FINAL PROJECT - TI 141501

PERFORMANCE IMPROVEMENT OF PRODUCTION PROCESS USING LEAN SIX SIGMA AND OVERALL LABOR EFFECTIVENESS APPROACH

(Case Study: CV. Cempaka Tulungagung)

AUDITYA DANIAL JIWANDONO

NRP 2511 100 182

SUPERVISOR

H. Hari Supriyanto Ir., MSIE

INDUSTRIAL ENGINEERING DEPARTMENT

Faculty of Industrial Technology

Institut Teknologi Sepuluh Nopember

Surabaya 2015

APPROVAL SHEET

PERFORMANCE IMPROVEMENT OF PRODUCTION PROCESS USING LEAN SIX SIGMA AND OVERALL LABOR EFFECTIVENESS APPROACH

(Case Study: CV. Cempaka Tulungagung)

FINAL PROJECT

Submitted to Acquire the Requirement of Bachelor Degree:
Department of Industrial Engineering
Faculty of Industrial Technology
Institut Teknologi Sepuluh Nopember
Surabaya

Author:
AUDITYA DANIAL JIWANDONO
NRP. 2511 100 182

Approved by Final Project Supervisor

H. Hari Supriyanto Ir., MSIE

KEMENTERIAN RISET, TEKNOLOGI, DAN PENDIDIKAN TINGGI
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
FAKULTAS TEKNOLOGI INDUSTRI
JURUSAN TEKNIK INDUSTRI

SURABAYA, JUNE 2015

PERFORMANCE IMPROVEMENT OF PRODUCTION PROCESS USING LEAN SIX SIGMA AND OVERALL LABOR EFFECTIVENESS APPROACH (CASE STUDY: CV. CEMPAKA TULUNGAGUNG)

Auditya Danial Jiwandono, H. Hari Supriyanto.
Industrial Engineering Department, Institut Teknologi Sepuluh
Nopember, Surabaya 60111 Indonesia,
E-mail: danialjiwandono@gmail,com

ABSTRACT

Labor performance can be very critical to the company which is daily required to produce continuously. As a company that use manual labor in the production process, decline in labor performance may become thing that will disrupt the existing production schedule can even more makes companies stop operate for a while. The quality of the output is very dependent on the labor performance. The better the labor performance, the better the result that the company gets. CV. Cempaka is a company that produces cigarette. Cigarette products produced by this company are a filter cigarette product produced by machine and non-filter cigarette product that produced manually by labor. The company is currently focused on doing improvement to win the market and maintain customer loyalty.

The problems faced by the company are the high number of workers absent due to illness and poor quality. To overcome these problems, it is necessary to use Lean Six Sigma methods which focus on waste reduction. Moreover, this method is used to minimize the resources that must be issued by the company in doing improvement, because by using this method, the focus will be more obvious, so there is no decision-making errors. In order to deepen the analysis and adjusting the observed object, then the labor performance will also be calculated using Overall Labor Effectiveness (OLE) and considered. Step of this study is based on Six Sigma DMAIC method. Use Big Picture Mapping (BPM), E-Downtime and Classification Activity to identify the problem. Based on these methods obtained the critical waste, namely Environmental Health and Safety (EHS) waste and Defect waste. As for the search for critical causes of those critical waste, use Pareto chart, Root Cause Analysis (RCA), and Failure Mode and Effect Analysis (FMEA). Based on the result found six alternatives, then parsed to be three alternatives. Of these three alternatives, then selected two alternatives of the results of the Value Engineering calculation, i.e. doing periodic maintenance, provide backup tools and chair replacement.

Keywords: ***Lean Six Sigma; Overall Labor Effectiveness; Waste; Labor Performance***

PREFACE

Alhamdulillah, all praises belong to Allah SWT. By whose grace, guidance, and blessing the author can finish this final research entitled "Performance Improvement using Lean Six Sigma and Overall Labor Effectiveness Approach (Case Study: CV. Cempaka Tulungagung)" by the end of fourth year study in the Department of Industrial Engineering of Institut Teknologi Sepuluh Nopember Surabaya.

This final research is conducted as a requisite to finish Industrial Engineering major and to achieve a Bachelor degree from Institut Teknologi Sepuluh Nopember (ITS). During the completion of this research, the author receives countless support, motivation, inspiration, and help from various people and communities. Therefore, in this opportunity, the author would like to express his biggest appreciation and gratitude sincerely to those who contribute the most and play an important part during the completion of this final research, namely:

1. The most beloved father Janta Wiwaha, mother Naning Kristiwinarni, my brothers, Rhesaldo Sabiq Ramadhani and Muhammad Benefito Wirayudha, my sister, Debita Istifadah Devaningrum, who have always been there for the author to support in any kind and in every situation.
2. Ir. H. Hari Supriyanto, MSIE as supervisor, the best lecturer for the author, under whose great motivation, clear direction, patient supervision in tutoring the author for the whole time.
3. Prof. Ir. Budi Santosa, M.Sc, Ph.D., as head of the Department of Industrial Engineering and Putu Dana Karningsih ST., M. Eng. Sc., Ph.D., as secretary of the Department of Industrial Engineering, whose support and advice have helped the author for the last couple years.
4. Yudha Andrian ST., MBA as the final project coordinator.
5. Yudha Prasetyawan, Dewanti ST., MT, and Prof. Dr. Ir. Udisubakti Ciptomulyono, M. Eng. Sc. Who have given many recommendations for the author to finish this final project.

6. Yuli Sugiarti, Ida Wahyu and Mr. Totok who have provided learning and opportunity for author in conducting research on the company.
7. Aditya Yanuar ST., Rajab Syahroni, ST., and Iskandar Zulkarnain ST., for all the guidance and help for the author during the final project.
8. Mr. Budi, Mr. Miyono, Mr. Aris, Mr. Sukimin, Mr. Buchori, as well as all employees of the Department of Industrial Engineering of ITS, for all knowledge, experience, and help for the author during the years of study.
9. Sandra Oktavia Teguh, who always accompany and has been become a tremendous spirit of the author during the final project.
10. Best friends: Reza, Chrisman, Ari, Husni, Mario, Tara, Helmi, Bram, Byra. Lubis, Salman, Budi, Raka, Dheni, and Rifqy. Thank you for support, motivation, and inspiration for the author.
11. Lina, Faisol, Redy, Didik, Ziyad, Fikri, Bagus, Andry, and Vira who have fought together for the final project.
12. Industrial Engineering 2011 “Veresis”, especially friends from Q-Class, who have spent 4 years during the study as the family and the best fellows. Thank you for the precious experience, togetherness, and help for the entire 4 years of study.
13. Padmanaba 66, who always give motivation and inspiration for the author.
14. Everyone else whom the author cannot mention explicitly due to the limit of this acknowledgement. Deepest gratitude is expressed towards you all.

Last, the author realizes that this research is far from perfect. Therefore, the author welcomes positive suggestion and constructive critique from anyone. May this research contribute to the academic world and provide improvement for a better future.

Surabaya, July 2015

Auditya Danial Jiwandono

Table of Contents

This page is intentionally left blank.

List of Tables

List of Figures

This page is intentionally left blank.

CHAPTER I
INTRODUCTION

This introductory chapter discusses various things for conducting research and identifying research problems. The components in this introductory chapter cover the background, problem formulation, research objectives, the scope of the research, and the benefits of research.

1.1 Background

The development of manufacturing industry became one of the top priorities in a developing country because it can support other sector development. However, in the increasingly fierce industry competition, any company or business is required to be able to improve the performance of the company in order to always keep up with competitors. Industrial growth that occurs causes increasing competition among companies and it creates greater awareness of a method that can maintain its competitiveness (Muthiah & Huang, 2007). Improvements that need to be applied should be able to handle problems of quality in the company, because the company that is adequate to survive in the market competition is a company that is capable to maintain the quality of its products in order to be accepted by the customer.

Indonesia is one of the developing countries, where the governments do economic development by developing the business world as a benchmark for the economic progress of a country. Various companies engaged in agriculture, mining, basic industry and chemical, consumer goods, industrial property, transport, finance, trade, services and investment. Consumer goods industry consists of food and beverage industry, cigarettes, pharmaceuticals, cosmetics and household appliances. Indonesia is one country with the largest number of smokers in the world after China, the United States of America, and Russia. The number of cigarettes consumed in Indonesia in 2013 recorded 341.9 billion cigarettes (source: BAPPEDA Java, March, 2014). The Ministry of Health of Indonesia stated, population of smoker aged 15 years above tend to have increased from 34.2% in 2007 to 36.2 % in 2013. The tobacco industry in Indonesia has been set by the government as one of the 10 priority industries. It reflects the high absorption of labor and industry contribution to state revenues. According to government data, the tobacco sector has more than 6 million workers, including farmers, as well as manufacturing, sales and distribution. In 2009, tobacco excise duty revenues and contributed 55 trillion in tax to the state, or 6.4% of total revenues. (Source: The Report Indonesia, 2012).

The increased sales of cigarette are inversely proportional to the number of cigarette companies in Indonesia. From year to year the number of cigarette companies in Indonesia continued to decline. According to data from the Association of Indonesian Cigarette Manufacturers Association (GAPRI) cigarette factory in 2009 amounted to 3,225 units, the number decreased to 2,600 units in 2010. The data can be seen in the chart below.

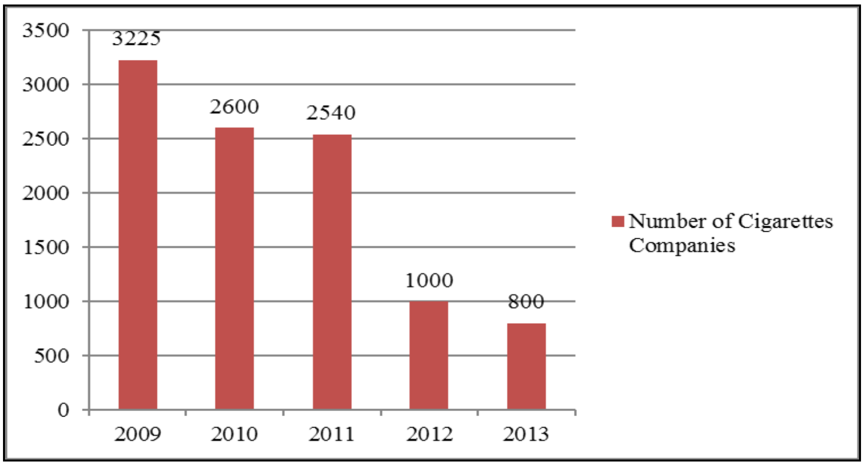

Figure 1.1 Numbers of Cigarette Companies in Indonesia

Source: Gabungan Perserikatan Pabrik Rokok Indonesia (GAPRI)

The reduced population of the national cigarette industry became a phenomenon; due to the reduced population will impact on the industry and the production of tax revenue for the government. Many medium and small companies that went bankrupt because their products are less competitive in the market.

CV. Cempaka is a medium enterprise cigarette that is located in Tulungagung, East Java. This cigarette company is one of the companies that experienced the phenomenon. Based on the data provided by the company, the company's product sales decreased continuously since 2011. This decline can be seen in the table below.

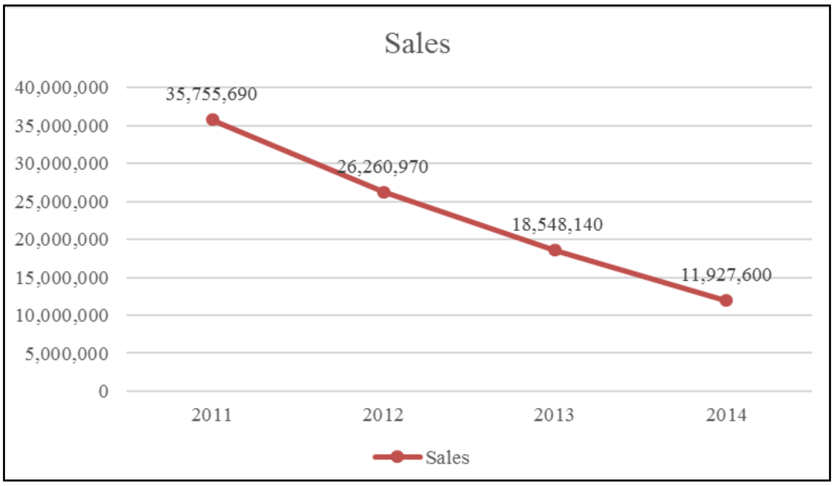

Figure 1.2 Decline in Sales per Year

The number of sales that continue to decline from year to year indicates that the company is less able to compete with other cigarette companies. In order to improve the competitiveness of this company, then improvements are needed.

Production process in CV. Cempaka is done in two ways, that are manually and using machines. Manual production process is better known as SKT (*Sigaret Kretek Tangan*) while using machines known as the SKM (*Sigaret Kretek Mesin*). The difference between SKT and SKM is the type of cigarettes produced. SKT produce cigarettes without filters while SKM produce cigarette filters. For SKT, CV. Cempaka produces 5 variants, which are Cempaka Kretek Long Size 10, Kretek Long Size 12, Kretek Super 12, Kretek Coklat 12, and Kretek Super Gold 12. While for SKM, CV. Cempaka also produces 5 variants, which are Cempaka Filter Coklat 12, Filter Coklat 16, Filter Merah 12, Filter Lights 12, and Filter Lights 16. Currently, CV. Cempaka focuses on doing development in order to improve quality. To determine the type of products that are most critical for the improvement stage, then recap the amount of production is made into a pie chart as shown in figure 1.3 below:

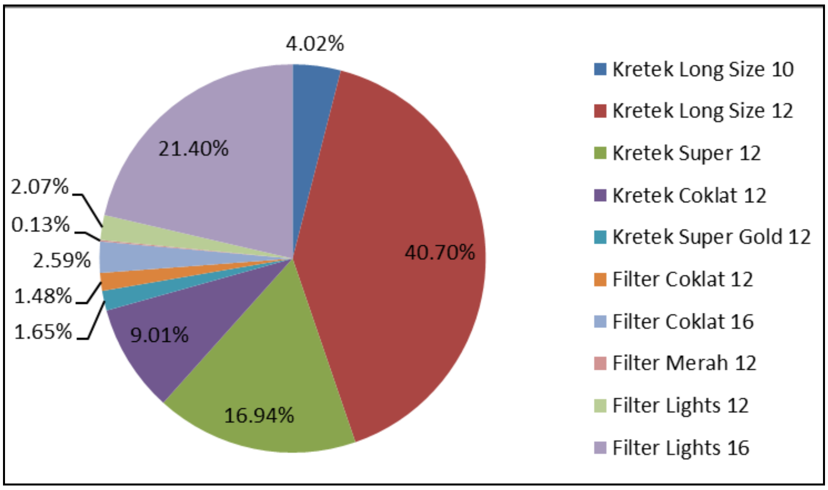

Figure 1.3 Production Proportion of CV. Cempaka in 2012-2013

Based on the pie chart above is known that during the two years from 2012 to 2013 Kretek Long Size 12 is a product with a percentage of 40.70% of the total product variants. Can be seen also in the chart, in the third and fourth position are Kretek Super 12 and Kretek Coklat 12 with percentage of 16.94% and 9.01%. Thus, for this thesis, clove cigarette process is selected, because this process has the largest contribution in this business process.

On the identification and field observations showed that CV. Cempaka has some problems in the production process. Here is the production process of clove cigarette in CV. Cempaka.

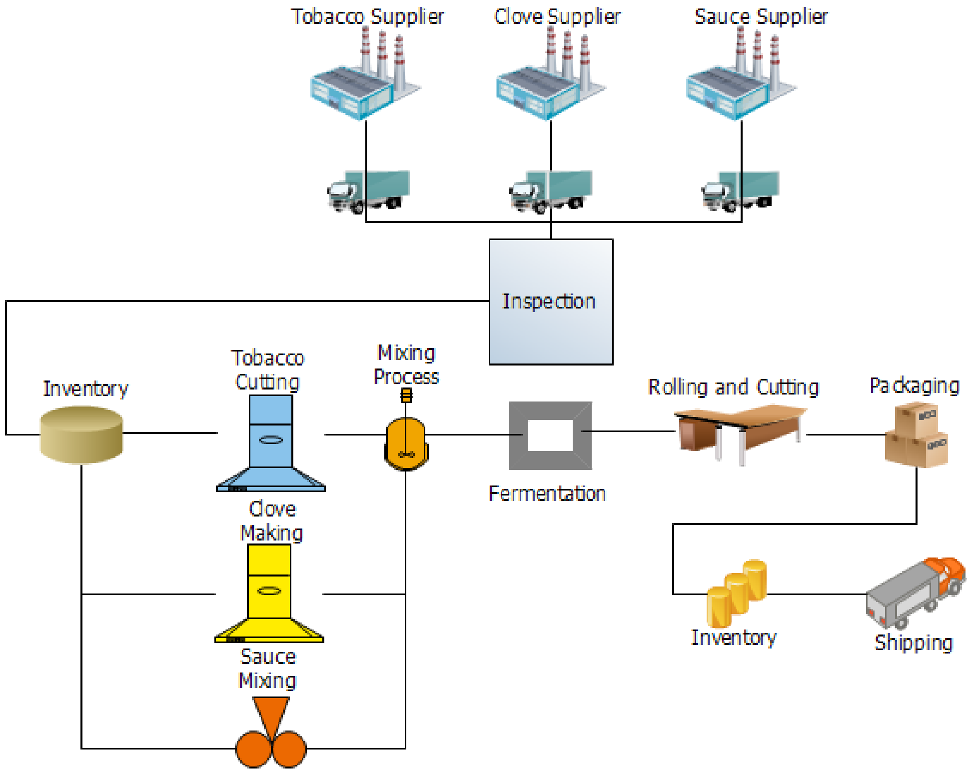

Figure 1.4 CV. Cempaka Production Process

In general, the clove cigarette production process consists of six stages, which are the quality inspection of raw materials, tobacco cutting, cloves cutting, mixing, rolling and cutting process and packaging. Quality inspection of raw material is an activity to sorting raw materials, which are clove, tobacco and sauces that will be processed into a cigarette. Tobacco cutting is the process of slicing tobacco into small pieces according to the desired size, then separates the tobacco from the leaves and dust. Clove making is the process of draining clove, dust separation and drying cloves so it has a nice fragrance and meet the required standards. Mixing is blending activity between cleaned tobacco, clove, alcohol and sauces that will be processed into a tobacco composition. Rolling and cutting process is a process in which the tobacco formed into sticks of cigarettes and then trimmed by means of cutting the ends of cigarette sticks. Packaging process is the process of packing cigarette sticks by using a plastic and then plastered with excise stamps and price.

From the initial observations in the company, by using the E-DOWNTIME method, there are three major issues faced by the production process. The first problem is defective products. From data provided by the company, there is an increase in the number of defective products. The highest average number ever recorded for all types of clove products is 10, 034%, an increase from the previous period which is only 6, 41%. The high number of defective products will affect the cost to the company to do rework. Generally the defective product is comprised of various types, such as uneven cutting on its ends, uneven size and shape, deflated and pigmentation. The entire defects occur in the rolling and cutting process. The next problem is Environmental, Health, and Safety (EHS). It is characterized by a number of workers who are absent due to fatigue and less supportive environment to the workers performance.

The existence of defective products and EHS waste indicate that the production process is still needs improvements. Based on the cases, the method that is suitable for dealing with the problem is Lean Six Sigma. Lean Six Sigma is a method developed to improve the quality of the production with the principles of lean manufacturing, which focuses on the waste elimination, including the defective products, rework and excessive process in the company. Judging from the observed object, the company is classified as medium enterprise that is expected to be able to minimize its resources with the suggested improvements.

