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# Quality Improvement of SKT Cigarette Products (A Case Study)

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**ABSTRACT**

Product quality is a feature that can fulfil the desires and needs of consumers so that consumers can feel happy and satisfied with the product. One of the products currently often used is cigarettes. Cigarettes are processed tobacco from the Nicotiana tabacum, Nicotiana rustica, and nicotine plants. The cigarette tobacco will be dried first and then put onto cigarette paper. There are two types of cigarettes: SKM (machine-made kretek cigarettes) and SKT (hand-rolled kretek cigarettes). SKT requires high creativity, so the quality control process must be considered. PT X is one of the cigarette factories domiciled in Malang City, and the percentage of defective SKT cigarettes at PT X is high (11,72%), exceeding the target. The expected target percentage of SKT cigarette defects is less than 10%. The stages and tools used to solve this problem are DMAIC, Pareto Diagrams, and 5 Why's Analysis. Based on the Pareto diagram, five primary defects must be corrected immediately: loose cigarettes, lack of glue, sangan defect, not symmetrical embroidered paper, and not precision diameters. The root causes of each type of smoking defect can be analysed using the 5 Why's Analysis tools and proven by data. The improvement implementation was carried out by changing work methods, work tools, and workers' bad habits. The implementation results showed that the target percentage of defects in SKT cigarettes decreased to 9.47%. PT X applies SOP, checklists for improvement plans, and defect data recap to maintain their performance.

***Keywords:*** quality control; DMAIC; SKT cigarettes

## 1. Introduction

Product quality is the feature of a product that can fulfill consumers' desires and needs so that consumers can feel happy and satisfied with the product [1]. Apart from product quality, quality characteristics are also crucial in product manufacturing, where product characteristics must be considered to meet consumer needs [2]. One of the products currently frequently used is cigarettes. Cigarettes are processed tobacco from the Nicotiana tabacum, Nicotiana rustica, and nicotine plants. The tobacco will be dried and put onto cigarette paper [3]. A survey conducted by WHO stated that around 85-90% of smokers in Indonesia use kretek cigarettes [4]. There are two types of kretek cigarettes: SKM (machine-made kretek cigarettes) and SKT (hand-rolled kretek cigarettes). SKT requires high creativity, so the quality control process must be considered. The SKT industry remains labor-intensive and relies heavily on manual production processes. Unlike SKM, SKT manufacturing faces unique challenges, particularly in maintaining product consistency. One of the significant issues

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in this industry is the high defect rate, which can impact production efficiency, operational costs, and consumer satisfaction.

PT X is a cigarette factory domiciled in Malang City, East Java, since 1984. This company produces two types of cigarettes, namely SKM and SKT. The SKM production process can be done using machines, which is different from SKT, where human workers carry out the production process. The SKT cigarette production process requires skill and patience in manufacturing, so the potential for defective products can be more significant. A defective product is a product that is not fatally damaged but can still be repaired to become a complete finished product [5]. PT X knows that the competition in the world of trade is increasing as time goes by. The Global Adult Tobacco Survey reported that there was a significant increase in e-cigarette users from 0.3% in 2011 to 3% in 2021, equivalent to 6.2 million adults. The increase in e-cigarette users has made the sales competition of cigarette factories, especially kretek cigarette factories in Indonesia, increasingly tight, so it is essential to implement strategies that help increase sales. Increasing sales can be done by improving product quality, significantly influencing a product's sales level [6].

Therefore, PT X must pay attention to and improve the quality of its products, especially in the production of SKT. PT X must also pay attention to consumers' desires to improve the quality of cigarettes. Product quality control is the most critical aspect of improving product quality. Product quality control is an essential aspect of the industrial sector, where companies must ensure that the goods they produce meet predetermined standards. This will create profits for companies such as PT. X to get a good name for the products they have produced. Products that are of good quality will be able to survive and compete with other competitors. Quality control is an effort to maintain the quality of production results according to the standards set by the company [7]. Similar research was conducted in a cigarette factory in Bondowoso Regency. The research used a qualitative descriptive method, namely by using the Strength-Weakness-Opportunities-Threats (SWOT) analysis and the Analytical Hierarchy Process (AHP) [8]. Another research discusses implementing the Six Sigma method with DMAIC (Define, Measure, Analyze, Improve, and Control) steps to reduce the number of defective products reaching 800,000 cigarettes in one month [9].

