tamimi, 2019).

Six Sigma DMAIC stage, the most widely used concept in improving the quality of a product or service. Implementation of Six Sigma, Six Sigma has 5 stages abbreviated as DMAIC (Define, Measure, Analyze and Control). Define, aims to identify the purpose and scope of the improvement project. One of the most important things at the define stage is determining critical to quality, because critical to quality is one of the factors that most determines customer satisfaction. Measure, is the stage of measuring the amount of deviation that occurs from a defect that you want to repair. At this stage the measurement of defect per million oppurtunity (DPMO) is carried out. Analyze, aims to investigate the root causes of a deviation or defect that occurs. Tools that are often used at this stage are cause and effect diagrams. Improve, aimed at finding remedial solutions that can reduce the number of defects that occur. This stage uses existing Six Sigma applications such as: Jidoka, Poka Yoke and others. Control, is the stage of monitoring the impact of improvements that have been made and ensuring the sustainability of the improvement process that has been carried out.

Six Sigma is a holistic approach to achieving near perfection, expressed in terms of no more than 3.4 errors per million opportunities.(D. Desai & Prajapati, 2017).

B. Research Method

This research is an exploratory study using a case study method. The case study approach can describe specific events that occur in a company. (Zikmund, et al, 2010). The research was conducted in the process of hand-rolled clove cigarettes from third partners from one of the largest cigarette companies in Indonesia. The analysis was carried out using the Six Sigma DMAIC. To do this, the team uses a series of Six Sigma tools which are called common tools in the Six Sigma toolkit. This study involved employees and parties involved in the process of producing hand-rolled clove cigarettes. and brainstorming to identify the root causes that caused high defects in incompletely filled. Brainstroming was attended by 12 people, including 2 scissors workers, 4 foremen, 3 supervisors, 1 production manager, 1 operational manager and researchers act as facilitators.

III. ANALYSIS AND RESULT

The researcher and the company team identified the forms of defects that occur in the production process.

A. Define Stage

Define stage identifies critical to quality (CTQ), which is done through a comparison of the most influential defects on customer satisfaction with the findings of defects that occur in the production process. There are 3 defects that most influence customer dissatisfaction, namely holes, incompletely filled and foreign matter.

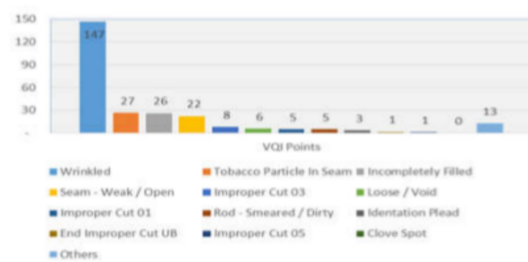


Fig 2. Achievement of Quality Index per Defect 2016

Based on the data from the company, information is obtained about the quality index as seen in figure-2. There are three most defects that occur in the production process, namely wrinkle, dirty and incomplety filled. When compared to customer dissatisfaction surveys of defects, it can be seen that incompletely filled defects are critical defects that often occur in the production process.

B. Measure Stage

The number of samples taken for examination of the quality of hand clove cigarettes was 28,608 cigarettes. From the total sample, it was found that 128 cigarettes have incompletely filled defects. Calculations using the DPMO formula (Defects per Million Opportunities), DPMO = (D / (U x O)) x 1,000,000. D:Total Defect; U: Number of Units. O: Amount of opportunities that will result in incompletely filled defects. In the production process, the incompletely filled defect only occurs when the cigarette is rolled so that the number of opportunities resulting in incompletely filled defects is 1. The results of the DPMO calculation defect incompletely filled in are:

DPMO = (D / (U x O)) x 1.000.000
DPMO = (128 / (28608 x 1)) x 1.000.000
DPMO = 4.474

DPMO on incompletely filled defect of 4,474 shows that it has not reached Six Sigma with DPMO of 3.4. Researchers see that there is still room for improvement to reduce DPMO to defect incompletely filled.

C. Analize Stage

In the analyze stage, the researcher and the production team of the company identify the causes of incompletely filled defects. The researcher uses the SIPOC chart to describe the flow process and the fishbone diagram in identifying root causes. The results of the investigation showed that defect incomplety filled occurred when workers carried out the process of rolling cigarettes in the grinding process & scissors.There are four of root cause of the problem, 1. Worker, 2. Equipment of mill tool, 3. work method and 4. work environment.

The results of the investigation showed that defect incomplety filled occurred when workers carried out the process of rolling cigarettes in the grinding process & scissors. Milled workers have difficulty controlling tobacco use. The amount of usage is determined based solely on the subjective estimates of the workers, there are no definite provisions. When workers see a small amount of tobacco remaining while the amount of cigarettes that must be produced is still large, milled workers tend to reduce the amount of tobacco in the milling process and cause the weight of cigarettes to be mild.

Equipments of mill tools indicate that the wider size of the mill mouth makes workers more likely to fill tobacco so that the resulting cigarette is heavier. At the beginning of the process the milling workers tend to use more tobacco than the standard while the amount of cigarettes that must be produced has been determined at the beginning of the production process so that at the end of the production process, the weight of cigarettes tends to be mild which has the potential to be incompletely filled.