Various problems also indicate if the production performance is still not good. Therefore, for the improvement alternatives that will be taken, in addition to considering the critical waste, is also considering the performance analysis of the production process, especially the utilization, performance, and quality of the workforce, considering that clove cigarettes production process done manually in general. Performance measurement that is suitable to measure the production process is Overall Labor Effectiveness (OLE). The use of OLE in analyzing the production performance provides convenience because it can show the company performance in measurable quantities. In addition, the OLE measurement may represent the result of a manufacturing operation run by the company. Therefore, OLE can be used by management to evaluate the performance improvement of the company.

1.2 Problem Formulation

Based on the background, then the problem is how to reduce waste that occurs in the production process of clove cigarette of CV. Cempaka Tulungagung to improve the quality and performance of production process based on Lean Six Sigma and Overall Labor Effectiveness (OLE) methods.

1.3 Objectives

Based on the problem formulation above, so the objectives of this research are:

1. Identify waste that occurs in the clove cigarette production process of CV. Cempaka Tulungagung.
2. Identify the causes of waste.
3. Provide alternative solutions that can be applied by the company to reduce waste and improve performance.

1.4 Benefits

Based on the research objectives, the benefits that can be gained by doing this research are:

1. Help the company to improve the production performance.
2. Obtain an alternative solution for the company in reducing waste so as to reduce the cost during the production process.

1.5 Scope of the Research

The scopes of the research are:

1.5.1 Limitations

Limitations that bound this research are:

1. The research was conducted in the production department of the company
2. 5 months research period
3. Limited to only proposing solutions

1.5.2 Assumptions

Assumptions used by the author in this research are:

1. The production process does not change significantly during the study.
2. The company's policy does not change during the study.
3. The test results represent the conditions in expected improvement in the study.

1.6 Thesis Systematics

Systematics of writing contains the details of the report that briefly describes the parts of the research conducted. The following are the explanation of each part:

CHAPTER 1 INTRODUCTION

This chapter contains background of the research, problems and issues to be addressed in this research, the scope of the research, objectives, benefits and writing systematic of this research.

CHAPTER 2 LITERATURE REVIEW

This chapter contains an initial basis of this research using a variety of literature which helps researches to determine the appropriate method to the problems faced.

CHAPTER 3 RESEARCH METHODOLOGY

The third chapter explains the stages of the research conducted, which includes: a preliminary survey, identification and formulation of the problem, setting goals and benefits, literature studies, observational research object, collection and processing of data, analysis and interpretation of data, and preparation of the conclusions and suggestions.

CHAPTER 4 DATA COLLECTION AND PROCESSING

This chapter consists of the methodology of data collection and processing is done in the study. This chapter will also describe systematically from the stage of data collection and processing as well as the results obtained in accordance with the purpose of the research that has been defined previously.

CHAPTER 5 INTERPRETATION OF DATA AND RESEARCH

The fifth chapter elaborates the analysis and discussion of the results of data collection and processing. The results will be analyzed and interpreted related objectives to be achieved.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

The final chapter provides conclusions and suggestions from the research conducted. This conclusion will answer the purpose of the research that has been done.

This page is intentionally left blank.

CHAPTER II

LITERATURE REVIEW

In this chapter, it will discuss about the literature review for the methods used by the writer in this final report to solve the company's problem. It is shown in each point below.

2.1 Lean Manufacturing

Lean is a method and also the concept of thinking that has the objective to maximize customer value by minimizing the use of existing resources. Lean seeks to optimize product flow along the value stream flow between the companies to the consumer. In each process flow will definitely waste. Lean eliminates waste arising in the whole process. Lean creates a process that requires fewer resources, ranging from human resources, costs, and also a process (Hines & Taylor, 2000).

Lean is a philosophy that is widely used by companies to increase their competitiveness. Because lean has many advantages such as those written by James Martin in his book titled Lean Six Sigma for Supply Chain.

Table 2.1 Lean Benefits

Process Development	Increase 25% - 75%
Labor	Decrease 15% - 50%
Floor Space	Decrease 25% - 50%
Error	Decrease 25% - 90%
Excess Capacity	Decrease 25% - 75%
Throughput time	Decrease 25% - 95%
Delivery time	Decrease 25% - 75%

(Source: Martin, 2006)

The fundamental principle of the waste elimination in accordance with the concept of Lean is as follows:

1. Identify customers and specify value. The starting point is to recognize that only a small fraction of the total time and effort in any organization actually adds value for the end customer. By clearly defining value for a specific product or service from the end customer's perspective, all the non-value activities or waste can be targeted for removal,
2. Identify and map the value stream. The value stream is the entire set of activities across all parts of the organization involved in jointly delivering the product or service. This represents the end-to-end process that delivers the value to the customer.
3. Create flow by eliminating waste. Eliminating waste ensures that the product or service flows to the customer without any interruption, detour or waiting.
4. Respond to customer pull. This is about understanding the customer demand and then creating process to respond to this. Produce only what the customer wants when the customer wants it.
5. Pursue perfection through waste handling continuously. (Hines, 2000).
6. The basis of the application of lean thinking is the concept described by Toyota or which can be known as Toyota Way. In the book "The Toyota Way", (Liker, 2004) put forward 14 principles of the Toyota. Toyota production system is often referred to Toyota House or Toyota Temple, as seen in Figure 2.1 below.

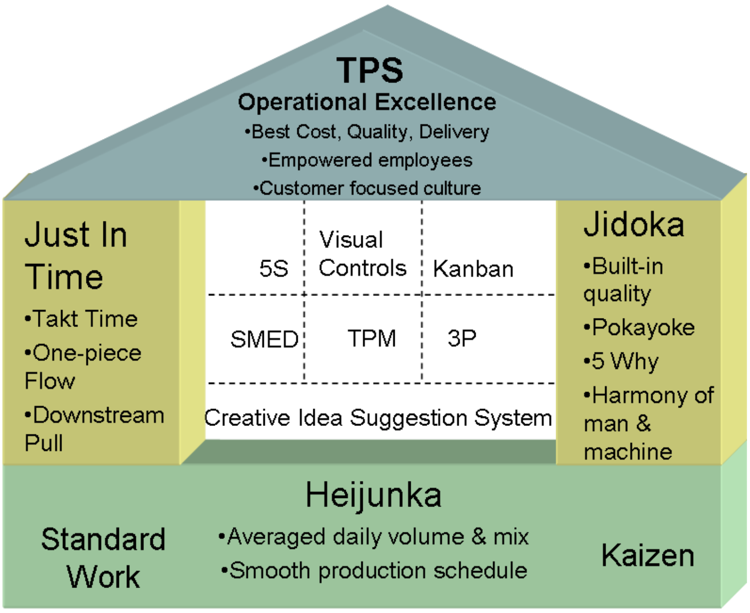

Figure 2.1 Toyota House

The figure shows that Toyota's management system aims to achieve QCD (Quality, Cost, and Delivery) by shortening the production flow and waste elimination. Toyota production system built by the three main pillars of Just in Time (The right part at the right time in the right amount), human resources are motivated, capable, and has a high flexibility, and Jidoka (Built-in Quality) or quality control.

2.2 Six Sigma

Sigma is a statistical term for measuring how far a given process deviates from perfection. Six Sigma is a business management system based on the rigorous, focused and systematic implementation of proven quality assurance principles and techniques. The main thrust of Six Sigma is the application of a well-disciplined, easy to follow methodology to the optimization of discrete business activities that impact on corporate performance. Concepts of Six Sigma jargon like defects, DPMOs (Defect Parts per Million Opportunities) illustrate this product-centric focus. Through the successive elimination of defects (unacceptable variances) in production processes, the costs of these production processes can be reduced, with increases in quality, predictability and certainty.

There are six key aspects that need to be considered in the application of Six Sigma in the field of manufacturing according to “Implementasi Six Sigma” book by Gasperz, 2002, namely:

1. Identify the characteristics of a product that will satisfy customers (according to the needs and expectations of the customers).
2. Classify all the quality characteristics as CTQ (Control to Quality) individually. Critical to Quality is attributes that are very important to note because it relates directly to the needs and customer satisfaction. CTQ is an element of a product, process or practices that have a direct impact on customer satisfaction.
3. Determine whether each CTQ can be controlled by controlling the material, machine, work processes, etc.
4. Specifies the maximum limit of tolerance for each CTQ, as desired by the customer (USL and LSL determine the value of each CTQ).
5. Determine the maximum variation of the process for each CTQ (determining the maximum value of the standard deviation for each CTQ).
6. Changing the product design or process in such way to be able to achieve the target value of Six Sigma.

2.3 Lean Six Sigma

The Lean Six Sigma concept is a comprehensive concept of business systems developed recently in the United States. The Lean Six Sigma concept has become very popular in the advanced industrial countries, especially in the United States and Canada. Lean concept derived from the concept of the Toyota management system, while the Six Sigma concept derived from the Motorolla management system. The strength of these two concepts synergized into an integrated concept, namely the Lean Six Sigma concept.

Lean Six Sigma is a combination of Lean and Six Sigma concepts. It can be defined as a systematic approach to identifying and eliminating waste or non-value-added activities through continuous improvement to achieve six sigma level of performance by flowing the product and system information using pull system of internal and external customers for the pursuit of excellence and perfection with only produces 3.4 defects per one million opportunities (DPMO). Lean Six Sigma means doing things simply and efficiently as possible, while still producing good quality and very fast service (Gasperz, 2006).

In the research of Lean Sigma (Helen, 2005) describes how the power of Lean and Six Sigma when combined. Where in the early stages of Six Sigma or Lean Sigma (Define, Measure, Analyze, Improve, and Control), Lean and Six Sigma have impartial strength. Then entered to the stage of Define, Measure and Analyze, Six Sigma has better strength, while in the stage of Improve and Control Lean has better strength than Six Sigma. So it can be conclude that if the method of Lean and Six Sigma synergized will make a very strong result, as Lean and Six Sigma itself overlap shortcomings of each.

2.4 Overall Labor Effectiveness

Lean Six Sigma focuses on elimination sources of waste and continuously looking for ways to improve the organization. In order to assess and measure the processes, organizations often use Key Performance Indicators (KPIs). KPIs are so useful that they are used in combination with a variety of business philosophies, from Lean to Six Sigma to Total Quality Management. Key performance indicators are factors that are tracked by organizations to analyze their manufacturing processes. These criteria are used to measure success relative to a set of predetermined goals or objectives. KPIs vary from one organization to the next. In this study, KPI used is Overall Labor Effectiveness, because the OLE calculation is capable to covers various issues and very suitable to the problem faced.

Overall Labor Effectiveness is a Key Performance Indicator (KPI) that measures the utilization, performance, and quality of the workforce and its impact on productivity. Similar to Overall Equipment Effectiveness (OEE), OLE measures availability, performance, and quality. OLE is an alternative of OEE, because OEE does not work when there is not a machine to measures. OLE supports Lean and Six Sigma methodologies and applies them to workforce processes, allowing manufacturers to make labor-related activities more efficient, repeatable and impactful. OLE calculation performed with the same formula as OEE calculation. Here is the calculation formula.

$$\text{OEE} = \textit{Availability} \times \textit{Performance} \times \textit{Quality Rate} \qquad (2.1)$$

2.4.1 Availability Measurement

Availability is the percentage of time spent by employees to contribute effectively during the production process. This percentage is obtained by calculating the loss of working hours of employees. Loss of the working hours of employees during the production process resulting in inhibition of the production process. Beside that loss of working hours of employees are also caused by the unavailability of the materials to be processed during the production process. Here is the formula of the availability.

$$\textit{Availability} = 100\% - \frac{\textit{Loss of Working Hours}}{\textit{Working Hours}}\% \qquad (2.2)$$

2.4.2 Performance Measurement

Performance is the ratio of the number of products produced in the production process with the target set. If the amount of production produced less than the target, meaning that the company's performance is not good enough. Calculation of performance is done by using the following formula.

$$\textit{Performance} = \frac{\textit{Total Production Output}}{\textit{Total Expected Output}} \qquad (2.3)$$

2.4.3 Quality Measurement

Quality is the percentage of product without defects or can be sold. Quality calculation performed using the following formula.

$$\textit{Quality} = 100\% - \frac{\textit{Defective Product}}{\textit{Total Product}} \qquad (2.4)$$

2.5 DMAIC Six Sigma

Lean Six Sigma book explains that Lean Six Sigma implementation will follow a specific process known as DMAIC. DMAIC is an approach to problem-solving defined by Motorola as part of the Six Sigma management philosophy. The five steps in DMAIC are Define, Measure, Analyze, and Control. DMAIC is a tool for improving an existing process. The steps can be summarized as follows.

1. Define phase

   Define phase is the first phase of the Lean Six Sigma improvement process. It consists of defining the problem, the goal, the process and the customer. Tools that can be used in this phase is SIPOC (Supplier, Input, Process, Output, and Customer). SIPOC is used to identify the needs of stakeholders; the resources required during the process, top-level process, process deliverables, as well as input and output requirements.

2. Measure phase

   At this phase, existing company performance measurement is done. Activities carried out during this phase includes the calculation of the company sigma level, calculate process capability, RCA (Root Cause Analysis), and FMEA (Failure Mode Effect Analysis). The purpose of this measurement is to determine the critical part of the scope of the process to be improved.

3. Analyze Phase

   Result of the measure phase is analyzed at this phase. The analysis is conducted to determine the critical parts of the process that has been measured previously. Analysis of RCA and FMEA is absolutely necessary as a basis for selecting projects to be implemented. This is the power of Six Sigma. Selection of improvement is not only based on intuition and subjectivity, but also based on the data that has been processed previously.

4. Improvement Phase

   Improvement phase is an important part because at this phase, the improvement that will be taken by the company to improve the process is determined. Improvement will provide a variety of impacts on the overall process. Improvement to a process is not necessarily going to be good. So it is necessary to make scenarios. There are many ways to get the best-case scenario; one of them is simulation method. Simulation is an easy and fast way to get an overview of the results of the implementation of an improvement. By using simulation, unneeded resources in tangible form so that the costs required will be cheaper.

5. Control Phase

   After the improvisation of the critical process, the improvisation was implemented. During implementation, it takes a control mechanism to prevent errors in the process. Various tools can be used, such as poka yoke (error proofing), kanban systems, SPC (Statistical Process Control), and so forth.

2.6 E-DOWNTIME (9 Waste)

Waste is defined as things that are not useful to the assessment of products and services according to the customer or the company. There are several kinds of waste according Gazpersz (2006) in the book "Cost Reduction through Continuous Lean Sigma Approach" which is known in the world of lean manufacturing. Waste is known as the E-DOWNTIME waste, where the waste are:

1. Environmental, health, and safety of waste, type of waste that occurs because of ignoring EHS principals
2. Defects, the waste that occurs due to defect or failure of the product. Defect can be defined by the incompatibility of products with desired specifications.
3. Overproduction, the waste that occurs due to excess production of the quantity ordered or at a time that is not supposed to be. This waste would result in lower movement of goods and information flow will result in the presence of additional inventory.
4. Waiting, the waste that occurs because of the wait for a process. Waste activity will lead to the increasing lead time.

5. Not utilizing employee knowledge, skills and abilities, kind of waste of human resources (HR) which occurs due to not using the knowledge, skills, and abilities of workers optimally.
6. Transportation, waste is caused by the movement (transportation) Excessive throughout the value stream.
7. Inventory, is waste that occurs as a result of the need for additional inventory, either because of the delay of a product or overproduction. In effect, the cost will increase and the level of customer service will decline.
8. Motion, the waste that occurs due to lack of orderly workplace. Employees will perform the movement more than it should. This will cause physical fatigue of the employees and also increase the time and cost of production processes.
9. Excess Processing, the waste that occurs because of the work carried out on the product that is not actually required, and which adds no value to the product.

2.7 Big Picture Mapping (BPM)

Big Picture Mapping (BPM) is an adapted tool from the Toyota production system. This tool can helpful in terms of describing a production process, can be used to describe the system as a whole, and the value stream in it by way of visualizing the flow of material and information, identifying where there is waste, also to know the relationship between the flow of information with the flow of material (Hines and Taylor, 2000). The symbols used in the Big Picture Mapping shown in the following figure:

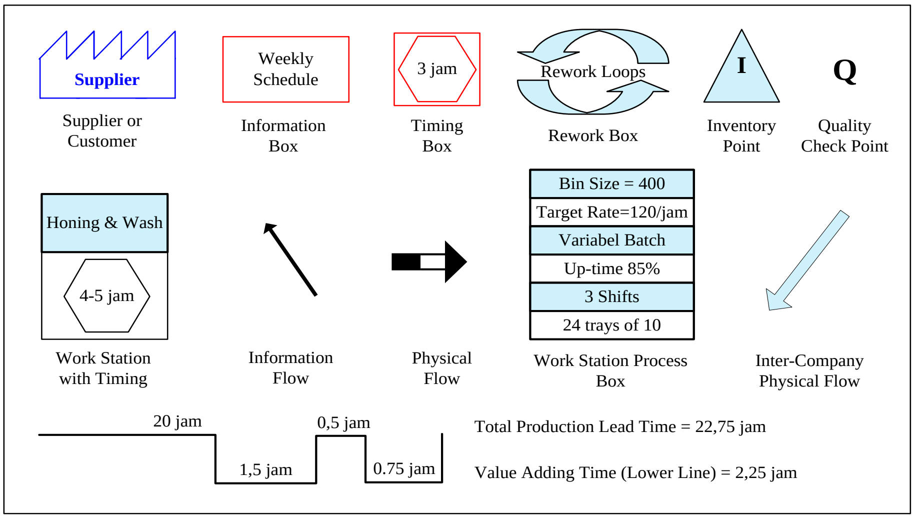

Figure 2.2 Symbols used in Big Picture Mapping

Here is the step of making big picture mapping:

1. Customer Requirement

   Identify the type and the amount that the customer wants, when the need for such products, delivery capacity, how often deliveries are made, and the amount of supplies needed to be kept for the customer demands.

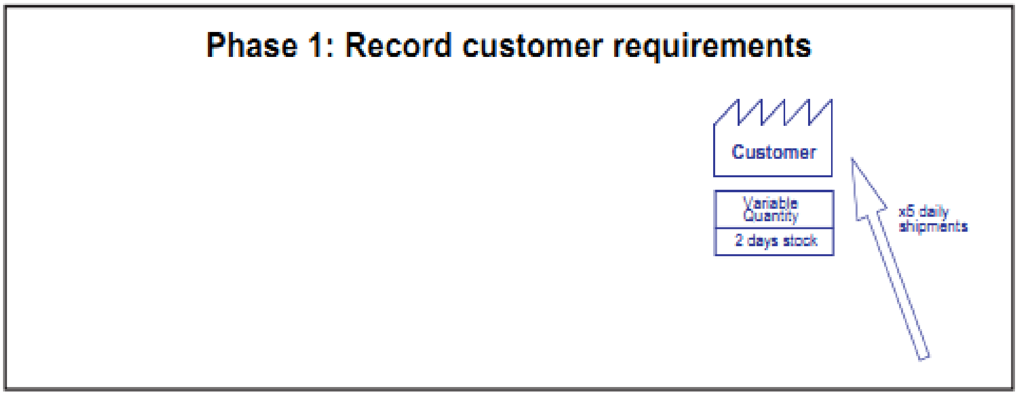

Figure 2.3 Customer Requirements (Hines & Taylor, 2000)

2. Information Flow

   Describe the flow of information from the customer to the supplier, which contains forecasting and cancellation information, organization or department that provides information to the company, how long the information appears to be processed, what information is communicated to suppliers, as well as requirements of order.