Based on data from the company (PT X), the average percentage rate of defective SKT cigarette products is 11.72%. Based on these results, product quality control on SKT cigarettes is relatively low, so the percentage of defective products is quite high. One of the causes of the high percentage of defective products is that human workers produce the SKT production process. PT X has set a target for the percentage of defective products in SKT cigarettes to fall below 10%.

Defects in cigarette sticks are an obstacle to profits for the company. A high level of cigarette defects will result in a decrease in consumer purchasing power, so this can reduce the company's sales level. Therefore, this research was carried out to reduce the percentage level of defective products in SKT cigarettes by finding the root cause of the problem and looking for appropriate alternative improvements so that the percentage level of defective products can decrease according to the company's target. The production process of SKT cigarettes usually takes longer and requires manual skills. Therefore, research is needed in various SKT cigarette industries to find the proper working method to minimize production defects. Previous research on cigarette production has primarily focused on regulatory aspects, health implications, and consumer behavior, while studies specifically examining product defects in SKT manufacturing remain limited. Some studies have explored the influence of raw materials, rolling techniques, and workplace conditions on product quality. However, research gaps still exist in areas such as early defect detection methods, optimization of manual processes, and more effective quality control strategies.

Additionally, changes in regulations, shifting consumer preferences, and technology adoption in labor-intensive industries present new challenges that require further investigation. Therefore, more

in-depth research is needed to identify the root causes of product defects in the SKT industry and to develop strategies for improving production efficiency and product quality. Addressing these issues is crucial for the industry's sustainability, worker well-being, and consumer satisfaction.

## 2. Methodology

DMAIC procedure is used to solve the problem. DMAIC is a stage that can be used to maintain, improve, and maintain product quality, especially to achieve an increase in quality to zero defects [10]. The stages in this research were carried out up to the control stage.

The first stage of DMAIC is the define stage, where at this stage, the problems that are occurring at the PT company are identified. X. This research will solve the problem of the high number of defective products produced in the SKT cigarette production process. Identification of such problems requires quality characteristics and the type of defect. The process of identifying problems can be done through direct observation and also by collecting information from local colleagues.

The second stage is the measuring stage, where at this stage, data collection and processing are carried out to determine defects that often occur in SKT cigarette products. The data required is current disability data with collection times in the morning, afternoon, and evening, past data on defective products, data on length of work, and worker age data. Past data can be obtained by asking the SKT cigarette production department. Data processing is carried out to determine which defects have the highest priority and which alternative improvements should be given. One method used to determine the level of disability is the Pareto diagram. The Pareto diagram is a tool in the form of a bar graph that identifies various problems based on the order of the number of events [11].

The third stage is the analysis stage, where the search for the root causes of the defective products produced is carried out by analyzing the data that has been collected [12]. The tools used to determine the defects' root causes are five whys analysis along with supporting data. The definition of five whys analysis is a tool often used to research and find the causes of problems down to their roots [13].

The fourth stage is the improvement stage, where an improvement plan is carried out to improve product quality [14]. Alternative suggestions for improvement can be tested first with several working staff to see the level of success. If the implementation results are satisfactory for the company, then alternative suggestions for improvement can be implemented for all workers.

The final stage is the control stage, where efforts are made to maintain the decline in defective products so they do not return to their original condition. This effort can be carried out in various ways, such as creating work SOPs, routinely checking equipment, etc.

## 3. Results

The results and discussion chapters will explain each stage of DMAIC in detail. The first stage starts from the define or problem identification stage. The final stage is the control stage or efforts to maintain conditions after implementing improvements.

### *3.1 Define*

Problems currently occurring at PT X are the high level of defective SKT cigarette products. PT X wants the resulting defect rate to be immediately reduced to the target, below 10%. SKT cigarette stems have eight types of defects (Table 1). Measuring methods are used for eight types of defects: visual, tactile, and measuring instruments. Quality control from PT X can be done by random sampling

per multiple of 20 cigarettes. Defected cigarettes will be sorted again, where the amber (cigarette paper) can be thrown away, and the sangan (cigarette filling) can be reused. PT X hopes that defective items can be reduced so that the level of defects in the future decreases below the target.