Work mehod shows that distribution of tobacco at the same mouth of the mill between the burn end and the suction tip while the diameter of the two ends of the cigarette is not the same. The amount of tobacco is not proportional to the diameter of the two ends of the cigarette, this can cause an incompletely filled defect

Work Environment indicate that the water content of tobacco is influenced by the water content in the air in the production area, this is due to the hydroscopic nature of tobacco where tobacco easily absorbs water vapor in the air. When tobacco has a high water content the ability to fill space becomes low and causes the cigarette to be less dense and potentially an incompletely filled defect.

D. Improve Stage

At this stage improvement proposals are formulated to reduce incompletely filled defects. The researcher and the team brainstormed again to formulate suggestions for improvement to reduce incompletely filled defects

TABLE 1. RECOMMENDATIONS FOR IMPROVEMENT

No	Root cause	Improvement	Impact
1	Workers have difficulty controlling tobacco use throughout the grinding process	1. Making indicators of tobacco use in mini silos	1.Workers can compare the use of tobacco to the remaining cigarette paper as a production target
2	Workers do not do tobacco flattening at the mill's mouth	2A. Make a tool to flatten tobacco in the mouth of the mill 2B. Flatten tobacco using thumb	2.Tobacco will be distributed evenly along the cigarette stem
3	The width of the mill mouth exceeds the standard	3.Standardize the width of the mill mouth according to the standard	3. Filling the amount of tobacco will be more stable according to the weight of the standard
4	The division of the amount of tobacco in the milled mouth is the same even though the diameter between the burn tip and the suction tip is not the same.	4.Make a guideline for the distribution of tobacco with a proportion of 4: 3 using 4 fingers and 3 fingers	4.The amount of tobacco at the end of the burn will be slightly more than the suction tip
5	The water content in the production process is high	4.Stabilize air moisture by using air conditioning	5.Tobacco ability to fill the room according to specifications

Before implementing the proposed improvements, the researcher and the team conduct an initial analysis of the effectiveness of each proposed improvement seen from the effort to be made and the impact to be obtained.

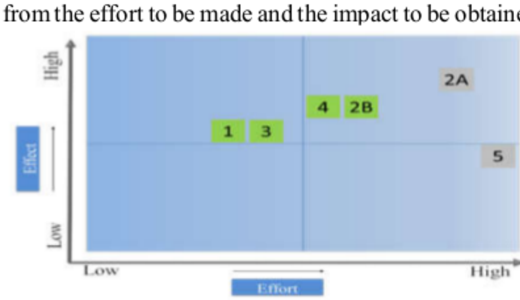


Fig 3. Effort & Effect Analysis

Figure-3 shows the results of the analysis that the proposed improvement is 1,3,4, and 2B requires a medium effort and provides a medium impact to reduce incompletely filled defects. Researchers and ordinary teams such as procuring air conditioning and changing the mill are much different from the previous design.

E. Control Stage

The researcher and the team conducted a pilot project to implement 4 proposed improvements in group 1 consisting of 36 milled workers. The monitoring process is carried out for 15 working days.

Fig 4. Control Chart of Incompletely Filled Defects Number

The number of samples taken for checking the quality of cigarettes during the monitoring process was 1,440 cigarettes. The number of incompletely filled defects during the monitoring process is 2 cigarettes. By using the DPMO formula (Defects per Million Opportunities). DPMO = (D / (U x O)) x 1,000,000.

Then DPMO defects incompletely filled or loose after implementing 4 proposed improvements:

DPMO = (D / (U x O)) x 1.000.000
DPMO = (4 / (1440 x 1)) x 1.000.000
DPMO = 2.777

When compared with the previous DPMO defect of 4,474 then DPMO after the pilot project has decreased by 38% or locked down from 4,474 to 2,777. This shows that the implementation of 4 proposed improvements has a positive impact in reducing the incompletely filled defect in the cigarette production process.

IV.CONCLUSION

The root of the problem that causes an incomplely filled defect in the cigarette production process is, (1) Milled workers have difficulty controlling tobacco use. (2) Workers do not do tobacco flattening along the mill mouth. (3) The size of the mouth of the mill is wider than the standard so that workers tend to fill the mill mouth with more tobacco. (4) The distribution of tobacco in the mill mouth is as much on the burnt end and the suction tip of the cigarette while the diameter of the two cigarette ends is not the same. (5) The level of tobacco water is too high so that the ability to fill space becomes low and causes the cigarette to be less dense. Implementation of 4 remedial solutions with the Poka Yoke principle on a pilot project can reduce defects per million opportunities incomplely filled by 38% from 4,474 to 2,777

A. Managerial implication

Implementation challenges are highly related to personnel ability, so that it is important to choose the right staff and motivate them to undertake changes in the right way.(Cheng, 2018). This research can be used as a practical guideline especially for production leaders and also quality assurance that are developing improvement projects in the process business of both manufacturing and in the service industry to improve the quality and productivity and competitiveness.The implementation of Six Sigma DMAIC also found several obstacles in sharing knowledge, further research can be done with the topic of knowledge management.

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