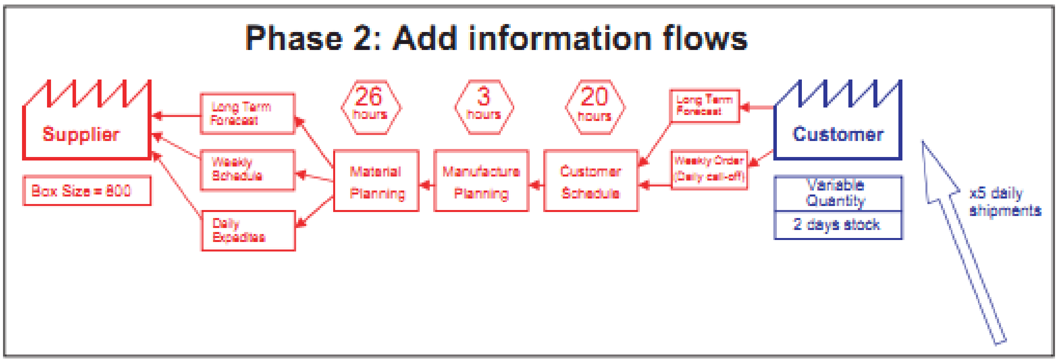

Figure 2.4 Information Flows (Hines & Taylor, 2000)

3. Physical Flow

   Describe the physical flow of a material or product within the company, the time required, the point of inventory and inspection, rework round, cycle time of each point, how many products are made and moved in each point, how many hours per day each work station operates, how many products are checked at every point, how many people who work at each station, where inventory is held and how many point the bottleneck that occurs, and defect.

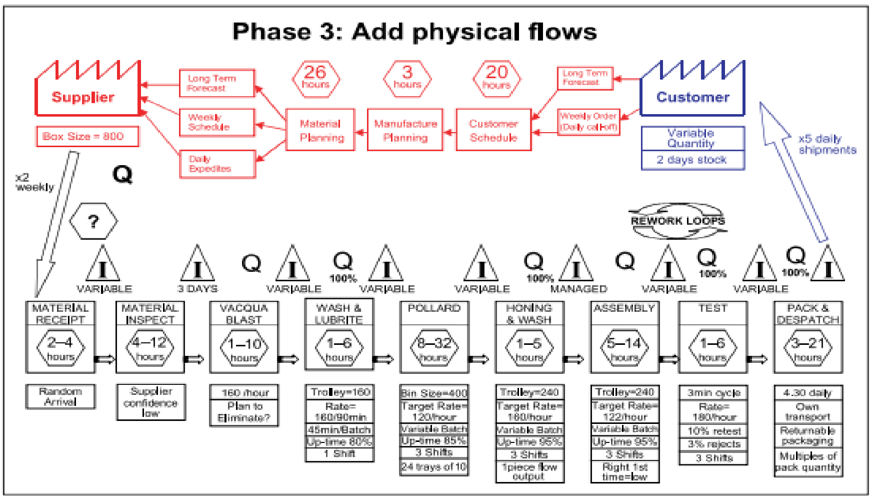

Figure 2.5 Physical Flows

4. Linking Physical and Information Flow

   Connect the information flow and physical flow with arrows that may contain information that is used schedules, work instructions are generated, from and to whom the information and instructions are sent, when and where the problems usually occur in the physical flow.

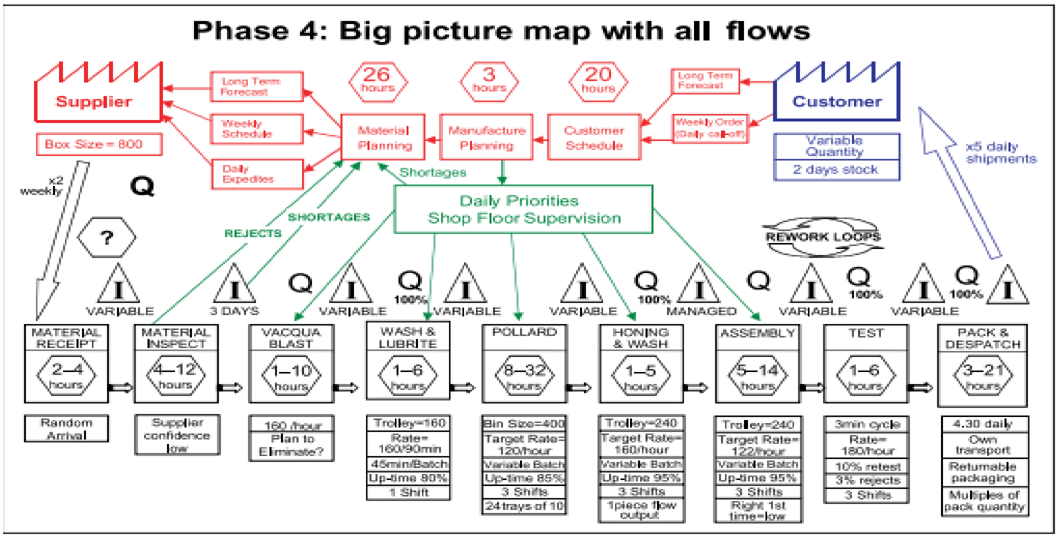

Figure 2.6 Big Picture Map with All Flows (Hines & Taylor, 2000)

5. Complete Map

   Completing the map or image flow and the physical flow of information is done by adding lead time and value added time at the bottom of the image stream created.

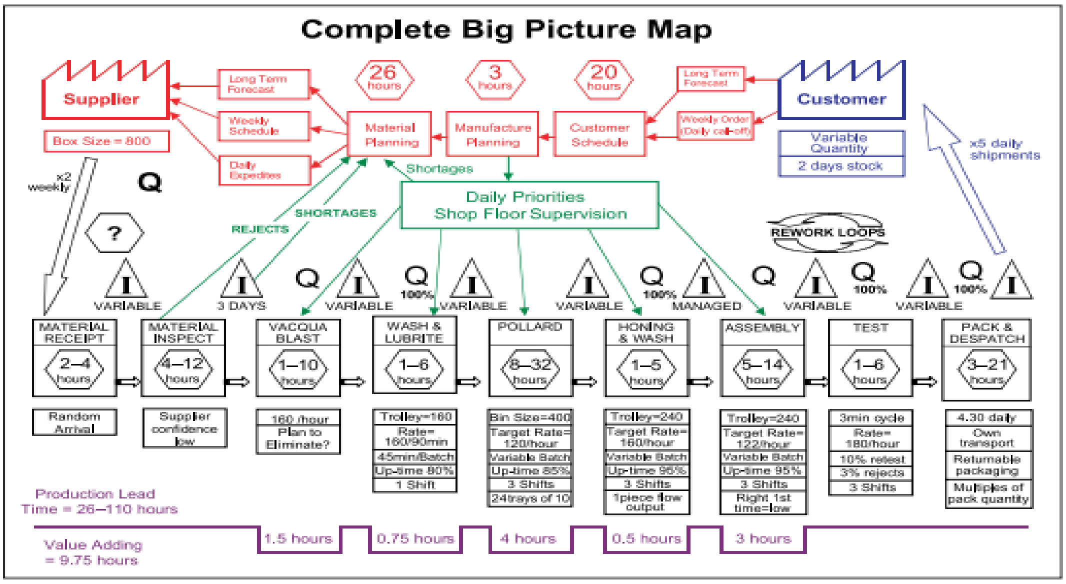

Figure 2.7 Complete Big Picture Map (Hines & Taylor, 2000)

2.8 Activity Classification

One important step in the lean approach is to identify which activities that add value and not. Activities that do not add value should be reduced to improve the efficiency and effectiveness of the company. According to Hines and Taylor (Hines & Taylor, 2000), the type of activity in the organization can be divided into three, namely:

1. Value adding activity, this activity is the activities according to the customer the best contribution to the product produced. With this value adding activity, consumers will feel the resulting product will be more valuable.
2. Non-value adding activity, this is an activity, which according to the consumer does not give any effect to the products that consumers want. Non-value adding activities are considered waste. The fewer the non-value added activities in a process, the more smoothly the process will flow.
3. Necessary non value adding activity, this activity is an activity which, according to the consumer does not affect any of the products produced, but these processes need to be done.

2.9 RCA (Root Cause Analysis)

Root Cause Analysis (RCA) is a process to identify and determine the root cause of a particular problem with the purpose of establishing and implementing a solution that would prevent repetition of the problem (Dogget, 2005). There are four steps in the making of RCA (Rooney & Heuvel, 2004), namely:

1. Data collection

   At this stage, data collection and understanding of the data to be searched root cause of the problem is done. Required information is complete and in-depth understanding of the factors that cause and root of the problems associated with the event can be identified with either.

2. Causal factor charting

   At this, the creation of a sequence diagram with logic test that describes the incidence and caused of and coupled with the surrounding conditions that affect it.

3. Root cause identification

   At this stage, the identification of the underlying reasons for each factor.

4. Recommendation generation and implementation

   After identification of the causes, then the next step is to make recommendations to prevent recurrence of such events, or occur in the future.

There are various methods of evaluation are structured to identify the root cause of a problem. Five popular methods to identify the root cause of a problem (Jing, 2008), namely:

a. Is/Is Not Comparative Analysis

   A comparative methods used for simple problem, can provide a detailed picture of what is happening and has often been used to investigate the root of the problem.

b. 5 Whys Method

   5 Whys is an iterative question-asking technique used to explore the cause-and-effect relationship underlying a particular problem. It can be

used to determine the relationship between different root causes of a problem.

c. Fishbone Diagram

The fishbone diagram identifies many possible causes for an effect or problem. Cause categories include materials, machines, methods and people.

d. Cause and Effect Matrix

A causal matrix in the tables forms and gives weight to each factor that causing the problem

e. Root Cause Tree

This tool is used to break down broad categories into finer and finer levels of detail. It is suitable for complex problems.

In this study, the analysis tools used is 5 Whys method because in this case it takes a deep understanding of the problem so that the problem does not reoccur. 5 whys technique used to drill down to the root causes.

2.10 FMEA (Failure Mode and Effect Analysis)

FMEA (Failure Mode and Effect Analysis) is an approach to describe all possible failures, the impact on the system (severity), the possibility of occurrence, and the possibility of failure detection. FMEA is able to classify the failure in detail so as to demonstrate critical failures that must be anticipated by the company (Pzydek and Keller, 2010). The steps of doing an FMEA are as follows:

1. Determine the system to be analyzed
2. Describe the system in a process map
3. Analyze the stakeholders that influence the system
4. Define functions in every part of the process
5. Find potential failures in every function
6. Determine the impact (severity), the potential of occurrence, and the potential of detection for every possible failure.

7. Calculate RPN (Risk Priority Number) for each potential failure events. RPN is the most potential critical value
8. Specifies the handling process for each potential critical failure. Determine the compensation to be prepared by stakeholders when failure occurs.
9. In FMEA, the identification process starts from finding the qualitative form of failure and provide a score that has been converted from three factors or FMEA components that are Severity, Occurrence, and Detectability. Afterwards, quantitative calculation is done by multiplying the score to calculate the value of Risk Priority Number (RPN). RPN is the product of severity (S)*detectability (D)*occurrence (O).

RPN = S*D*O .... (2.5)

S (Severity) is score or value that indicates the seriousness of the failure rate and how serious the impact to customers if this occurs. Severity assessment in this study refers to the time in each process up to its influence on the subsequent process based on quantitative data of disturbance report.

Table 2.2 Severity Scaling Example

Rating	***Effect***	***Severity effect***
10	*Hazardous without warning* (HWOW)	Failure could injure the customer or an employee.
9	*Hazardous with warning* (HWW)	Failure would create noncompliance with federal regulations.
8	*Very high* (VH)	Failure renders the unit inoperable or units for use.
7	*High* (H)	Failure causes a high degree of customer dissatisfaction.
6	*Moderate* (M)	Failure results in a subsystem or partial malfunction of the product.
5	*Low* (L)	Failure creates enough of a performance loss to cause the customer to complain.

Table 2.2 Severity Scaling Example (Continued)

Rating	***Effect***	**Severity effect**
4	*Very low* (VL)	Failure can be overcome with modification to the customer's process or product, but there is minor performance loss.
3	*Minor* (MR)	Failure would create a minor nuisance to the customer, but the customer can overcome it without performance loss.
2	*Very minor* (VMR)	Failure may not be readily apparent to the customer, but would have minor effects on the customer's process or product.
1	*None* (N)	Failure would not be noticeable to the customer and would not affect the customer's process or product.

Source: (www.qualitytrainingportal.com)

O (Occurrence) is score or value that indicates the frequency of failure. Assessment occurrence in this study refers to the frequency of delays that occur in each process based on data of disturbance report.

Table 2.3 Occurrence Scale

<table>
<tr><th>Rating</th><th>Probability of occurrence</th><th>Failure probability</th></tr>
<tr><td>10</td><td rowspan="2">Very High (VH) : almost inevitable failure</td><td>> 1 in 2</td></tr>
<tr><td>9</td><td>1 in 3</td></tr>
<tr><td>8</td><td rowspan="2">High (H) : repeated failure</td><td>1 in 8</td></tr>
<tr><td>7</td><td>1 in 20</td></tr>
<tr><td>6</td><td rowspan="3">Moderate (M) : occasional failure</td><td>1 in 80</td></tr>
<tr><td>5</td><td>1 in 400</td></tr>
<tr><td>4</td><td>1 in 2000</td></tr>
<tr><td>3</td><td rowspan="3">Low (L) : relatively few failures</td><td>1 in 15000</td></tr>
<tr><td>2</td><td>1 in 150000</td></tr>
<tr><td>1</td><td>< 1 in 150000</td></tr>
</table>

Source: (Wang, et al., 2009)

D (Detectability) is score or value that indicates how often the intensity of the quality control mechanisms to detect any failure in the system before it happens. Assessment of detectability in this study refers to the frequency of data does the controlling process for each process based on data of disturbance report.

Table 2.4 Detection Scale

Rating	***Detection***	**Description**
10	*Absolute Uncertainty* (AU)	The product is not inspected or the defect caused by failure is not detectable
9	*Very remote* (VR)	Product is sampled, inspected, and released based on Acceptance Quality Level (AQL) sampling plans.
8	*Remote* (R)	Product is accepted based on no defective in a sample.
7	*Very Low* (VL)	Product is 100% manually inspected in the process.
6	*Low (L)*	Product is 100% manually inspected using go/no-go or other mistake-proofing gages.
5	*Moderate* (M)	Some Statistical Process Control (SPC) is used in process and product is final inspected offline.
4	*Moderately High* (MH)	SPC is used and there is immediate reaction to out-of-control conditions.
3	*High* (H)	An effective SPC program is in place with process capabilities (Cpk) greater than 1.33.
2	*Very High* (VH)	All products are 100% automatically inspected.
1	*Almost Certain* (AC)	The defect is obvious or there is 100% automatic inspection with regular calibration and preventive maintenance of the inspection equipment.

Source: (www.qualitytrainingportal.com)

2.11 Value Engineering

Value Engineering is a management technique using a systematic approach to find the best balance between cost function, reliability and performance of a project (Dell'Isola, 1966). This method using value. The value that will be used as a comparison between each alternative. Here is a formula to calculate the value:

$$PC_n = \frac{P_n}{P_o} \ x \ PC_o \quad \text{.......} (2.6)$$

$$C_n = C_o + \textit{Improvement Cost} \quad \text{...(2.7)}$$

$$V_n = \frac{PC_n}{C_n} \quad \text{...(2.8)}$$

Notes:

PCn : n-Performance Cost

Pn : n-Performance

Po : Initial Performance

Co : Initial Cost

Cn : n-Cost

Vn : n-Value

This page is intentionally left blank.

CHAPTER 3
RESEARCH METHODOLOGY

This chapter illustrates the flow chart of research as a whole, along with an explanation of each stage in the research. In general, there are four stages to be discussed in this chapter, namely the problem identification stage, data collection and processing, analysis and improvement as well as conclusions and suggestions stage. Where all stages of the research refer to the Six Sigma DMAIC (Define, Measure, Analyze, Improve and Control) methodology.

The following is the flowchart of this research.

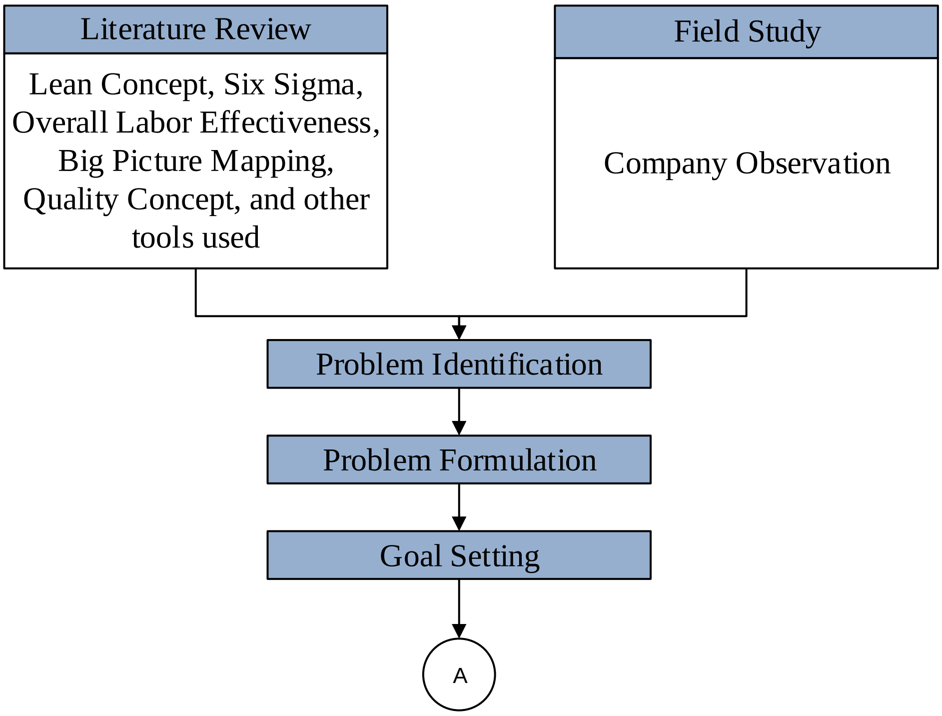

Figure 3.1 Research Methodology Flowchart

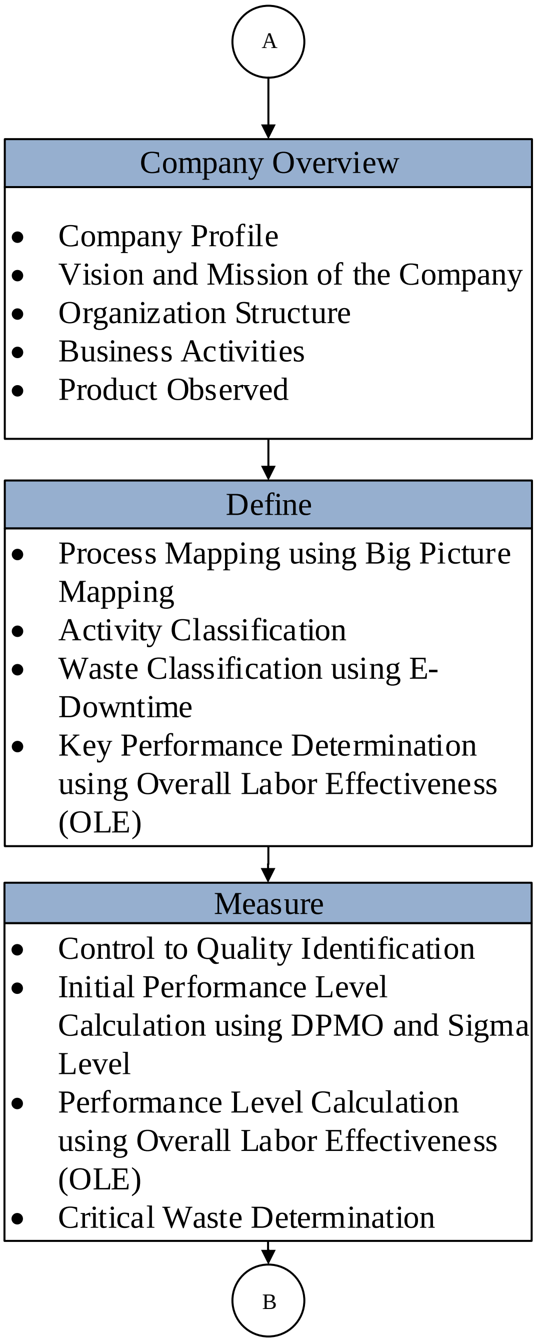

Figure 3.1 Research Methodology Flowchart (Continued)

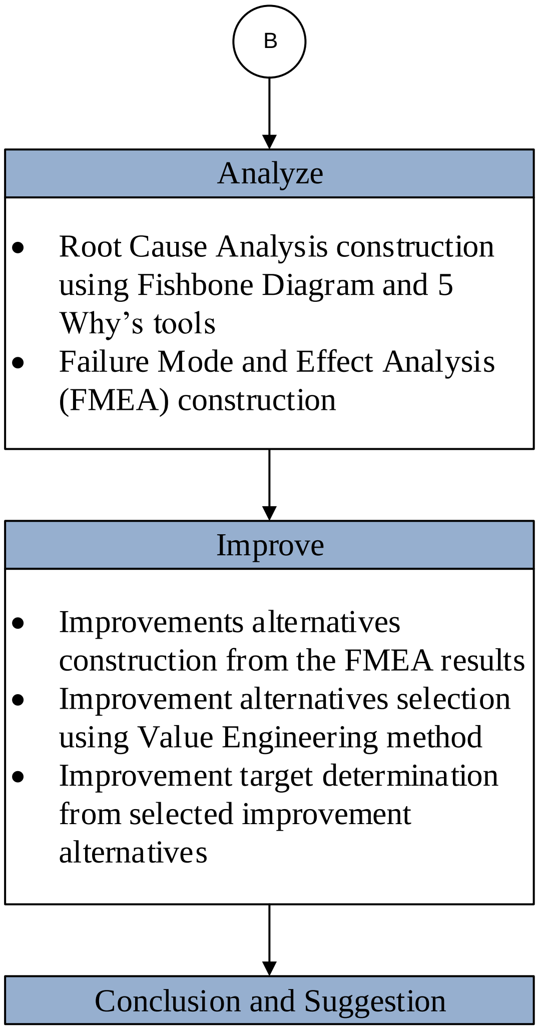

Figure 3.1 Research Methodology Flowchart (Continued)

3.1 Identification Phase

Identification phase is an initial stage of this study. This stage consists of several steps such as literature review, field studies, problem identification, problem formulation, and goal setting. Here is the explanation of each step.