**Table 1**
Quality characteristics and types of defects for SKT product

| Quality Characteristic | Defect | Measuring method | Potential process |
|---|---|---|---|
| Symmetry of ambry paper | Ambry paper is not symmetrical | Visually | Ambry paper placement |
| Ambry paper should not be open | Lack of glue | Visually | Glueing |
| Clean cigarettes | Glue spills out | Visually | Glueing |
| | Stains on ambry paper | Visually | Glueing |
| Nice cigarette shape | Deflated cigarettes | Visually and tactile | Sangan filling |
| | Diameter does not meet specifications | Visually and using measurement tool | Sangan filling |
| | Lack of sangan on the top and bottom area | Visually | Sangan filling |
| Neat tobacco cuttings | Sangan came out of cigarettes | Visually | Cutting |

*3.2 Measure*

The next stage is the measuring stage. The initial step that must be taken at the measure stage is to collect data related to the problem to be resolved. The data needed in the measuring stage are the number and type of defect data, number of defective products, operator working hours, and worker age. This data was obtained by making direct observations and asking the PT's quality control department. X. The data that has been collected can be used to find out which possibilities can influence defective products produced at PT X (Table 2).

**Table 2**
Defective product

| Month | Sample | Number of Defective Product | Percentage |
|---|---|---|---|
| July | 53,280 | 6,405 | 12.02% |
| August | 61,120 | 7,424 | 12.15% |
| September | 46,700 | 5,262 | 11.27% |
| October | 49,120 | 5,878 | 11.97% |
| November | 41,900 | 4,746 | 11.33% |
| December | 43,500 | 4,932 | 11.34% |
| Total | 295,620 | 34,647 | 11.72% |

In the last 6 months, the percentage of defective cigarettes reached 11.72%. There are not the same number of cigarette samples taken every month. This is because quality control staff take samples by random sampling. The highest percentage of defective cigarettes was in August, reaching 12.15%. Apart from the percentage of defective products, defect data is also very important in this research (Table 3). Defect data was collected from 35 SKT cigarette workers for six working days. Data collection starts at 08.00 am, 11.00 am, and 1.30 pm. The number of cigarette samples observed from each worker was 60 cigarettes. Each cigarette can contain zero, one, or more defects.

**Table 3**
Defect data

| No | Defect Type | Total Defect | Percentage |
|---|---|---|---|
| 1 | Lack of glue | 359 | 2.85% |
| 2 | Ambry paper is not symmetrical | 210 | 1.67% |
| 3 | Deflated cigarettes | 503 | 3.99% |
| 4 | Diameter does not meet specifications | 206 | 1.63% |
| 5 | Glue spills out | 125 | 0.99% |
| 6 | Lack of sangan on the top and bottom area | 158 | 1.25% |
| 7 | Sangan came out of cigarettes | 279 | 2.21% |
| 8 | Stains on ambry paper | 149 | 1.18% |

The highest defect is deflated cigarettes, which is 3.99%. The defect data can be used to create a Pareto diagram. The Pareto diagram itself is one of the tools used to make it easier to prioritize defects that must be followed up immediately. Pareto Diagram has 80/20 principle, which means that 80% of the effects arise from 20% of the causes [[15]]. Based on the Pareto diagram (Figure 1), the highest percentage is for deflated cigarettes, reaching 25.3%, and the lowest is for glue spills out, reaching 6.3%. According to the 80/20 principle, the first five types of defects are priority improvements because the total percentage reaches 78.3% or nearly 80%. The defects that must be followed up immediately are deflated cigarettes, lack of glue, sangan coming out from cigarettes, the ambry paper not symmetrical, and diameters not meeting specification.