3.1.1 Literature Review

The first stage is to search references that will support the course of the study. References to be used adapted to the issues raised. With the study of literature, research is expected to be more focused because it has a strong base and guidance in resolving problems and achieve the research objectives. Literature is derived from textbooks, research journals, thesis, as well as the latest news. The literature used include the concept of Lean, Waste, Big Picture Mapping, the concept of Six Sigma, DMAIC Six Sigma, Root Cause Analysis (RCA), Overall Equipment Effectiveness and Value Engineering.

3.1.2 Field Study

Field study is a step in the observations of the observed objects. A field study was conducted to collect the necessary data in the study and to determine the existing condition of the observed object.

3.1.3 Problem Identification

This stage is the problem identification to the observed object. After the observation at CV. Cempaka, it was found that there are defective products, excessive processing and overproduction in the process of clove cigarettes making.

3.1.4 Problem Formulation

After the problem identification, the next stage is the problem formulation. The problem formulation is based on problem identification that has been done before, so that this problem leads to the increasingly critical area of the problems experienced by the observed object. Based on the problem identification, the problem formulation is to overcome the problem of waste and non-value adding activities in order to improve the production quality.

3.1.5 Goal Setting

Goal setting is done in order to be more focused. Since the purpose of the study are based on specific objectives to be achieved to fix the problem on the observed object. The purpose of this study will be answered in the recommendation for improvements to the observed object.

3.2 Data Collection and Processing

Referring to the Six Sigma methodology, the stage of data collection and processing consists of two steps that are define and measure phase. Here is the explanation of each step.

3.2.1 Company Overview

This stage contains observations of the observed object. The data collected are the company profile, the vision and mission of the company, organizational structure, business activities, and the observed product. From these data will be processed in the next stage for further analysis.

3.2.2 Define

Define is an early phase in the six sigma methodology that identify the various issues to be resolved. At this phase will be explained the problems that become observations to do improvement. This phase consists of the Big Picture Mapping (BPM), Activity Classification, Waste and OLE Identification that occurs in the company.

3.2.3 Measure

This phase contains calculations of the data collected. The data collected includes data in accordance with Lean and Six Sigma. The data are the types of waste data based on the E-DOWNTIME. At this stage, the calculation of the initial OLE is done. Afterwards, the CTQ variables are determined. CTQ criteria determined by the desires of consumers and also critical process.

3.3 Analysis and Improvement

Analysis and improvement stage consists of three phases of DMAIC Six Sigma, which are analyze, improve and control. Here is the explanation of each step.

3.3.1 Analyze

Analyze phase is a phase that is conducted to analyze the result of the calculations that have been performed. Analysis were performed to determine the waste and critical processes that occur in the production process. This phase is carried out through two methods, namely Root Cause Analysis (RCA) and Failure Mode and Effect Analysis (FMEA). Tools that are used in the RCA are Fishbone diagram and 5 Whys technique. Critical waste that has been found in the previous stage, then identify the root cause of each waste that arises. In this study, the analysis tools used are Fishbone diagram and 5 Whys technique, namely by identifying problems from 5 factors, which shortened to 5M, namely Machine, Method, Materials, Manpower, Measurement. Then provide 5 times the question why for each factor on an ongoing basis. The results of the RCA will be input for FMEA in assessing the incidence of failure. FMEA analysis is then used to determine the most critical failure opportunities through RPN value. Each mode of the RCA will be assessed its severity, occurrence, and detection. Severity is the value of the impact of failure events. The greater the impact when a failure occurs, then the value will be greater. Occurrence is the possibility of a failure, then the value of occurrence will be greater. While detection is the ability of a failure to be detected. The more likely it is not detected, the greater its detection value. Those values of severity, occurrence and detection are then multiplied up into the value of RPN. Potential value that has the largest RPN value is the most critical potential. The most critical potential will be the focus of improvement.

3.3.2 Improve

This improve phase is the stage of determination and selection of improvement alternatives that may be applied to the company. This stage depends on the results of FMEA, where provided improvement alternatives are only for critical failures only. In an improvement alternatives should also look at the root causes of the problem, so that the right solution provided can resolve the roots of the problem. After several alternatives are arranged, the next step is to choose an alternative of improvement. This step using value engineering method with two criteria: performance improvement alternative to an improved quality company as well as the costs to be incurred by the company. Afterwards, recalculate the OLE value to determine the increase of the company's performance.

3.4 Conclusions and Suggestions

Conclusions and suggestions stage is the final stage in the thesis. Conclusions will answer the purpose of the research that has been set in the beginning. While the suggestions contain proposed improvements for the company. Suggestions will also be made for further research.

This page is intentionally left blank.

CHAPTER IV
DATA COLLECTION AND PROCESSING

This chapter describes the collection and processing of the data that has been obtained. The methodology used in this chapter is in accordance to the Six Sigma methodology that is supported by the appropriate tools to analyze and evaluate the problems as described in the previous chapter.

4.1 Company Overview

This stage is about the company in general. This stage is done to find a problem that needs to be improved. This stage contains the company profile, the vision and mission, organizational structure, business activities, and the product observed.

4.1.1 Company Profile

The origin of the company cannot be separated from the background of its founder. Previously, Mr. Karmani cooperate with CV. Sri Rejeki Tulungagung, the product brand “Banteng Sumoro”, where Mr. Sumiran as owner. In 1976, Mr. Karmani trying to develop his existing capabilities to develop. At that time, the production deposited to the “Banteng Sumoro’, where the company has not received the official construction permit but legally the company has been producing since 1976 which was passed by the Department of Industry by the numbers: 5522/E.6/VII/81. While technically has not been able to stand by himself, because of other factors that have not been adequate.

With the development of the company, prompting him to get a business license in order to operate more freely, which the company was capable enough to produce by itself. Then, he made another product brand “Cempaka”, while “Banteng Sumoro” is now well known as “Retjo Pentung”.

On April 1, 1982 or since the legal permission by the numbers: B 79/B2/H0/KDH/AA by the government, and got production permit by customs numbers: 00481/F, thus, the company was officially established under the name of

“PR. Cempaka” in Tulungagung in the form of CV (Commanditaire Venootschaap). With the development of CV. Cempaka, the company was trying to get a business license, which was permits a place of business, based on law number 530.08/08/445/14/1985 which was passed by the regent level II Tulungagung.

At first the company only producing one type of product, namely “Cempaka Long Size”. Along with the development, in July 1984, the company produced new products, namely “Cempaka Super”. While in mid-August 1986 produced “Cempaka Filter”, and in 1987 produced “Cempaka Spesial”, and mid-October 2000 produced “Cempaka Lights”. So in general the company produces six kinds of production cigarette brand “Cempaka”.

4.1.2 Vision and Mission

Vision of CV. Cempaka is “Being a profitable company and has a dominant role in the domestic cigarette industry”. While the mission of the company is divided into long-term and short term missions. Here is the missions of CV. Cempaka.

a. Short term missions
    1. Maintain the continuity of the company
    2. Achieve production targets
    3. Improve quality

b. Long term missions
    1. Achieve optimal profit level
    2. Doing business expansion
    3. Enhance the company’s reputation

4.1.3 Organizational Structure

The organizational structure of CV. Cempaka using a functional organization with the structure in which each department is responsible for a particular function. The organizational structure system uses the line organizational structure, where supreme authority lies in the hands of the leader. Here is the organizational structure of CV. Cempaka.

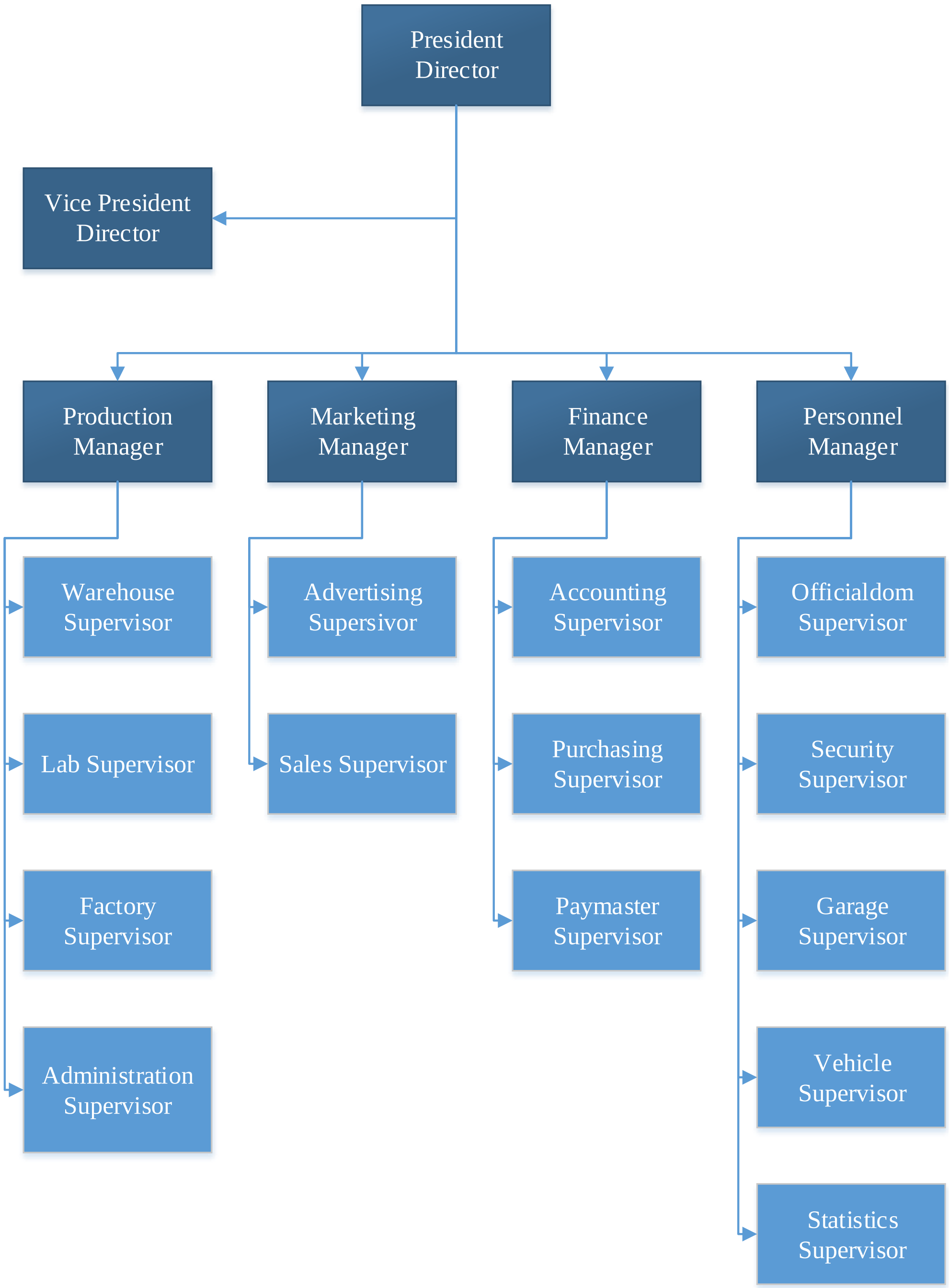

Figure 4.1 Organizational Structure

Based on the figure above can be seen that CV. Cempaka is headed by a president director who is assisted by a vice president director, in charge of four departments that headed by a manager that are production, marketing, finance and personnel department.

a. President Director

Duties and authorities:

1. Develop organizational systems in order to be effective in performing the task to achieve the company goals.
2. Create guidelines so that there is coordination and synchronization for each section in their duties.
3. Perform general supervision of the activities of the company.
4. Setting a long-term plan to develop the company.

b. Vice President Director

Duties and authorities:

1. Assist the president director in carrying out its duties.
2. Perform general supervision of the activities of the company.

c. Production Manager

Duties and authorities:

1. Draw up an annual production plan as guidelines and targets to be met.
2. Give direction and coordination of the activities of laboratories, warehouses, and factory administration in the implementation of production activities
3. Doing development to company in the field of production
4. Ensuring that can be created methods and better ways of working in production activities.

d. Marketing Manager

Duties and authorities:

1. Draw up an annual sales plan as guidelines and targets to be achieved.
2. Creating a policy, strategy, and marketing techniques on the basis of the results of market research conducted.
3. Directing and coordinating promotional and sales activities.
4. Finish everything relating to claims or compensation for the sale.

e. Finance Manager

Duties and authorities:

1. Develop a budget or the budget of the company as a whole as working guidelines all activities of the company.

2. Coordinate the activities of internal parts that include accounting, purchasing and cashier.
3. Conduct internal control over the financial management of the company.
4. Prepare financial statements and other required information periodically.

f. Personnel Manager

Duties and authorities:

1. Arranging the office personnel and good governance so as to support the company.
2. To supervise the implementation of the tasks which include staffing, security, garage, vehicle, and statistics.
3. Conducting employee development efforts in improving productivity.

4.1.4 Product Observed

Clove cigarette is cigarette that use the original dried tobacco, combine with clove and sauce. The company is engaged in the manufacture and sale of clove cigarettes, both filter clove cigarette and non-filter clove cigarette, which are better known as filter and clove cigarette. Both can be distinguished from the form and how the manufacturing process of the cigarette. On each category, there are various types of products which are distinguished by the number of cigarettes in a pack, taste and aroma. Here are the explanations of each product category:

- Filter Clove Cigarettes or Filter Cigarette

  This category of products using foam as a filter on one end of the cigarette. It is processed through the rolling, cutting and packing process using machines and therefore this category of products is often called Machine Clove Cigarettes or *Sigaret Kretek Mesin* (SKM). In general, in Indonesia all cigarette brands in this category are contained "SKM" emblem on the cigarette pack. For this product category, the company is able to produce five kinds of product types as mentioned below:

  1. Cempaka Filter Coklat 12
  2. Cempaka Filter Coklat 16

3. Cempaka Filter Merah 12
4. Cempaka Lights 12
5. Cempaka Lights 16

- Non-filter Clove Cigarette

  This product category does not use filter. It is processed through the rolling, cutting and packing process manually. Therefore, this category of products is often called Hand Clove Cigarettes or *Sigaret Kretek Tangan* (SKT). This product category cannot be processed through the machine due to difference is the diameter of the base to the tip of the cigarette, while in SKM cigarette, the diameter of the base and the tip are same. For this product category, the company is also able to produce five kinds of product types as mentioned below:

  1. Cempaka Super Premium (SP) Long Size 10
  2. Cempaka Super 12
  3. Cempaka Long Size 12
  4. Cempaka Coklat 12
  5. Cempaka Gold Super 12

This research conducted focusing on the non-filter cigarette product, because of the initial observation, the problems derived from the production process of the non-filter cigarette product. In addition, the product category provides the highest profits for the company. The type of products that provide the highest profits is kind of product with the highest sales amount. The following is a table recap of sales of each type of products.

Table 4.1 Sales by Each Type of Products

Product Category	Product Type	2012		2013		2014		Total		Total by Product Category	
		Pack	Value	Pack	Value	Pack	Value	Pack	Value	Pack	Value
Non-filter Cigarettes	LONG SIZE 10	1,281,600	2,953,367,300	538,000	1,335,618,000	274,860	761,756,800	2,094,460	5,050,742,100	41,444,080	121,995,973,510
	LONG SIZE 12	10,789,600	28,868,244,860	7,510,020	22,674,999,800	4,827,660	16,080,754,500	23,127,280	67,623,999,160		
	SUPER 12	4,241,530	11,475,635,750	3,288,400	10,354,960,000	2,748,800	9,172,710,000	10,278,730	31,003,305,750		
	KRETEK 12 COKLAT	2,456,110	6,788,223,750	1,563,900	4,780,833,000	1,032,600	3,512,614,000	5,052,610	15,081,670,750		
	GOLD SUPER 12	106,800	373,800,000	624,500	2,250,038,250	159,700	612,417,500	891,000	3,236,255,750		
Filter Cigarettes	FILTER 12 MERAH	74,400	217,510,000	8,300	39,979,000	13,400	73,030,000	96,100	330,519,000	15,292,630	90,466,764,680
	FILTER 12 COKLAT	379,530	1,794,003,500	260,720	1,274,893,200	146,700	801,450,000	786,950	3,870,346,700		
	FILTER 12 LIGHT	695,600	3,157,065,000	237,400	1,124,792,000	96,700	495,195,000	1,029,700	4,777,052,000		
	FILTER 16 COKLAT	628,800	3,587,440,000	523,000	3,340,245,750	387,020	2,800,924,500	1,538,820	9,728,610,250		
	FILTER 16 LIGHT	5,607,000	31,584,141,480	3,993,900	24,768,440,250	2,240,160	15,407,655,000	11,841,060	71,760,236,730		

From the table 4.2 above, it is found that in the last 3 years, the production of the category of non-filter cigarettes have a greater product sales than the filter cigarettes. The amount of sales of non-filter cigarettes is 41,444,080 packs with a total sales value reaches 123,615,183,150 rupiahs or an excess of 26,151,450 packs with differences in sales value reaches 37,364,576,200 rupiahs compared to sales of filter cigarettes. To determine the type of products that are most critical do improvements, then the data recap of the amount of sales of products whether in packs and rupiahs are made into pie charts shown below.

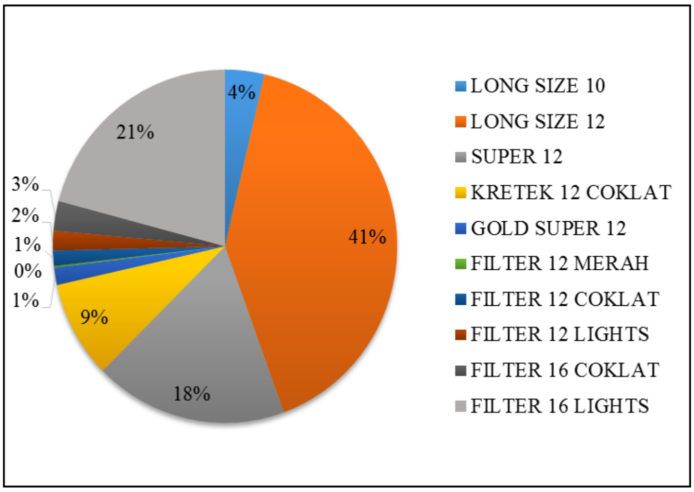

Figure 4.2 Pie Chart of Sales in Last 3 Years (Packs)

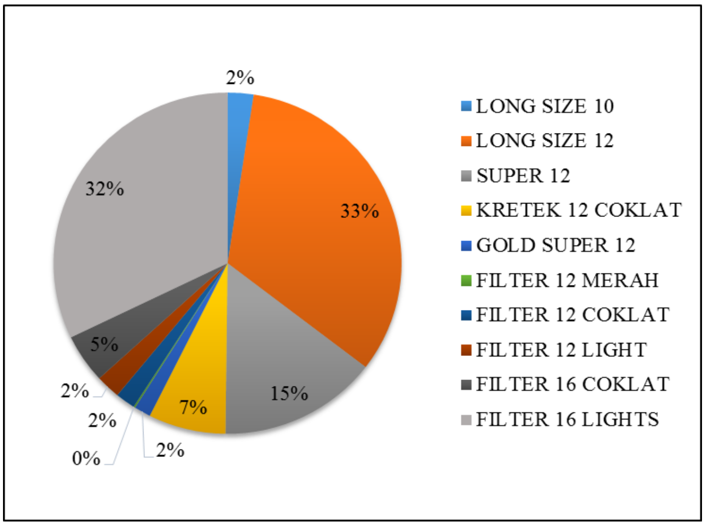

Figure 4.3 Pie Chart of Sales in Last 3 Years (Rupiahs)

Based on the figures above, it was found that in the last 3 years, both the sale of products in the amount of the pack and the amount of income derived from the sale, non-filter cigarette type Cempaka Long Size 12 has the largest contribution. This product type makes a significant contribution in the sales in the amount of packs as much as 41% of the overall product types, far less than any other types of product. While financially, this type of product accounted for 33%, compared with a thin lead to Cempaka Lights 16. Cempaka Long Size 12 is one of the oldest product type that is owned and maintained by the company. This product is the same as Cempaka Long Size 10, only the number of cigarette sticks in a pack that distinguish the two.

4.1.5 Manufacturing Process

This section discusses about the manufacturing process, from the identification of the main raw materials, auxiliary raw materials and the production process. Next will be identified physical flow and information flow in the implementation of the production process.

4.1.5.1 Raw Materials

The raw materials are all the resources used for the benefit of the production process. The production process can be run when the raw materials can be provided. To anticipate that raw materials remain, then the company must be possessed raw material inventory that will constitute inputs or materials required in a production system of a company. The raw material in the production process of CV. Cempaka can be divided into two, namely the main raw materials and auxiliary raw materials. The following is an explanation of each of the raw materials:

a. Main raw material

   The main raw material used in the production process is mixed tobacco, i.e. tobacco that is ready to be milled, then add the clove and sauce. This raw material consists of:

   1. Tobacco

Tobacco that is used is obtained by buying a chopped tobacco from farmers or local entrepreneurs in Madura (*Nicotiana Tabacum)*, Bojonegoro (*Virginia*), Jember (*Kastun*), Kedu (*Patri*), and Temanggung (*Orient*).

2. Sauce

   The sauce is used to scent and soften cigarettes, in addition, the sauce is material that served to determine the flavor and aroma of tobacco products produced. Certain types of sauce can serve to the tobacco to fit certain standards. The condition in question is the humidity of materials, whether or not the product is on fire, as well as other conditions that become a standard of the company. The sauce obtained from the suppliers. The following types of sauces used by the CV. Cempaka:

   - *Hexsarome*
   - Cream Butter
   - Vanilla
   - Cocoa
   - Sweet Oil
   - Tobago Chocolate
   - Tobago Sweet

3. Clove

   Clove used is a variety of Zanzibar clove that is obtained from suppliers in Trenggalek and Sulawesi.

b. Auxiliary Raw Material

The auxiliary raw material is extra material that serves as a support in order to better quality, durable, and easy to distribute. Here are auxiliary raw materials used in the production process of the Cempaka Long Size product:

1. *Ambri* Paper

Ambri paper is used for packaging tobacco, clove and sauce to be a stick of cigarette. On the paper there already painted the brand of cigarette and cut in such a way to facilitate the rolling process.

2. Cellophane

   Cellophane is used to wrap cigarettes prior to packing

3. Etiquette Paper

   Etiquette paper is a packing box. One etiquette paper box contains 12 cigarettes that have been wrapped in a cellophane. On the etiquette paper there has been a picture or logo, along with the cigarette brand along with other information.

4. Wrap Paper

   This wrap is made of waxed paper that used to wrap 240 packs of cigarette in one unit.

5. Box

   This box is made of cardboard used to wrap 6 wrap box.

6. Paper Cap

   This paper is used as the logo of the brand of cigarettes that is being stuck on the outer of the box.

7. Glue

   Glue is used as an adhesive in the *Ambri* paper used for rolling the tobacco into a stick of cigarette as well as an adhesive in packaging process.

8. Banderole

   Banderole is proof of payment of state levies on goods subject to excise duty, where in the banderole listed the price that government provision that is the retail price of each pack of cigarettes and excise tax rates imposed upon it.

CV. Cempaka in the use of raw materials from the warehouse is using the FIFO system, which is the raw material that entry first will be processed first. This system is done in order to avoid damage due to long storage time. However, there are some WIP in the process with a limited number to avoid stopping in the middle of the production process.

4.1.5.2 Production Process

The production process is mechanical or chemical steps used to create an object, usually repeated to create multiple units of the same item. The production process of CV. Cempaka is continuous production process which is a process that continues over time to meet the market demand with a predetermined standard. The production process flow of Cempaka Long Size 12 can be seen in the image below.

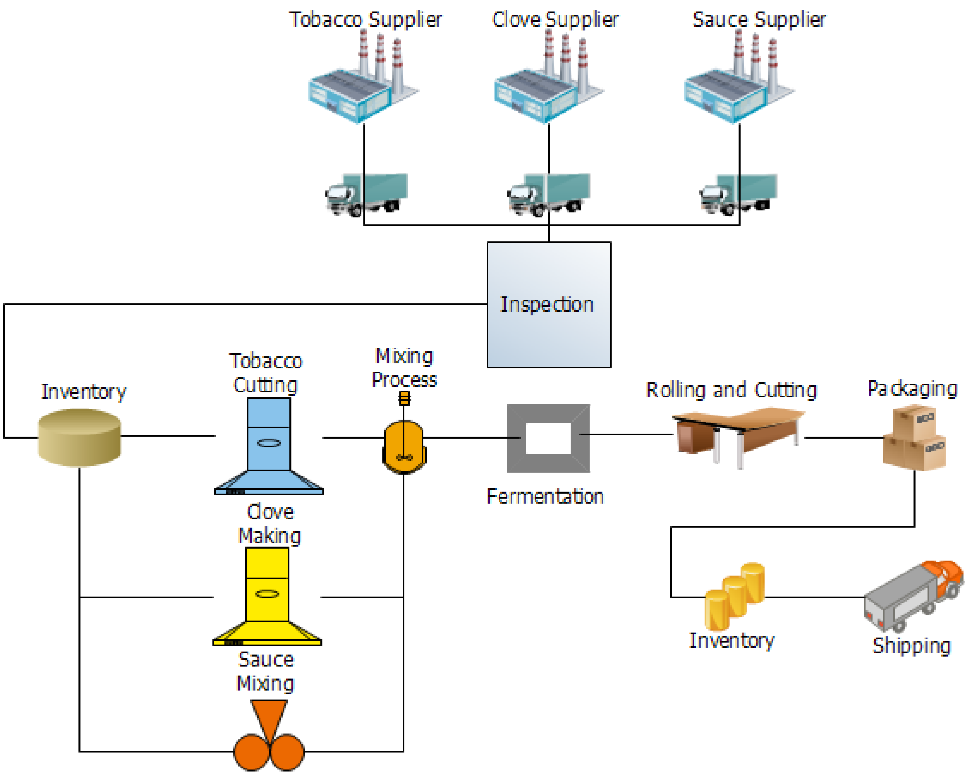

Figure 4.4 Production Process Flow

The production process starts from bringing the main raw materials, namely tobacco, clove and sauce as well as auxiliary raw materials. The inspection process is the first process experienced by the materials come. During the inspection process will be checked, whether the raw material comes in accordance with the request or not. Tobacco and clove inspection carried out by taking some of the contents and then will be checked its aroma, softness and appearance, while the sauce inspection carried out by checking whether the drum of the sauce is still in a good condition or not. The next process is to store the raw materials to each warehouses continued with the each processes so that the raw materials ready to be mixed.

The tobacco cutting process starts with picking tobacco from the warehouse to the tobacco cutting machine. Then the tobacco is inserted into the cleaning machine, where the process of removing impurities attached to the tobacco is done. From the cleaning machine, the next entry is the tobacco cutter machine for the cutting process, the process of cutting the tobacco into small pieces according to the standard size, but in this process, but the output is still the tobacco leaves, handles of the tobacco and dust. Furthermore, the output is processed in the classifier machine. On this machine between the leaves, the handles, and the dust will be separated. The handle will be taken to a dust collector, the dust will rise into the air duct and thrown into the air, while tobacco leaves will fall in the *outleet*. Furthermore, the finished tobacco is stored in the mixing process. For more details can be seen in the figure 4.5 below. Blue arrows show the overall flow of the tobacco, while the red arrows show the flow of the tobacco dust.

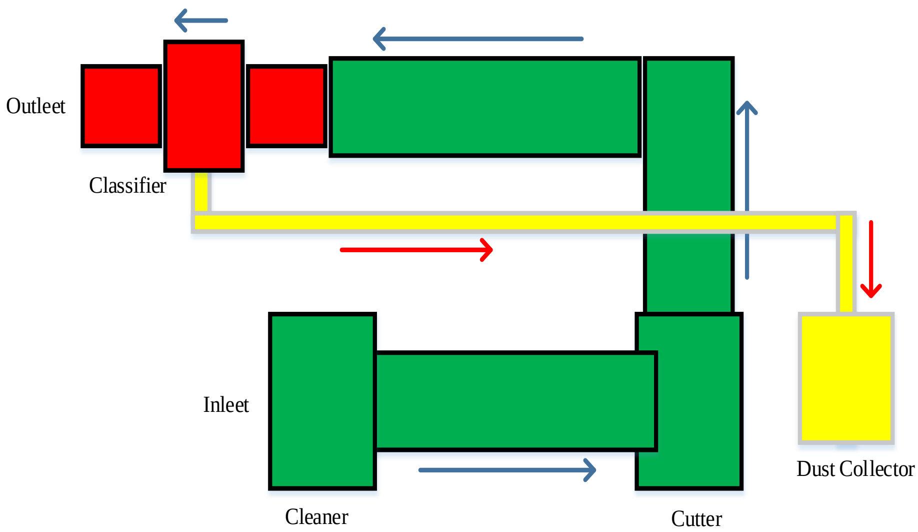

Figure 4.5 Tobacco Production Process

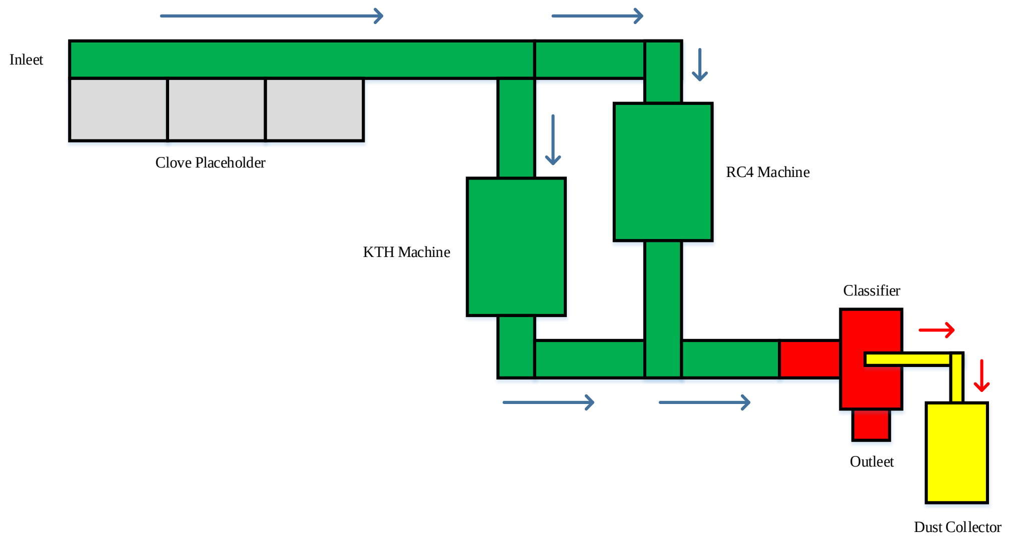

Figure 4.6 Clove Production Process

The clove production process is not much different from the tobacco production process. Clove production process to become clove that is ready to be mixed is starting from the immersion process that is carried out for 6 to 7 hours in the pool. Furthermore, clove drained and entered the *inleet* to get into the cutting machine, in this case the machine is KTH or RC4, non-filter products using KTH machine. Then, the clove goes into the classifier machine to be separated between the handle, dust and leaves, the output will be out in the *outleet*. The output will be dried for a day. It aims to open the pores of the cloves, thus extracting a good aroma and meet the standards.

Unlike the process of tobacco and clove, the sauce mixing process is done manually and not too complicated. In the process of sauce mixing, sauce that will be mixed taken from the sauce warehouse and then mixed in the sauce mixing room, then the results are stored in the finished sauce room.

The mixing process is the process of mixing the finished tobacco, finished clove and mixed sauce. This process is using a small machine, mixer machine. The finished tobacco, finished clove and mixed sauce brought to the mixing room. The tobacco and clove inserted into the machine, then the machine is running and when the machine is working conduct spraying the mixed sauce by an operator. After a few minutes the process ends, the output spilled onto the floor and put into drums for storage and brought to the warehouse before they are fermented.

The next process is the fermentation process, which results of the mixing process carried from the warehouse to a hot stuffy room that gets enough solar heat. The result will be put into boxes that will be taken to the rolling process.

The rolling process is done manually by entering the result of the fermentation process to a roller tool that is made of wood. Furthermore, it rolled with *Ambri* paper that has been given glue by pulling a lever of roller tool and then pushing it back so that it form a cigarette bar. The process continued with the cutting process, in which the ends of the stick are cut, so that the cigarettes will look neat. Cigarette bars further examined by the foreman to be checked according to the quality standard of the company, among others, include the size, roundness, and the neatness. For bars that do not meet the standards will be destroyed so that the tobacco can be reprocessed. The number of workers in the rolling process is 210 workers per May 2015.

The cigarette bars that meet the standards subsequently packed into 12 bars, using plastic. To pack them, used a tool made of wood and then glued together by heat from the element tool. Etiquette box is then plastered with banderole and price using glue. Furthermore, packed again using plastic, so as not to be easily damaged. 240 packs of cigarettes were then packed again into 1 carton and stamped. After that 6 cartons packed again into one box. Then the boxes are stored in the warehouse of finished goods.

4.1.5 Operation Process Chart (OPC)

OPC is a working map that describes the sequence of work of the whole production process. With the OPC, it can simplify the deception of the production process mapping systematically. On OPC there are some necessary data, for example the duration of a process. Figure 4.7 below is an OPC mapping of the production process of Cempaka Non-filter Long Size 12. The measurement unit used is 100 boxes or the equivalent of a ton tobacco, because, usually the company production uses 100 boxes as the target of production, besides, the machine’s capacity that used in the production process are a ton.

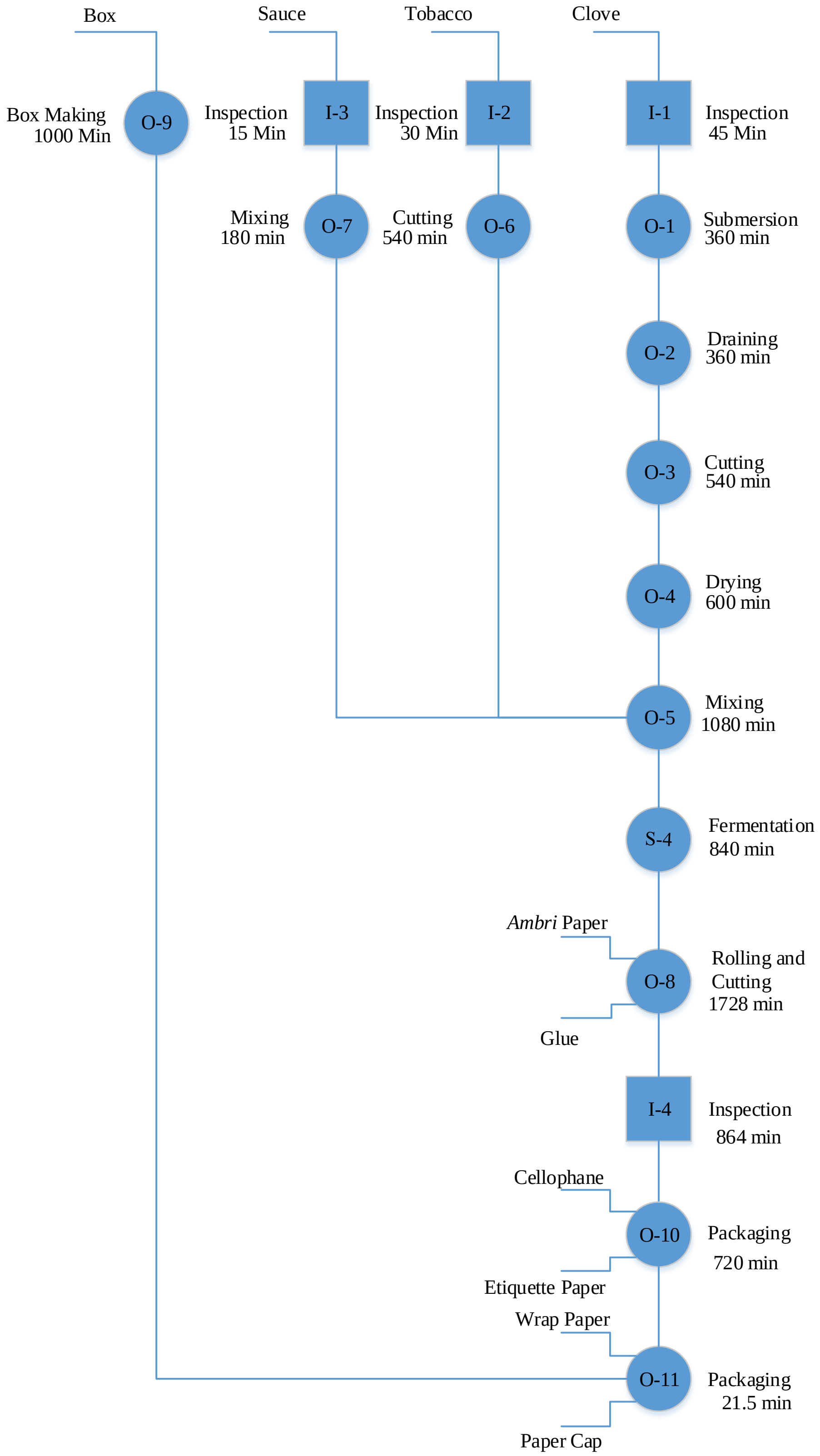

Figure 4.7 OPC of Production Process

Based on the OPC above, can be known that the total average time in processing a ton of tobacco into finished cigarette products is 6798.5 minutes. With a note that the fermentation process is actually done outside the working hours.