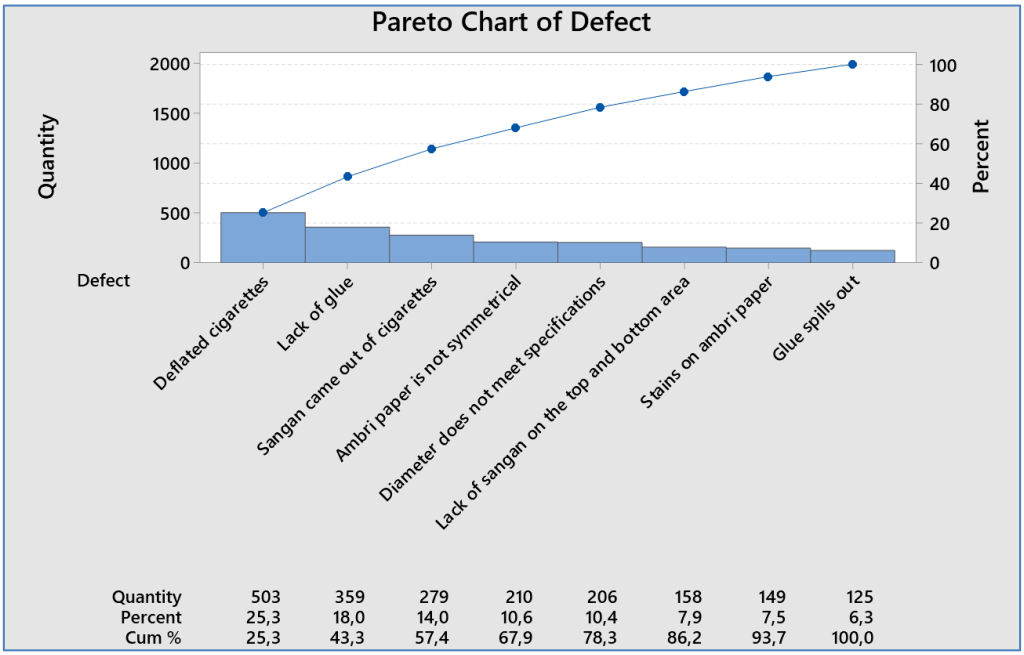


**Fig. 1.** Pareto chart

### *3.3 Analyze*

The next stage is the analysis stage, where further analysis of the root causes of each type of defect is carried out. The tool used is the 5 Why's Analysis and supporting data. At this analysis stage, a search for the root causes of the five main types of defects is carried out.

**Table 4**
Five why analysis of delated cigarette

| Problem | Why 1 | Why 2 | Why 3 | Why 4 | Why 5 |
|---|---|---|---|---|---|
| Deflated Cigarettes | Uneven sangan filling | Workers do not pay attention when placing the sangan | Workers are not focused and talking | | |
| | | | Workers are in a hurry during the work process (especially in the afternoon) | Workers have not reached daily target | |
| | Lack of sangan filling | Number of sangan taken is not the same | There are no measuring tools to take sangan | | |
| | | Workers fill cigarettes only by estimation | | | |
| | Sangan's humidity levels have decreased | Worker took sangan out of its place | Workers are in a hurry | | |
| | Gunungan on the machine is uneven | Sangan goes into the mori cloth | Workers do not clean the sangan inside the mori cloth regularly | Workers are in a hurry | Workers have not reached daily target |
| | | | | There is no provision for cleaning the premises in one working day | |

There are four leading causes of deflated cigarettes, each with root causes (Table 4). The first cause of flat cigarettes is the uneven filling of the sangan. The cause of the uneven filling of the sangan is that workers do not pay attention when placing the sangan. Two root causes of workers not paying attention when placing the sangan exist. They are not focused and talking to other colleagues, and workers are in a hurry in the work process (especially in the afternoon). Observation data have proved these root causes. Observations were made on two people for three days of observation with the same observation hours. Morning observation hours were conducted at 09.00 am, and afternoon observation hours were carried out at 1.00 pm. The collection of evidence of this data was done by observing workers when making 100 cigarettes without a break. Throughout the observation, workers will not entirely focus on the machine, but workers can talk to other colleagues. Observations of the 100 cigarettes will take a test sample of 1 bundle or equivalent to 20 cigarettes. Based on this data, the production process in the morning is more focused than during the day. Defective products produced in the morning are much smaller when compared to the afternoon. Therefore, if workers are not focused during production, the number of defective products produced will also increase. The amount of production between morning and evening is very different during the 6 days of observation. Defective products produced between morning and evening are also very different. The morning production process is slower than in the afternoon, so workers must close the target quickly in the afternoon. The slowness in the morning production process can be seen from the number of products produced in the morning, which is much lower than in the afternoon. The amount of production can affect the number of defective products produced. The cause of workers rushing is that there are still many targets that have not been met. Based on the data taken, production in the morning produces a low number of defective products. Meanwhile, cigarette production in the afternoon produces many more defective products.