4.2 Define

Define is an early phase in the six sigma methodology that identify the various issues to be resolved. At this phase will be explained the problems that become observations to do improvement. This phase consists of the Big Picture Mapping (BPM), Activity Classification, and Waste Identification that occurs in the company.

4.2.1 Big Picture Mapping (BPM)

Big Picture Mapping (BPM) is a tool to define the flow material and information on the production process of the company. The flow of materials and information described starting from the supplier, the company to the customer. BPM also can describe the lead time for each process along the value stream in the company, so that BPM can also know where there is waste. Here is a Big Picture Mapping of the production process of Cempaka Non-filter Long Size 12.

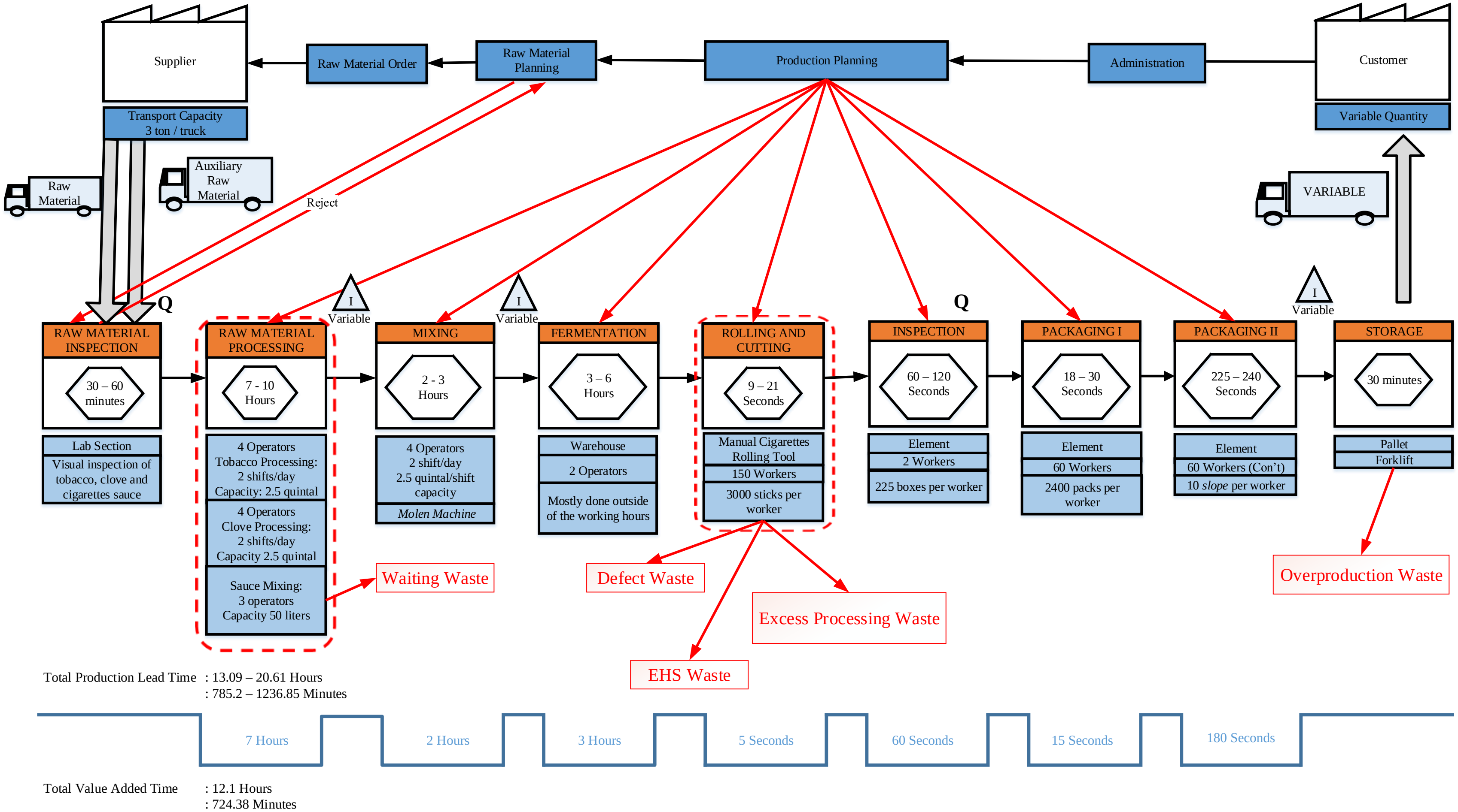

Figure 4.8 Big Picture Mapping

4.2.2 Information Flow

Existing conditions of production information flow in the company is described according to the Big Picture Mapping. The parties represent in the information flow are CV. Cempaka, suppliers, and customers in the form of agents, wholesalers, and non-wholesalers. Where parties of the company involved are the marketing, warehouse, administration, factory, purchasing, paymaster, lab, and vehicle. Here is the explanation of the information flow based on the company condition.

1. Order from the customer received by the marketing, which in turn forwarded to the warehouse, to be examined the availability of finished products in the warehouse. Administration in charge of deciding whether the request is accepted, pending or denied based on the condition of the machinery and production equipment, materials, production schedules that have been created, also the labor capability.
2. When an order is received, then the administration confirmed to the marketing. While the factory unit began to make the production planning, that starts from the determination of the amount of production. These units are generally preparing the production quantities greater than the number of orders received, this is done to anticipate the defective products. Another are planning the production schedule, resource and production equipment. These planning are necessary so that the person in charge on the production floor can prepare its resources in production activities.
3. Activities that are closely related to the production planning is prepare the raw materials to be used. Information on raw materials needed will be used to check the material stock in the warehouse. If the materials are available, then the person in charge of warehouse make the expenditure material planning and create the usage material report. However, if the material is not available, the person in charge of warehouse must immediately inform the administration to make a request to the person in charge of material purchasing.
4. Before the purchasing department do order material to the supplier, there are several mechanisms to do. The first mechanism is the warehouse section need to create a demand for the material letter. This letter is required as proof to the

management, that there has been a shortage of material in the warehouse. Based on the amount of material written on the letter, then the next mechanism is the purchasing section contacts several suppliers listed in the database to ensure the capability of material compliance with the order number of the company. The company uses multiple fixed suppliers, due to differences in tobacco, clove or sauce can affect the taste and aroma of cigarettes produced, in addition to the good relationship that has been established.

5. Suppliers deliver the raw materials in accordance to the delivery schedule specified by the company. When the material arrives at the company, the lab section perform quality control in accordance to the specifications. When the raw materials do not qualify for the quality control, then administration may cancel the acceptance of material.
6. When materials qualified from the quality control, material receipts can be done by the warehouse section and payment process is done by paymaster section when materials have entered all into the warehouse. Furthermore, the warehouse section must make a receipt of materials report as evidence that the materials have been entered into the warehouse.
7. Warehouse section also need to make a report on the use of materials issued for the production purposes, so that the information on the stock of materials in the warehouse continued to be up to date.
8. When the production is completed, the finished product could be carried out into the finished product warehouse. The warehouse section is responsible to record the amount of product that goes into the finished product warehouse, so that the marketing can do the planning of product delivery to the customers.
9. Furthermore, to make the delivery, the warehouse section must contact the vehicle section to confirm how many vehicles are needed along with the driver. When everything is confirmed, delivery to the customer is can be done.
10. Then the last process is the customer gives the confirmation to the marketing when the products are already acceptable.

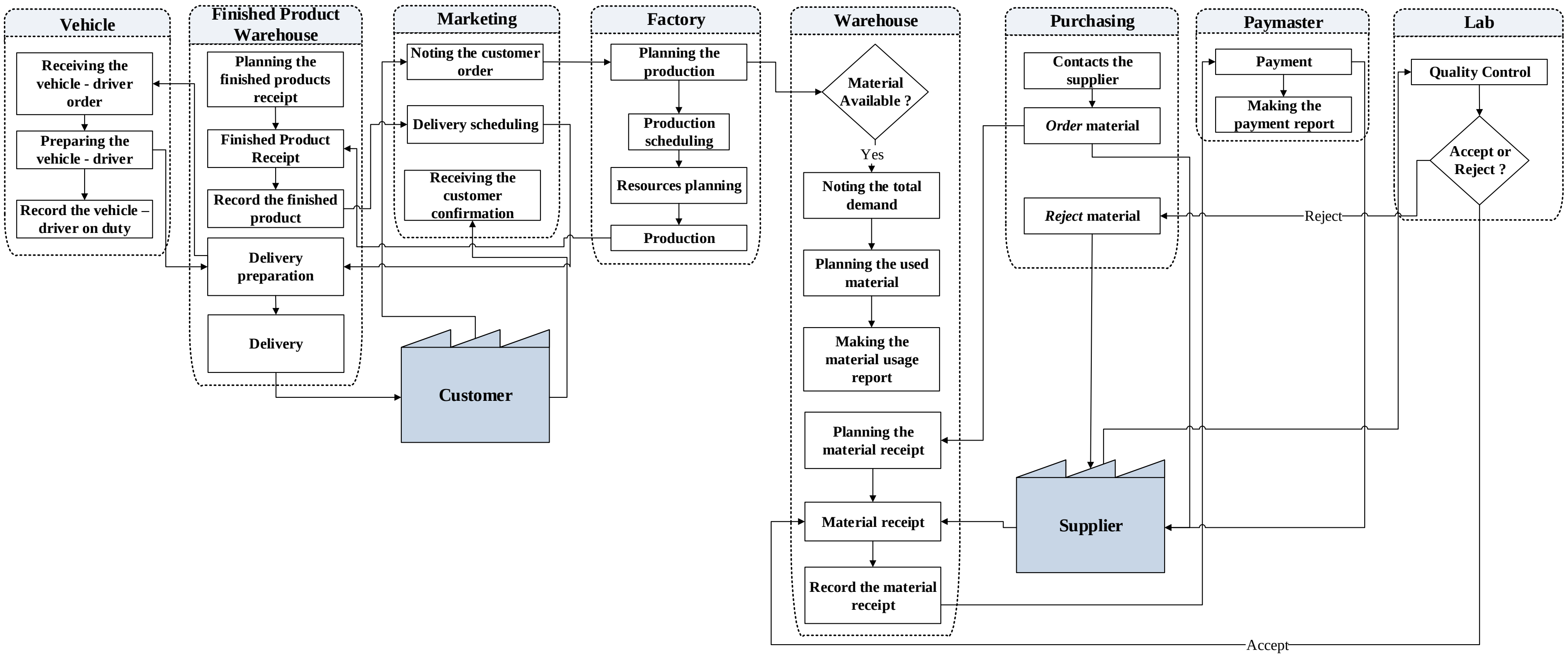

Figure 4.9 Information Flow of CV. Cempaka

4.2.3 Activity Classification

This stage is used to determine the amount of non-value adding activities that occur on the entire production activity of Cempaka Long Size 12 product. In the lean manufacturing concept, non-value adding activity is an activity that must be eliminated to reduce the amount of waste which is covered by the company. To do the activity classification, the first step is identifying all the activities of production at the company. The following are the activities at all stages of the production process.

1. Initial Inspection (Tobacco and Clove)
    - Unwrapping
    - Take samples
    - See the conditions (samples)
    - Weight check (samples)
    - Note raw materials coming
    - Transport to the warehouse

    Initial Inspection (Sauce)
    - See the seal condition
    - Note raw materials coming
    - Transport to the warehouse
2. Tobacco Cutting
    - Bring the tobacco to the cutting machine
    - Unwrapping
    - Prepare the machine
    - Prepare the tobacco in the *infleet*
    - Turn on the machine
    - Collect the output into sacks
    - Bring into the tobacco warehouse

    Clove Processing
    - Bring the clove into the immersion pool
    - Unwrapping
    - Soak the clove into the pool

- Fill the water into the pool
- Wait 2-3 hours
- Discard the water
- Let the clove drying for a night
- Input the clove into drums
- Bring the clove into the cutting machine
- Prepare the machine
- Prepare the clove in the *infleet*
- Turn on the machine
- Collect the output into sacks
- Bring the output into drying room
- Do drying for 1 day
- Flip upside down the dried cloves
- Collect the dried cloves
- Insert into sacks
- Bring the sacks to the clove warehouse

Sauce Mixing

- Bring the sauce to the sauce mixing room
- Spill sauces into the tub
- Do the mixing
- Incorporate the output into drums
- Shut the drums
- Bring to the mixing room

3. Mixing Process
    - Bring materials from each warehouse
    - Turn on the *molen* machine
    - Insert tobacco into the machine
    - Insert clove into the machine
    - Insert sauce to the spraying machine
    - Spray inside the *molen* machine
    - Stop the machine

- Spill the output onto the floor
- Put into drums
- Shut drums
- Bring to the fermentation warehouse

4. Fermentation Process
    - Set the temperature
    - Put the processed tobacco on the space
    - Ensure that tobacco has been fermented properly
    - Take the fermented tobacco
    - Put into drums
5. Rolling and Cutting Process
    - Bring drums to rolling compartment
    - Distribute the materials (*pambri* paper, fermented tobacco drums, glue)
    - Glue the *ambri* paper
    - Insert tobacco into the rolling tool
    - Take paper that has been glued and insert to the rolling tool
    - Take the cigarette sticks
    - Cut at the ends
    - Bind every 25 sticks using paper
    - Bring the results to the foreman
    - Do sorting and counting
    - Note the results
6. Packaging Process
    - Prepare the materials (cigarette sticks, plastic, etiquette paper, banderole, wax paper)
    - Insert sticks into the *press* tool
    - Glue plastic using *element*
    - Insert the plastic to the etiquette paper
    - Attach the banderole
    - Do packing with plastic

- Put the results into a box
- Do packing 20 packs of cigarettes in a wax paper
- Give cap
- Bring the results to the foreman
- Do packing 6 slopes into a box
- Bring to the finished product warehouse

The next step is to do the classification of all the activities that have been identified. Classification is based on three types of activities, which are value adding activity, non-value adding activity and necessary non-value adding activity. Here's a table of activity classification for each stage of the process.

Specification:

VA : Value Adding Activity

NNVA : Necessary Non Value Adding Activity

NVA : Non Value Adding Activity

Table 4.2 Activity Classification of Initial Inspection

Initial Inspection				
No.	Activities	Activity Classification		
		VA	NNVA	NVA
Tobacco and Clove				
1	Unwrapping		v	
2	Taking samples	v		
3	Seeing the conditions (samples)	v		
4	Weight check (samples)	v		
5	Note raw materials coming		v	
6	Transport to the warehouse			v
Sauce				
1	See the seal condition	v		
2	Note raw materials coming		v	
3	Transport to the warehouse			v

Table 4.3 Activity Classification of Initial Process

Initial Process				
No.	Activities	Activity Classification		
		VA	NNVA	NVA
Tobacco				
1	Bring the tobacco to the cutting machine			v
2	Prepare the machine		v	
3	Turn on the machine		v	
4	Put the tobacco in the *infleet*	v		
5	Turn off the machine		v	
6	Collect the output into sacks		v	
7	Bring to the tobacco warehouse			v
Clove				
1	Bring the clove into the immersion pool			v
2	Unwrapping		v	
3	Soak the clove into the pool	v		
4	Fill the water into the pool	v		
5	Wait 2-3 hours			v
6	Discard the water	v		
7	Let the clove drying for a night	v		
8	Input the clove into sacks		v	
9	Bring the clove into the cutting machine			v
10	Prepare the machine		v	
11	Turn on the machine		v	
12	Put the clove in the *infleet*	v		
13	Collect the output into sacks		v	
14	Bring the output into drying room		v	
15	Do drying for 1 day	v		
16	Flip upside down the dried cloves	v		
17	Collect the dried cloves		v	
18	Insert into sacks		v	
19	Bring the sacks to the clove warehouse			v
Sauce				
1	Bring the sauce to the sauce mixing room			v
2	Spill sauces into the tub	v		
3	Do the mixing	v		
4	Incorporate the output into drums		v	
5	Shut the drums		v	
6	Bring to the mixing room			v

Table 4.4 Activity Classification of Mixing Process

Mixing Process				
No.	Activities	Activity Classification		
		VA	NNVA	NVA
1	Bring materials from each warehouse			v
2	Turn on the *molen* machine		v	
3	Insert tobacco into the machine	v		
4	Insert clove into the machine	v		
5	Insert sauce to the spraying machine	v		
6	Spray inside the *molen* machine	v		
7	Stop the machine		v	
8	Spill the output onto the floor		v	
9	Put into drums		v	
10	Shut the drums		v	
11	Bring to the fermentation warehouse		v	

Table 4.5 Activity Classification of Fermentation Process

Fermentation Process				
No.	Activities	Activity Classification		
		VA	NNVA	NVA
1	Set the room temperature	v		
2	Put the processed tobacco on the space		v	
3	Ensure that tobacco has been fermented properly		v	
4	Collect the fermented tobacco		v	
5	Put into drums		v	

Table 4.6 Activity Classification of Rolling and Cutting Process

Rolling and Cutting Process				
No.	Activities	Activity Classification		
		VA	NNVA	NVA
1	Bring drums to rolling compartment		v	
2	Distribute the materials (paper, fermented tobacco drums, glue)		v	
3	Glue the *ambri* paper	v		
4	Insert tobacco into the rolling tool	v		
5	Take paper that has been glued and insert to the rolling tool	v		
6	Take the cigarette sticks	v		
7	Cut at the ends	v		
8	Bind every 25 sticks using paper		v	
9	Bring the results to the foreman			v

Table 4.6 Activity Classification of Rolling and Cutting Process (Continued)

Rolling and Cutting Process				
No.	Activities	Activity Classification		
		VA	NNVA	NVA
10	Do sorting and counting by the foreman		v	
11	Note the results by the foreman		v	

Table 4.7 Activity Classification of Packaging Process

Packaging Process				
No.	Activities	Activity Classification		
		VA	NNVA	NVA
1	Prepare the materials (cigarette sticks, plastics, etiquette papers, banderoles, wax papers)		v	
2	Insert sticks into the *press* tool	v		
3	Glue plastic using *element*	v		
4	Insert the plastic to the etiquette paper	v		
5	Attach the banderole	v		
6	Do packing with plastic	v		
7	Put the results into a box	v		
8	Do packing 20 packs of cigarettes in a wax paper	v		
9	Give cap	v		
10	Bring the results to the foreman			v
11	Do packing 6 slopes into a box	v		
12	Bring to the finished product warehouse		v	
13	Note the finished product by the warehouse foreman		v	

Table 4.8 Overall Activity Classification

No.	Activities	Number of Activities	VA	NNVA	NVA
1	Initial Inspection	9	4	3	2
2	Initial Process	32	10	14	8
3	Mixing Process	11	4	6	1
4	fermentation Process	5	1	4	0
5	Rolling and Cutting Process	11	4	5	2
6	Packaging Process	13	9	3	1
Total		81	32	36	13
Percentage (%)			40%	44%	16%

From the Table above, it was found that the total of value adding activities are 32 activities or 40%, while the total of necessary but non value adding activities are 35 or 43% and non-value adding activities are 14 or 17% of the total activities. From these data, it can be seen that in general process of the production process of Cempaka Long Size 12 is still less efficient, due to the low number of the value adding activities. There are still many activities that aren't providing value in the production process, so there are many opportunities to improve the production process that has been running in the company. Because the non-value adding activities could be eliminated and the necessary but non-value adding activities could be improved to be value adding activities.

4.2.4 Waste Identification

In this study, the waste identification carried out against 9 types of waste, namely the E-DOWNTIME waste. The types of waste are EHS (Environmental, Health and Safety) waste, Defects, Overproduction, Waiting, Not utilizing employee knowledge, Transportation, Inventory, Motion, and Excess Processing. The following is a description of the chances of waste in the production process at the company.

4.2.4.1 EHS (Environmental, Health and Safety) Waste

EHS waste is a type of waste that comes from not paying attention to the principles of environmental, health and safety, so that the impacts arising from this waste is interference to those three.

There are three EHS waste issues that need to be explored in the company. The first problem is the lack of awareness of the company and the employee to provide or wear a mask at work. Yet most processes release much of dust, which is not good for the respiratory health of the employees. Problems occur, especially on the rolling and cutting process, employees who do rolling and cutting do not use masks, even though there are a lot of dust in this process. Another problem occurs due to the chair used for the employees are considered less ergonomic, especially since there is no backrest of the chair. In addition, poor condition of the rolling and cutting room. Lack of air vents make the room was very hot and stuffy. Of course, both of these are very detrimental to the health and the performance of employees.

The company's production process involves two types of employees, i.e. permanent employees and temporary employees. Permanent employees get a monthly salary, while temporary employees receive a daily salary after the employee doing his job.

The absence of permanent workers is not too influential in the production process, because when someone is absent, the production process is still running. In addition, the position will be replaced by others who used to work in the position. For example, is the machine operator, the machine will still work when the employee is absent and he will be replaced by another machine operator, since one machine to the other does not differ much in its operation. Unlike the temporary workers, the company will know whether he is absent during the production process runs. So it is not possible to be replaced by other workers. Here is the data of the temporary employees who are absent when the company doing production of Cempaka non-filter Long Size 12.

Table 4.9 Number of Absent due to Illness

Month	Working Days	Expectation	Illness	Others
January	6	900	75	22
February	6	900	68	49
March	5	750	39	19
April	6	900	62	25
May	5	750	45	30

4.2.4.2 Defect Waste

A defect is a waste that is often found in manufacturing companies. In the production process of Cempaka Long Size 12 there are some defects were found. A defect is an event where the products are not in accordance with specifications. In the production process of Cempaka Non-filter Long Size 12 defects occurs during the rolling and cutting process. Usually, defects that occur are uneven cutting on its ends, non-perishable products, pigmentation and unequal size. Those 4 defects can be known at the time of inspection by the foreman. Here are a defective product data from January through May were recorded by the foreman.

Table 4.10 Number of Defect

Month	Production (Rods)	Defect (Rods)
January	2,736,000	507,130
February	3,244,000	537,615
March	2,864,000	513,643
April	3,660,000	625,664
May	2,532,000	579,059

4.2.4.3 Overproduction Waste

Overproduction is a type of waste, where the number of products produced exceeds the planned quantity. Although there are a lot of idle in the production process, based on the observations in the company, it is known that the company's production capacity is much higher than the capacity required to meet the customer demand.

Overproduction in the process of Cempaka Non-filter Long Size 12 caused by unstable demand, when demand is at a low position, the company tends to take a policy to increase the number of monthly production, so labor and production facilities to keep operating, the management cannot terminate the labor force at any time, especially when demand is at its low condition. That is the reason why overproduction occurs more frequently in the production of non-filter cigarette that is done by labor force, compare to filter cigarette that uses automation.

Under these conditions there will arise the financial loss to the company. The first disadvantage is the amount of production costs incurred by the company on products that do not provide revenue to the company. The condition can occur because of some products with a large quantity already in the finish goods warehouse and unsold on the market. Though there is a time limit so that the cigarettes can be sold in good condition. The second disadvantage is an additional cost that must be issued by the company to give special treatment to the product, the cost of inventory holding cost.

In order to perform further calculations to determine the capabilities of the company against the overproduction waste, it is necessary to identify the inventory data of finished product compared to order. Listed below is the data of the procurement to the amount of order or sales from January to May 2015.

Table 4.11 Number of Overproduction per Month

Month	Order/Sales	Production	Overproduction
January	218,880	228,000	9,120
February	264,927	270,333	5,406
March	217,187	238,667	21,480
April	292,800	305,000	12,200
May	195,175	211,000	15,825

The data are presented in pack units, due to sales or order by the customer are usually in units of pack or boxes. Where 1 box contains 6 wrap paper boxes, 1 wrap paper boxes contains 240 packs of cigarettes, and 1 pack contain 12 rods.

4.2.4.4 Waiting Waste

Waiting is a waste where machine or production facility stopped operating due to wait activity. If a process spends more time than other processes, the operator and the machine. In the company there are waiting waste that mainly occurs in processes that use machine. In particular, this problem occurs on cutting machines, both in clove and tobacco cutting machine. Sometimes it also happens on the *molen* machine. The standard time is determined from the average time of machine works in cycles. In one cycle, there are 6 shifts. Usually, in one month machine do 2 times cycles for this product. Usually, the occurrence of machine downtime at the company caused by the production capacity that exceeds the capacity of the machines, so the machine will get overloaded and stops, another cause is periodic power cuts, as well as the lack of available workers to run the process. Preventive maintenance of the machines by the operator are usually done outside of the working hours. The following is downtime data that occurs in the production process of non-filter cigarette Long Size 12. Data taken from January to May.

Table 4.12 Machines Downtime Data

Month	Cycle	Process	Normal Time	Production time	Downtime
January	1	Tobacco Cutting	540	555	15
		Clove Cutting	540	540	0
		Mixing	1080	1080	0

Table 4.12 Machines Downtime Data (Continued)

Month	Cycle	Process	Normal Time	Production time	Downtime
	2	Tobacco Cutting	540	550	10
		Clove Cutting	540	540	0
		Mixing	1080	1080	0
February	1	Tobacco Cutting	540	540	0
		Clove Cutting	540	555	15
		Mixing	1080	1080	0
	2	Tobacco Cutting	540	555	15
		Clove Cutting	540	555	15
		Mixing	1080	1080	0
March	1	Tobacco Cutting	540	540	0
		Clove Cutting	540	540	0
		Mixing	1080	1080	0
	2	Tobacco Cutting	540	550	10
		Clove Cutting	540	550	10
		Mixing	1080	1080	0
April	1	Tobacco Cutting	540	540	0
		Clove Cutting	540	550	10
		Mixing	1080	1080	0
	2	Tobacco Cutting	540	540	0
		Clove Cutting	540	540	0
		Mixing	1080	1110	30
May	1	Tobacco Cutting	540	570	30
		Clove Cutting	540	560	20
		Mixing	1080	1080	0
	2	Tobacco Cutting	540	545	5
		Clove Cutting	540	555	15
		Mixing	1080	1080	0

Waiting waste that occurs in the company can lead to financial losses. The loss is the loss of production capacity in production process as long as the machine is deal with the downtime, or the process delayed. So that the company will incur a loss as a product that should be able to be produced by the company as long as the machine undergoing refurbishment or unplanned downtime.

4.2.4.5 Not Utilizing Employee Knowledge Waste

This waste is a type of waste that arise from non-utilized knowledge, skills, and abilities of the employees. This kind of waste is rarely encountered in CV. Cempaka, especially in the production floor. Production floor employees in the company are very experienced in dealing with the production in the company. This is due to the long period of service, so that the labor force was skilled in a wide range of production activities at the company. This was evidenced by the ability of workers to carry out work in another part, due to rolling of labor. For example, the operators of clove cutting machine that are able to do submersion process of clove and able to do mixing process.

4.2.4.6 Transportation Waste

At the time of initial observations, there were many indications of this waste, due to many warehouses, which affects the movement of the forklift. However, after being given an explanation and brainstorming by the company, that the warehouses are indeed distinguished by various functions to maintain the quality of products in it, then this problem cannot be indicated as waste. While in the rolling, cutting, and packaging process hasn't indicated the amount of goods movement, because every person has provided the material each in its place. The movement just occurred when workers collecting the results to the foreman, which is at a very low intensity.

4.2.4.7 Inventory Waste

Inventory is a type of waste caused by excess material. This raises the cost of storage of these materials. For this type of waste, observations conducted on two types of storage, the storage of raw materials and WIP (Work in Process) materials. However, based on observations as well as brainstorming with the company, not indicated any problems of this kind of waste.

Raw material storage on raw material warehouses, both in a tobacco warehouse, clove warehouse and sauce warehouse are considered in the optimum condition, because it does not look too much stock. Also, according to the explanation from the company, it is known that the company had been considering the material stock based on the production plan that has been created.

WIP materials that exist in the company is quite high in number. This can be seen from the number of sacks of WIP that was in some corner of the production floor, especially in the mixing room. However, storage of this type of material is also not a problem, because, according to the company this is done so that the production process more balanced, not mutually wait for each other. In addition the company has set up the laying of WIP materials in order to avoid wastage of material handling costs.

4.2.4.8 Motion Waste

This type of waste occurs because of the excessive movement of employees on the production floor, causing physical fatigue on the employee. In the company, the type of waste was initially indicated occurs in the rolling, cutting, and packaging process, but after do brainstorming with the workers who do this, the rolling, cutting, and packaging employee, it was found that in the process of rolling, cutting and packaging more worker fatigue occurs due to the heat of the room, not because of the movement, plus workers in this section has been working regularly with the same tasks every day throughout the year, so they have become accustomed to perform the movement of rolling, cutting and packaging.

In addition to the process of rolling, cutting and packaging, motion waste can occur because of too many activities that must be carried out in accordance with the standard operational procedure of operator. The machine used by the company is old machines with a conventional working principle, so it takes a lot of activities from the operators. Activities that most people do and most potentially cause fatigue to the operator is moving materials activity, either materials that have not been processed or materials that have been processed. However, based on the brainstorming with the company, it was found that the probability of this waste can be minimized by increasing the number of operators. So that the moving material activity can be shared with other operators. Additional operators of this activity can be done because in one day not all machines are operating, so that the number of existing operators could be maximized for the machines that operate.

4.2.4.9 Excess Processing Waste

This waste is one type of waste that is caused by over activity of a product. Where the waste of this type is closely related to the rework activity to reject products. Rework activities done by the company due the defective cigarette products, such as less dense cigarettes, damaged cigarettes because of uneven gluing, and uneven cutting on its ends. Those defective products were destroyed and the tobacco reused with the new *Ambri* paper.

The rework result in waste of resource in the company as well as the energy consumed by the company to carry out production activities. Due to the high level of rework in the company is determined by the amount of defect products, then to suppress expenses, the company needs to decrease the number of defects.

4.2.5 Key Performance Identification

In this study, the key performance identification carried out against the Overall Labor Effectiveness. Where there are three indicators used to measure the performance of the company's production process, namely availability, performance, and quality. Below are the description and identification of factors that affect all three.

4.2.5.1 Availability

Availability is the percentage of time spent by employees in contributing effectively during the production process. The percentage is obtained by calculating the loss of working hours of employees during the production process resulting in delays in the production process caused by a shortage of employees in the production area.

Initially, there are 3 cause indication of availability problems in the company, namely the absence of workers, whether sick, permission, or alpha, the unavailability of raw material during the production process, and loss of working hours because the workers perform rework of the defective products. However, after direct observation on the rolling and cutting process is done, it was found that from those three factors, the unavailability of raw materials to be processed is rarely happening. So in this study, availability just focus on the absence of workers and loss of working hours because of the rework.

- Absences

  Here are the data obtained from the company about the absence of workers.

Table 4.13 Number of Absences

Month	Working Days	Illness	Permission	Others
January	900	75	20	2
February	900	68	15	0
March	750	39	19	0
May	900	62	20	5
June	750	45	21	1

- Rework

  Rework problems reduce the availability of worker performance due to the time wasted to do rework due to defective products. Here is the data of the time wasted to do rework.

Table 4.14 Number of Workers needed to do Rework

Month	Defects	Rework (Person)
January	507,130	127
February	537,615	134
March	513,643	128
April	625,664	156
May	579,059	145

4.2.5.2 Performance

Performance is the number of products submitted or generated in the production process. If the amount of production delivered less than the production target, means the company's performance is also not good. At this observation, this indicator is not counted as a problem, given every worker is pegged to produce 4,000 rods per day, and the rise and fall of production per month are caused by other factors, such as the absence of workers, the number of defects that need to rework or products that intentionally diverted to other types of products for the needs of the market.

4.2.5.3 Quality

Quality is the percentage of products that can be sold to the market. The data used to calculate the percentage of quality is the same data as the defect waste. Where the data used are data on the number of defective products from January to May.

4.3 Measure

Measure phase is the second stage in the Six Sigma DMAIC method. This phase addresses and calculate how big the problems that exist in the company and its impact to the company. Then the critical problems will be improved in at the later phase.

4.3.1 Waste Measurement

In this phase will be calculated the financial waste and the sigma value of each waste that has been identified in the previous section. This measure phase aims to find out how big the waste problem that occurs as well as its influence on the company financially.

4.3.1.1 EHS (Environmental Health and Safety) Measure

At this stage will be measured the Environmental Health and Safety to the production activities in the company. The impact which is calculated in this study, is the amount of loss to the company, as a result of lack of attention to the EHS factors in the company. Losses are calculated based on the large number of worker absenteeism caused by illness or occupational accidents. As explained in the previous subchapter, the occupational accident compensation is borne by *BPJS Ketenagakerjaan*, then it is not a loss for the company.

Has been explained before, that the company's production process involves two types of employees, i.e. permanent employees and temporary employees. Permanent employees get a monthly salary, while temporary employees receive a daily salary after the employee doing his job. So that the impact measurement, especially the financial waste impact was distinguished between the permanent and temporary employees. Here are the data that has been processed to determine the impact of employee absenteeism due to illness.

Table 4.15 Loss Caused by Workers Absent due to Illness

Month	Working Days	Illness	Loss (Rods)
January	6	85	340,000
February	6	88	352,000
March	5	79	316,000
April	6	72	288,000
May	5	75	300,000
Total		399	1,596,000

a. Control to Quality

The first step in EHS waste of measure phase is to identify the CTQ (Critical to Quality). Here is the calculation of absence due to illness of data given by personnel section that occurred from January to May 2015.

Table 4.16 Classification of causes of worker illness led to absences

Month	Headache or dizziness	Muscle disorders (Stiff neck, Back pain)	Respiratory (Flu, Cough, Asthma)	Others
January	39	22	17	7
February	31	32	14	11
March	29	30	19	1
April	27	23	17	5
May	32	19	19	5
Total	158	126	86	29

Next, making a Pareto chart by running the Minitab software. Figure below is a Pareto chart, output from the Minitab software.

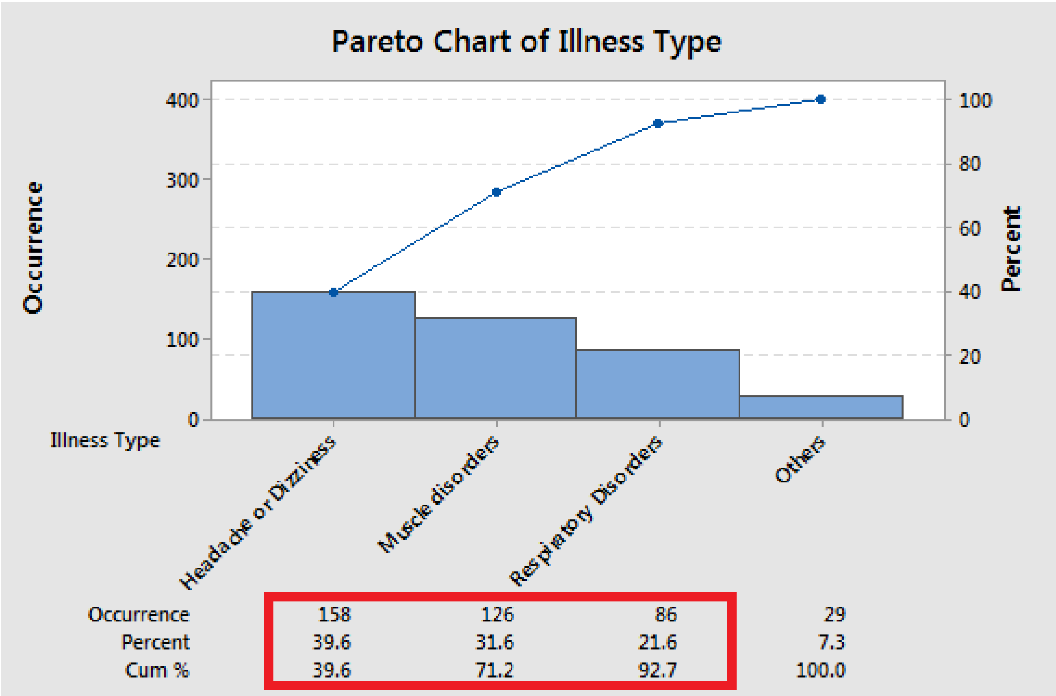

Figure 4.10 Pareto Chart of Illness Type

Based on the Pareto chart, then on those four causes of EHS waste that occurred, the selected number and types of CTQ selected are Headache or Dizziness, Muscle Disorders, and Respiratory Disorders

b. Sigma Level Calculation

To calculate the sigma level, use the following formula.

$$\mathrm{DPMO} = \left(\frac{D}{U \times O}\right) \times 10^6 \quad \text{.........(4.1)}$$

$$\text{Sigma level} = 0.8406 + \sqrt{29.37 - 2.221 \times \ln(\mathrm{DPMO})} \quad \text{.........(4.2)}$$

Where:

D, is the number of failures

U, the number of outputs

O, the number of possible defect or failure or CTQ

DPMO (Defects per Million Opportunity), the chances of defects per one million is likely to occur.

To simplify the sigma level calculation, then from the above formula is made into a calculation table of DPMO and sigma level. Based on the previous table, the known number of absences in the last 5 months is 392. The number of absences due to illness is 399 employee working days. Then the following, the calculation for health problems in the company.

Table 4.17 Sigma Level Calculation of EHS Waste

Information	Value
Number of Output	4382
Number of Illness	399
Illness per Absences	0.091
CTQ	3
Failure rate opportunity per CTQ	0.030
DPMO	30351
Sigma Level	3.38

Based on the table above, the DPMO of the company loss due to illness is 30,351. Meanwhile, the sigma level is 3.38. That means below the good limit, then, the improvement is still needed in this waste.

c. Financial Waste

Calculation of financial losses borne by the company for this type of waste is based on the production capacity loss when an employee is absent due to illness. Losses are calculated based on the production capacity of the employee. Every employee in this process each day shall collect 4000 rods to the foreman, then the employee would be paid and the results are inspected by the foreman. Each non-filter Long Size 12 cigarette packs has a price of 3,000 rupiahs. Therefore, the price of each rod is 250 rupiahs. Based on this, the following is the calculation of EHS waste loss financially.

Table 4.18 Financial Loss from EHS Waste Calculation

Month	Working Days	Illness (Working Days)	Loss (Rods)	Value (Rupiahs)
January	6	85	340,000	85,000,000
February	6	88	352,000	88,000,000
March	5	79	316,000	79,000,000
April	6	72	288,000	72,000,000
May	5	75	300,000	75,000,000
Total		399	1,596,000	399,000,000

From these explanation, the financial loss from EHS waste is 399,000,000 rupiahs.