The second cause of flat cigarettes is the insufficient filling of the sangan. The cause of insufficient filling of the sangan is that the grip of the sangan taken by the worker does not necessarily have the same weight size, and the worker also fills the sangan based on the estimation. Both causes have the same root problem: in the production process, there is no measuring tool to take the sangan according to the weight size set by the company. Workers each produce 20 cigarettes with uneven weight. The weight of the 20 cigarettes varies greatly; some are the lightest at 31.5 grams, and some are the heaviest at 35.4 grams. The standard used for the minimum weight of the company is 32 grams per 20 cigarettes. Data verification was carried out for three working days. Observations were also conducted at 09.00 am and 2.30 pm. Three bundles of 30 cigarettes do not meet the company's minimum weight standards.

The third cause of flat cigarettes is that the humidity level has significantly decreased. The cause of the decrease in humidity level is that workers remove sangan from their places. By company standards, the sangan has been provided with a place on each worker's desk, but some workers remove the sangan from their place. The root of the problem is that workers are in a hurry because many targets have not been met. Workers removing or not removing cigarettes from their place can affect the type of defect in deflated cigarettes. Data verification was carried out for five working days, during which observation occurred at 1.00 pm. The data proves that every day, each worker takes one bundle of sangan. By removing the sangan from its place, workers can affect the humidity level of the sangan so that the cigarettes produced can be defective products.

The last cause of deflated cigarettes is uneven gunungan on the cigarette rolling machine. It is because sangan enters the mori cloth. The production process is so fast that sangan can get stuck between the mori cloth and the gunungan of machines. If left for a long time, the sangan can affect the cigarette products produced. The root cause of the sangan entering the mori cloth is that workers do not clean the sangan that enters the mori cloth regularly. There are two root causes of this problem: workers are in a hurry because there are still many targets that have not been met, and there are also no provisions for how many times to clean in one working day. The workers' targets are still lacking, making the workers forget to clean the sangan that enters the mori cloth. Data verification was conducted for five working days, where the observation was conducted in the morning at 09.00 WIB. The data verification took four bundles of cigarettes, or 80 cigarettes daily, in each session. The data collection consisted of 4 sessions, starting at 09.00 am and then every multiple of 30 minutes at 09.30 am, 10.00 am, and the last at 10.30 am. After cleaning the mori cloth, the number of defective products produced was still relatively small. Meanwhile, after one hour of use, the number of defective products produced increased.

For lack of glue defects, three leading causes cause cigarettes to experience a lack of glue on the top, middle, and bottom. The first cause is that there is glue that has hardened. There are two causes of hardened glue: the glue is placed in an open place on each worker's table, and the glue place uses a tablespoon as a glue spoon so the glue lid cannot close properly. There are two root problems of this cause: there is no glue place used so that it is not directly exposed to air on each worker's table, and there is also no glue spoon that fits the size of the glue place. The glue left in an open place can be exposed to wind, dust, and so on, which can reduce the level of adhesiveness of the glue. Both of these root problems have been proven through observation. Observations were conducted for five working days, at 9.00 am and 12.30 pm. From the observation results, placing glue in an open place can affect the number of defective products, especially the remaining glue left to rest first. The tools used to take glue can also be changed so the lid can be closed properly. The second reason cigarettes lack glue is that workers do not apply enough glue to the brush paper. Workers do not apply enough glue to the ambry paper because they only apply glue once to a batch. Applying glue once to ambry paper could cause the glue to dry out in the middle of the work. The root of the problem is that

workers are in a hurry because there are still many targets that have not been met, and also, workers do not re-glue after rolling several cigarettes. Observations were carried out for five working days. From the observations, it can be concluded that if workers only apply glue to the ambry paper once, the number of defective products produced will increase when it is almost finished. The last cause of cigarettes lacking glue is that there is ambry paper that is not or is only slightly exposed to glue. The cause of ambry paper that is not or only slightly exposed to glue is that widening the ambry paper to be glued is not optimal. The widening of the ambry paper to be glued can affect the type of defect in cigarettes lacking glue. The widening of the ambry paper, which is not optimal, causes the amber paper to be exposed to little glue, so the level of the stickiness of the ambry paper will also decrease. The root of the problem is the amount of glued ambry paper is too much—types of Gluing at PT. X consists of 3 types: thin gluing, medium gluing, and thick gluing. Thin gluing is when workers glue with several ambry papers of ± 80 sheets. Medium gluing is when workers glue with several ambry papers of ± 120 sheets. Thick gluing is when workers glue with several ambry papers of ± 240 sheets, but this gluing is no longer applied because it can increase the number of defective products. From observations, the amount of ambry paper glued can affect the number of defective products produced.

Three leading causes cause the sangan to come out of the ambry paper. The first cause is the cigarette scissors setting. The root of the problem of the funny cigarette scissors setting is that there is still no routine scissors inspection schedule. The standard used by the company PT. X is to repair the scissors within a period of ± 6 months to 1 year once a check. The scissors available at the time of observation were scissors that had just been repaired, scissors 3 months after repair, scissors 5 months after repair, 8 months after repair, and 11 months after repair. One of the factors that causes the scissors to be broken is that the scissors often fall. The observation results showed that 5 months after repair, scissors had produced many defective products. The second cause of the sangan coming out of the ambry paper was that the cutting side of the cigarette scissors was not sharp. The cause of the cutting side of the cigarette scissors not being sharp was that the cigarette scissors used were not sharpened enough. The root of the problem of this cause was that there was still no routine scissors inspection schedule. The standard used by the company PT. X is to sharpen scissors every ± 3 months. The scissors available during observation were newly sharpened, 1 month after sharpening, and 3 months after. The observation results showed that the sharpness of the scissors can be affected even over months. The data showed that using scissors for ± 3 months can produce many defective products. The last cause of the sangan coming out of the ambry paper was that the workers cut the sangan less neatly. The root of the problem of workers cutting the sangan less neatly was that the workers were in a hurry to cut the sangan because they still had a lot of targets, especially in the afternoon. The workers' targets were still lacking, making the workers carry out the cutting process quickly, too.

Meanwhile, there are two main causes of asymmetrical ambry paper. The first cause is that the marking line on the calico is unclear or missing. The cause is that the worker did not thicken the line on the mori cloth, and the mori cloth was dirty or covered by the marking line. The root of the problem of dirty calico or covering the marking line is that the worker used a pencil to make the marking line. The observation results found that the number of defective products produced was minimal at the beginning of marking (morning). During the day, the number of defective products produced had increased. While observations in the afternoon, the number of defective products produced increased again. The last cause of asymmetrical ambry paper is that the worker placed the ambry paper imprecisely. The root of the problem of workers placing ambry paper imprecisely is that workers are in a hurry because there are still many targets that have not been met. The worker's target, which is still lacking, makes the worker carry out the production process quickly, too.

The upper and lower diameters do not meet specifications for two reasons. The first cause is inappropriate mold setting on the rolling machine. The cause of the mold setting on the rolling machine not being appropriate is that the setting can change after several uses. The root cause of this cause is that workers do not check the mold setting regularly. PT. X does not have a standard that requires workers to correct the mold setting every hour, but each worker knows when to correct the mold setting. The observations show that the mold setting on the rolling machine can affect the number of defective products produced, especially after 2 hours of use. The defective products produced increased drastically after 2 hours of using the rolling machine without paying attention to the mold setting again. Another cause is that senior workers ignore checking the mold setting. The last cause is that the sangan is filled unevenly. The cause of the uneven sangan filling is that workers do not pay attention when placing the sangan. Two root causes of workers not paying attention when placing the sangan: workers are not focused and talking to other colleagues, and workers are in a hurry in the work process (especially towards the afternoon).

All the root causes written are not just conjectures but are proven by supporting data. For example, data in Table 5 is proof of data regarding the influence of mall settings on the number of defective products produced. The supporting data is collected within five working days at the same collection time. From the results of these data, the mall settings produce a few defective products after repair. Using mall settings for up to 1.5 hours produces relatively few defective products (4 cigarettes). Meanwhile, after 2 hours of using the mall setting, it produced more than two times more defective products (10 cigarettes).

**Table 5**
The effect of mall settings on the number of defective products

| Day | After setting | | 30 minutes after setting | | 1.5 hours after setting | | 2 hours after setting | |
|---|---|---|---|---|---|---|---|---|
| | Sample | Number of defects | Sample | Number of defects | Sample | Number of defects | Sample | Number of defects |
| 1 | 20 | 0 | 20 | 0 | 20 | 1 | 20 | 3 |
| 2 | 20 | 1 | 20 | 2 | 20 | 0 | 20 | 2 |
| 3 | 20 | 0 | 20 | 1 | 20 | 2 | 20 | 2 |
| 4 | 20 | 0 | 20 | 0 | 20 | 0 | 20 | 1 |
| 5 | 20 | 1 | 20 | 0 | 20 | 1 | 20 | 2 |
| | Total | 2 | Total | 3 | Total | 4 | Total | 10 |

### *3.4 Improve*

The next stage is the improvement stage, where an improvement plan is made to overcome the root problems of defective cigarette products. The improvement plan that has been determined results from ongoing discussions with the company. The proposed design must consider several factors, such as effectiveness, cost, etc.

#### *3.4.1 Periodic observations*

Implementing supervisor workers carrying out regular observations can overcome defects in deflated cigarettes and the diameter problem. The root of the problem of these two types of disabilities is that workers rolling cigarettes are not focused and are also talking while working. The proposed improvement that can be given is to carry out observations, where workers who talk too much will be warned 3 times. If workers still violate, they will be given sanctions by reducing the daily production target by 500 cigarettes for 1 week. Reducing daily production targets can affect the salary you will receive.

### *3.4.2 Production target adjustment*

Implementation of production target adjustments can overcome the five main types of defects. The production targets of each worker are different. One of the right ways to divide the production target for each worker is to divide the target into two. The production target for each worker must be completed half the time before break time. The remaining production targets can be completed after the break.

### *3.4.3 Unscheduled inspection*

The implementation of unscheduled inspections can overcome the defect of deflated cigarettes. Several cigarette workers took out sangan from the place provided. The potential defect that can occur is that cigarette cigarettes experience evaporation until they dry out. Suggestions to overcome this problem include allowing supervisor workers to carry out unscheduled inspections to ensure that workers take the sangan from their place. Suppose a worker is found to have committed fraud and has violated it repeatedly. In that case, the worker will be punished by reducing the daily production target by 500 cigarettes for one week.

### *3.4.4 Gulungan cleaning*

Implementing gunungan cleaning can overcome deflated cigarettes. Cigarette workers often do not clean gunungan in the machine when production targets are still too high. Over time, this can cause sangan to slip between the mori cloth and the gunungan. If cleaning is rarely done, the surface of the mori cloth may become uneven. Recommendations for gunungan cleaning can be made every half hour. The decision to set a time limit is based on observational data.

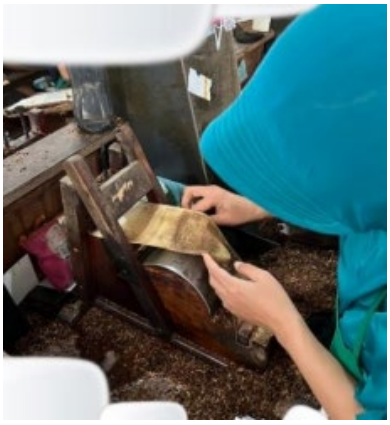

**Fig. 2.** Gunungan cleaning

### *3.4.5 Glue retrieval*

Implementing glue retrieval frequency can overcome the lack of glue defects. Workers originally collected glue once a day, where the worker had to be able to estimate how much glue was needed. Excess glue cannot be returned to its place because it has been contaminated with chemicals. Apart from that, taking glue once a day has the potential for the glue to dry quickly, especially after rest hours. Therefore, the correct suggestion for improvement is to change the method of taking glue from once to twice a day. First, pick up in the morning until before break time. The second pick-up is for after break time until after work.

### *3.4.6 Additional tools for placing glue spoons*

Additional tools to place the spoon outside the glue holder can overcome the lack of glue defects because the glue hardens. The glue container is shaped like a lunch box, and the spoon used to collect the glue is a tablespoon. A tablespoon handle that is too long can result in the glue area being unable to cover correctly. The suggestion is to provide tools like a paper base or a glass that is no longer used. The aim of adding tools is so that the glue area can be adequately closed after the worker takes the glue.

**Fig. 3.** Glue spoon base

### *3.4.7 Amount of ambry paper*

Rearrange the amount of ambry paper to be glued to overcome lacking glue defects. Gluing is divided into thin gluing of ± 80 sheets and medium gluing of ± 120 sheets. Workers who do moderate gluing can create more defects in cigarettes. Therefore, the suggestion for improvement is to determine the amount of gluing for all workers, which is thin gluing.

### *3.4.8 Checklist*

Applying checklists can overcome types of defects that sangan has come out of cigarette and diameter problems. Initially, the supervisor did not have data regarding scissor inspections or mall arrangements. This can result in increased losses due to the absence of inspections. Therefore, the appropriate improvement suggestion to overcome this problem is to create a checklist system related to scissors and mall settings.

**Fig. 4.** Checklist implementation

### *3.4.9 Marking lines*

Marking line implementation can overcome types of asymmetrical ambry paper defects. Initially, the worker made marks on the mori cloth using a pencil. The marks made by workers can fade over time as more cigarettes are produced. Therefore, the appropriate improvement suggestion to overcome this problem is to change the method of making marking lines using a black or light-colored ballpoint pen.

**Fig. 5.** Marking lines

### *3.4.10 Implementation*

Improvements will be implemented within six working days. Sampling after implementation of improvements was carried out on the same 35 workers as before. This sampling aims to compare data before and after the implementation of improvements. Based on the data above, implementation over six working days produced good results for PT X. The percentage of defective products during the six working days decreased to 9.47% (Table 6). Meanwhile, all five types of defects also decreased (Table 7). The most significant reduction in defects was deflated cigarettes and asymmetrical ambry paper.

**Table 6**
Number of defective products after implementation

| Number of samples | Number of good products | Number of defective products | Percentage |
|---|---|---|---|
| 12600 | 11407 | 1193 | 9.47% |

**Table 7**
Number of defects after implementation

| Defect | Before improvement | After improvement | Gap |
|---|---|---|---|
| Lack of glue | 2.85% | 2.28% | 0.57% |
| Ambry paper is not symmetrical | 1.67% | 0.57% | 1.10% |
| Deflated cigarettes | 3.99% | 2.22% | 1.77% |
| Diameter does not meet specifications | 1.63% | 1.38% | 0.25% |
| Sangan came out of cigarettes | 2.21% | 1.87% | 0.35% |

### *3.5 Control*

The final stage is the control stage, where PT X needs to maintain a decrease in the percentage of defective products. There are several ways to maintain the percentage of defective products, such as running a new Standard Operating Procedure (SOP), running a checklist for implementing the improvement plan once a month, and recapitulating defect data.

SOP is a written work procedure in physical form. The SOP has created a new work procedure related to the proposed improvement plan to be implemented. SOP will be created by quality control staff, and it will later need to be approved by the leadership of SKT cigarettes. The SOP the leader has approved will be distributed around the production field by attaching SOP sheets to the production walls. Besides reading work SOPs, supervisors or foremen can share the task of explaining updated work rules. Each supervisor or foreman can accompany ± 30 workers for one work week. Workers can read new work procedures around the SKT production field.

The proposed improvement plan has not yet been implemented 100% for SKT workers. If the proposed improvement plan has been fully implemented, the supervisor must carry out a checklist for periodically implementing the proposed improvement. The purpose of creating a checklist for implementing the improvement plan is to ensure that all SKT workers have implemented the improvement plan completely. The supervisor can carry out the checklist for implementing the improvement plan once a month at random times and days.

The defect data recap format is a template that PT X. can use to recap disability data. Initially, PT X did not recap defect data, so the company did not know the types of defects that produced the most defective products. Defect data templates can be taken from cigarette samples that undergo quality control. Company PT X can use this format to make finding the most significant number of defects easier. The defect data summary format can help PT X to see that the number of defects is classified as decreasing, stable, or could also increase.

## 4. Conclusion

PT X is a cigarette factory domiciled in Malang City. PT X expects the percentage of defective products to fall according to the target, below 10%. The percentage of defective SKT cigarette products at PT X is 11.72%. Based on the data, there are five highest defects: deflated cigarettes, lack of glue, sangan coming out of cigarettes, ambry paper not symmetrical, and Diameter not meeting specifications. Efforts to reduce the percentage of defects in SKT cigarettes can be made using the DMAIC procedure. Searching for the root of the problem in more detail can use the five-why analysis tool. The results of this analysis prove that several factors cause defects in SKT cigarettes, such as work methods, work aids, and bad habits of workers. Several improvement plans have been implemented to overcome existing problems. The improvement suggestions that have been approved were implemented on 35 workers for six working days to carry out trials. The results showed that the percentage of defective products decreased according to PT X's target, reaching 9.47%, and the most significant five defects decreased. The reduction in the percentage of defective products is very significant for PT X. Therefore, PT X needs to maintain the current conditions by running a new SOP, checking the implementation of improvement regularly (once a month), and making defect data recapitulation. For further research, SKT cigarette companies can implement Kaizen as a form of continuous improvement and conduct research related to waste in SKT cigarette companies.

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