4.3.1.2 Defect Measure

Defect waste calculation is done based on the identification of waste defect in the previous section, there are 4 types of defect waste that occur, that are uneven cutting on its ends, non-perishable products, pigmentation and unequal size. Here are a recap data of defect waste.

Table 4.19 Recap Data of Defect Waste

Month	Production (rods)	Defect (rods)
January	2,736,000	507,130
February	3,244,000	537,615
March	2,864,000	513,643
April	3,660,000	625,664
May	2,532,000	579,059
Total	15,036,000	2,763,111

a. CTQ (Critical to Quality) Identification

The first step in defect waste of measure phase is to identify the CTQ (Critical to Quality). To determine the CTQ of defect waste, it would require a data of defect types and its frequency of occurrence in the company. However, the number of production per day that is so high and an indication that the normal calculation will disrupt the production process, so after doing brainstorming with the company, the data of defect types and its frequency of occurrence is taken by sampling.

By using Slovin formula (Riduan, 2005), the average number of defects per month is 552,622, then found that the number of samples to be taken is 400 to facilitate the counting.

Here is the Slovin formula

$$n = \frac{N}{1 + Ne^2} \quad \text{...} (4.3)$$

n = Sample Size

N = Population Size

e = Margin of Error

So, the number of defect samples taken is 200 sticks per period. Here are the calculation data of defect samples that occurred from January to May 2015.

Table 4.20 Classification of Defect Type

Month	Period	Defects			
		Uneven Cutting	Uneven Size and Shape	Deflated	Pigmentation
January	1	87	58	38	17
	2	63	71	30	36
February	1	91	62	24	23
	2	70	72	49	9
March	1	85	72	37	6
	2	82	84	19	15
April	1	71	77	41	11
	2	74	88	33	5
May	1	90	76	29	5
	2	98	66	33	3
Total		811	726	333	130

Next, making a Pareto chart by running the Minitab software. The figure below is a Pareto chart, output from the Minitab software.

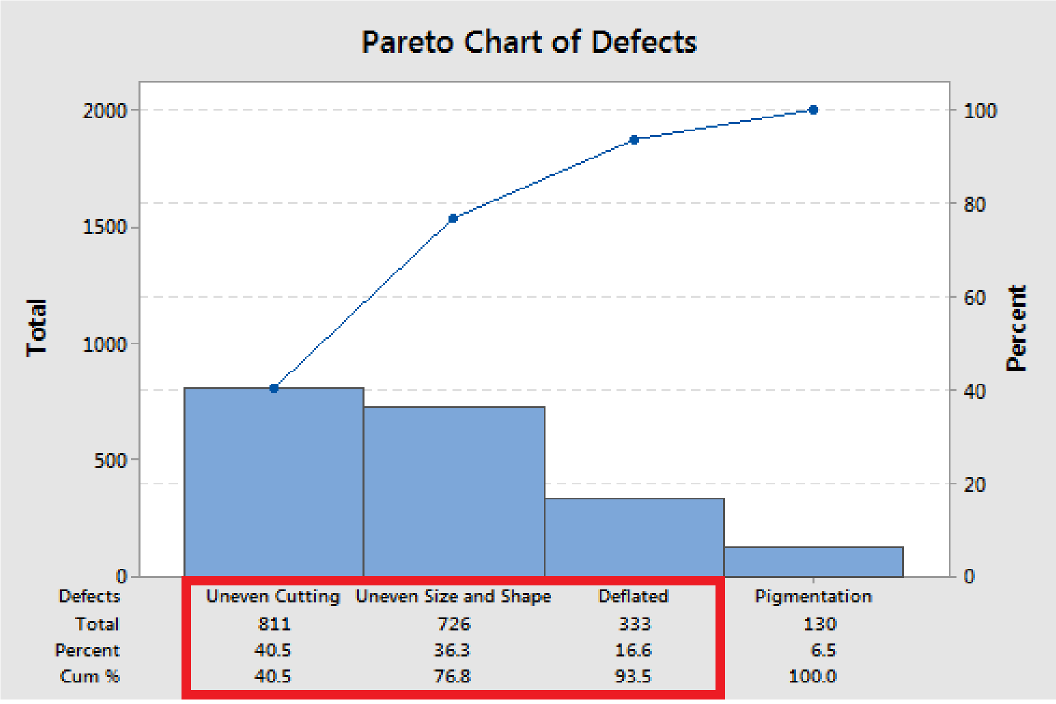

Figure 4.11 Pareto Chart of Defect Waste

Based on the Pareto chart, then on those four causes of defects that occurred, the selected number and types of CTQ selected are uneven cutting, uneven size and shape, and deflated.

b. Sigma Level

To calculate the value of DPMO and sigma level of the defect waste. Then use the DPMO and the sigma level calculation table. Here is the table of DPMO and sigma level calculation of defect waste.

Table 4.21 Sigma Level Calculation of Defect Waste

Information	Value
Number of Output	15,036,000
Number of Defect	2,763,111
Defect per Unit	0.1838
CTQ	3
Failure rate opportunity per CTQ	0.061
DPMO	61255
Sigma Level	3.05

Based on the calculation of the sigma level above, shows that the production process has a sigma level of 3.05 against the defect waste. That means the sigma level is still below the limit, so it still requires improvements.

c. Financial Waste

Financial waste of defect in this company is based the financial loss due to the defects that exist. Previously described, defect occurs in the rolling and cutting process, and identified in the inspection process. When there is a defect product, the foreman would destroy the cigarettes rod manually, then tobacco will be collected so that it can be reused. Loss of rework is calculated based on the production capacity lost when the employees do rework.

Table 4.22 Financial Waste of Defect Calculation

Month	Defect	Value
January	507,130	126,782,500
February	537,615	134,403,750
March	513,643	128,410,750
April	625,664	156,416,000
May	579,059	144,764,750
Total	2,763,111	690,777,750

From these explanation, the financial loss from defect waste is 690,777,750 rupiahs.

4.3.1.3 Overproduction Waste

In this chapter will be measured the overproduction waste impact on the company. Here are the data obtained from the company regarding the overproduction waste.

Table 4.23 Recap Data of Overproduction Waste

Month	Order/Sales	Production	Overproduction
January	176,619	185,739	9,120
February	220,126	225,532	5,406
March	174,383	195,863	21,480
April	240,661	252,861	12,200
May	146,920	162,745	15,825
Total	958,710	1,022,741	64,031

a. Control to Quality

Because there is no particular characteristics of this waste, then the number of CTQ is 1.

b. Sigma Level

To calculate the value of DPMO and sigma level of the overproduction waste. Then use the DPMO and the sigma level calculation table. Here is the table of DPMO and sigma level calculation of defect waste.

Table 4.24 Sigma Level Calculation of Overproduction

Information	Value
Number of Output	1022741
Number of Overproduction	64031
Overproduction per Output	0.063
CTQ	1
Failure rate opportunity per CTQ	0.063
DPMO	62607
Sigma Level	3.04

Based on the calculation of the sigma level above, shows that the overproduction waste has a sigma level of 3.04. That means the sigma level is still below the limit, so it still requires improvements.

c. Financial Waste

On the overproduction waste, the financial loss calculation is based on the unsold finished goods. Calculation is based on how many pack that cannot be sold to the customers. Furthermore, the amount will be multiplied by the price of its pack, where the price is 3,000 rupiahs per pack. Moreover, the holding cost borne by the company because of the unsold goods is also will be added. From the brainstorming with the company, the holding cost is assumed at 25% of the production cost, and the production cost is 1,750 rupiahs. The high percentage of the holding cost is caused by the presence of a particular treatment in order to keep the products quality. The calculation of financial waste of overproduction is as follows.

- Unsold Goods

Table 4.25 Financial Calculation of Unsold Goods

Month	Order/Sales	Production	Overproduction	Value
January	176,619	185,739	9,120	27,360,000
February	220,126	225,532	5,406	16,218,000
March	174,383	195,863	21,480	64,440,000
April	240,661	252,861	12,200	36,600,000
May	146,920	162,745	15,825	47,475,000
Total	958,710	1,022,741	64,031	192,093,000

- Holding Cost

Table 4.26 Financial Calculation of Holding Cost

Month	Overproduction	Holding Cost
January	9,120	3,990,000
February	5,406	2,365,125
March	21,480	9,397,500
April	12,200	5,337,500
May	15,825	6,923,438
Total	64,031	28,013,563

Then from the unsold goods total value holding cost summed up as follows.

Total financial waste overproduction

= Rp. 192,093,000 + Rp. 28,013,563

= Rp. 220,106,563.00

From these explanation, the financial loss from overproduction waste is 220,106,563 rupiahs.

4.3.1.4 Waiting Waste

To measure the waiting waste, the data that has been recorded on the stage of waste identification is used to find the CTQ and sigma level. It was explained earlier that there are two cycles in every month. Each cycle has been done for 3 days, and every day there are 2 shifts.

a. Control to Quality

CTQ calculations on waste aims to find which machines are critical for further analysis based on the theory of Pareto chart. For the identification of the CTQ, then the data required each machine downtime. Here are the data of each machine downtime from January to May 2015.

Table 4.27 Calculation of Machines Downtime

Process	Month	Cycle Time	Downtime	Percentage	Total
Tobacco Cutting	January	1105	25	2.3%	9.02%
	February	1110	30	2.7%	
	March	1090	10	0.9%	
	April	1080	0	0.0%	
	May	1115	35	3.1%	
Clove Cutting	January	1080	0	0.0%	7.68%
	February	1110	30	2.7%	
	March	1090	10	0.9%	
	April	1090	10	0.9%	
	May	1115	35	3.1%	
Mixing	January	2160	0	0.0%	2.06%
	February	2175	15	0.7%	
	March	2160	0	0.0%	
	April	2190	30	1.4%	
	May	2160	0	0.0%	

Then do running the Minitab software to get the Pareto chart of each process. Here is the result.

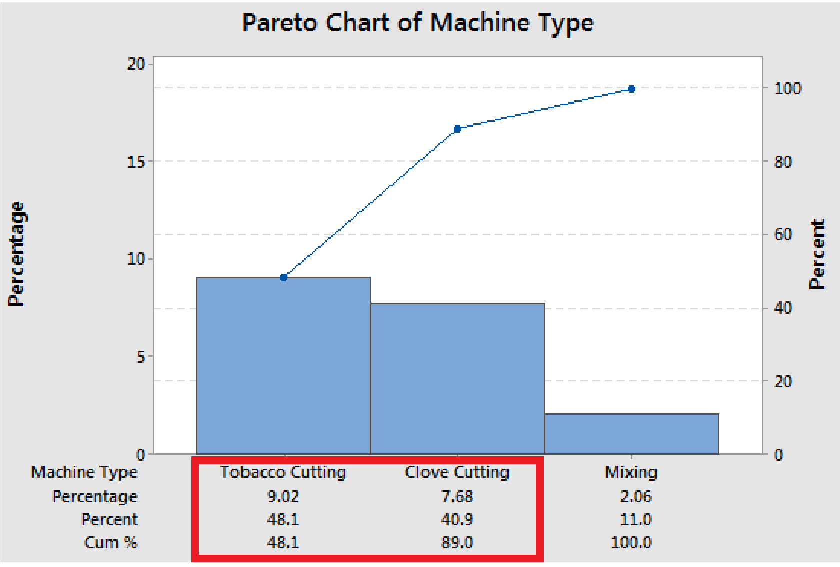

Figure 4.12 Pareto Chart of Machines Downtime

Based on the Pareto chart, both machines are chosen as the CTQ. Then the number of CTQ is 2.

b. Sigma Level

To calculate the value of DPMO and sigma level of the waiting waste. Then use the DPMO and the sigma level calculation table. Here is the table of DPMO and sigma level calculation of defect waste.

Table 4.28 Sigma Level Calculation of Waiting Waste

Information	Value
Number of Output	21830
Number of Overproduction	230
Downtime per Output	0.0105
CTQ	2
Failure rate opportunity per CTQ	0.0053
DPMO	5268
Sigma Level	4.06

Based on the calculation of the sigma level above, shows that the overproduction waste has a sigma level of 4.10. That means the sigma level is above the limit, so it doesn't require improvements.

c. Financial Waste

In calculating the financial waste of waiting, the calculation is based on the amount of cigarettes that should be able to be produced, when the machine is downtime. Then calculating the loss of sales of the amount of cigarette rods that are not capable to be manufactured by the machine when the machine is downtime.

The number of cigarette rods that should be able to be produced in the 1 cycle is obtained from the conversion of the number of cigarettes produced on average in a month, where the machines work 6 days per month or 3 days per cycle, i.e. 2,454,578 rods, there are 2 cycles in a month, so on a cycle the machine should be able to produce 1,227,289 rods. Here is the calculation

Table 4.29 Financial Cost of Waiting Waste Calculation

Month	Cycle	Process	Production time	Downtime	Percentage	Loss sales per production	Cost
January	1	Tobacco Cutting	555	15	2.7%	33,170	8,292,493
		Clove Cutting	540	0	0.0%	-	-
		Mixing	1080	0	0.0%	-	-
	2	Tobacco Cutting	550	10	1.8%	22,314	5,578,586
		Clove Cutting	540	0	0.0%	-	-
		Mixing	1080	0	0.0%	-	-
February	1	Tobacco Cutting	555	15	2.7%	33,170	8,292,493
		Clove Cutting	555	15	2.7%	33,170	8,292,493
		Mixing	1080	0	0.0%	-	-
	2	Tobacco Cutting	555	15	2.7%	33,170	8,292,493
		Clove Cutting	555	15	2.7%	33,170	8,292,493
		Mixing	1095	15	1.4%	16,812	4,203,045
March	1	Tobacco Cutting	540	0	0.0%	-	-
		Clove Cutting	540	0	0.0%	-	-
		Mixing	1080	0	0.0%	-	-
	2	Tobacco Cutting	550	10	1.8%	22,314	5,578,586
		Clove Cutting	550	10	1.8%	22,314	5,578,586
		Mixing	1080	0	0.0%	-	-

Table 4.29 Financial Cost of Waiting Waste Calculation (Continued)

Month	Cycle	Process	Production time	Downtime	Percentage	Loss sales per production	Cost
April	1	Tobacco Cutting	540	0	0.0%	-	-
		Clove Cutting	550	10	1.8%	22,314	5,578,586
		Mixing	1080	0	0.0%	-	-
	2	Tobacco Cutting	540	0	0.0%	-	-
		Clove Cutting	540	0	0.0%	-	-
		Mixing	1110	30	2.7%	33,170	8,292,493
May	1	Tobacco Cutting	570	30	5.3%	64,594	16,148,539
		Clove Cutting	560	20	3.6%	43,832	10,957,938
		Mixing	1080	0	0.0%	-	-
	2	Tobacco Cutting	545	5	0.9%	11,260	2,814,883
		Clove Cutting	555	15	2.7%	33,170	8,292,493
		Mixing	1080	0	0.0%	-	-
Total						457,945	114,486,203

From the financial loss of the waiting waste is 114,486,203 rupiahs.

4.3.1.5 Not Utilizing Employee Knowledge

This type of waste is very little found in the company, so the calculation of the sigma level and financial waste is not done. Besides the issue has also been able to be resolved by the company, so this type of waste is not regarded as a problem that interfere to the quality of the production process.

4.3.1.6 Transportation

Has been explained in the previous chapter, that this type of waste by the company are not considered as a problem because the number of transportation in the production process in the company is considered to have value added, so the calculation of sigma level and calculation is not done.

4.3.1.7 Inventory Waste

Has been explained in the previous chapter, that this type of waste by the company are not considered as a problem because the number of inventory, especially in the WIP in the company is considered to have value added, so the calculation of sigma level and calculation is not done.

4.3.1.8 Motion

Based on the brainstorming with the company, it is known that the problem of waste is not significantly influence the wastage in the company. So it is not required further analysis to this waste.

4.3.1.9 Excess Processing

Excess processing occurs due to do excessive process conducted on a product. Indicators that can be used is the occurrence of rework. Because of this excess processing is associated with rework activities, then the data used is the same as the defect waste. Here is the data.

Table 4.30 Excess Processing Waste Calculation

Month	Production (Sticks)	Defect (Sticks)
January	2,736,000	507,130
February	3,244,000	537,615
March	2,864,000	513,643
April	3,660,000	625,664
May	2,532,000	579,059
Total	15,036,000	2,763,111

a. Control to Quality

Because there are no particular characteristics of this waste, then the number of CTQ is 1.

b. Sigma Level

Sigma level calculation is based on the comparison of the total production time to a total rework time on defective items. Where the total production time during January to May was 25.6 days, and the total rework time was 4.61 days.

Table 4.31 Sigma Level Calculation of Excess Processing Waste

Information	Value
Number of Output	25.06
Number of Defect	4.61
Defect per Unit	0.1840
CTQ	1
Failure rate opportunity per CTQ	0.184
DPMO	183958
Sigma Level	2.40

Based on the calculation of the sigma level above, shows that the Excess Processing waste has a sigma level of 2.4. That means the sigma level is far below the limit, so it still requires improvements.

c. Financial Waste

Calculation of financial loss is calculated from the costs incurred due to the rework process. There are two variable costs due to the rework process, the first is the cost of raw material of the rework activities, and the second is the cost of labor required to perform the rework. Here are the calculation and explanation.

- Raw material

  Has explained before that in the production process, when there is a defective cigarette rod, the cigarette rod is being destroyed, so that the tobacco can be reused and rework using a new *Ambri* paper. So, at this time the financial loss is calculated based on the *Ambri* paper that is used in the rework process. While each *Ambri* paper has a price of 2.5 rupiahs per sheet. The price obtained from the conversion of standard price, that is 146,000 rupiahs per ball, while 1 ball can be used for 20 *slop*, where there are 240 packs in a slop, and a pack contained 12 cigarette rods. Here is the calculation table.

Table 4.32 Financial Calculation of Raw Material Loss

Month	Defect	Value
January	507,130	1,267,825
February	537,615	1,344,037
March	513,643	1,284,107
April	625,664	1,564,160
May	579,059	1,447,647
Total	2,763,111	6,907,777

- Workforce

  Another loss is the power that is wasted due to the rework process. The production process is using manual labor, then the financial loss is calculated from how much it costs the company incurred to hire workers to do rework. Worker salary per day is 30,000 rupiahs. While each worker produces 4,000 cigarette rods per day. The following is the calculation.

Table 4.33 Calculation of Worker Needed Loss

Month	Defect	Worker Needed	Value
January	507,130	127	3,803,475
February	537,615	134	4,032,113
March	513,643	128	3,852,323
April	625,664	156	4,692,480
May	579,059	145	4,342,943
Total	2,763,111	691	20,723,333

Then from the raw material summed up to the workforce as follows.

Total financial excess processing waste

= Rp. 6,907,777 + Rp. 20,723,333

= Rp. 27,631,110

From these explanation, the financial loss from excess processing waste is 34,538,887 rupiahs.

4.4 Key Performance Indicator Measurement

Has been described previously, that from the three OLEs indicators, only 2 that are used and fit with the observed object, namely the indicator of Availability and Quality. Here is the calculation of the indicators.

a. Availability

At the observations, availability calculation is based on the percentage of employees do work effectively outside of absent and rework process. Then the following is a calculation table of the workers availability.

Table 4.34 Availability Calculation

Month	Working Days	Absence			Rework	Availability
		Illness	Permission	Others		
January	900	85	10	2	127	75.1%
February	900	88	9	0	134	74.3%
March	750	79	7	2	128	71.1%
April	900	72	10	5	156	73.0%
May	750	75	9	1	145	69.4%
Average Availability Percentage						72.6%

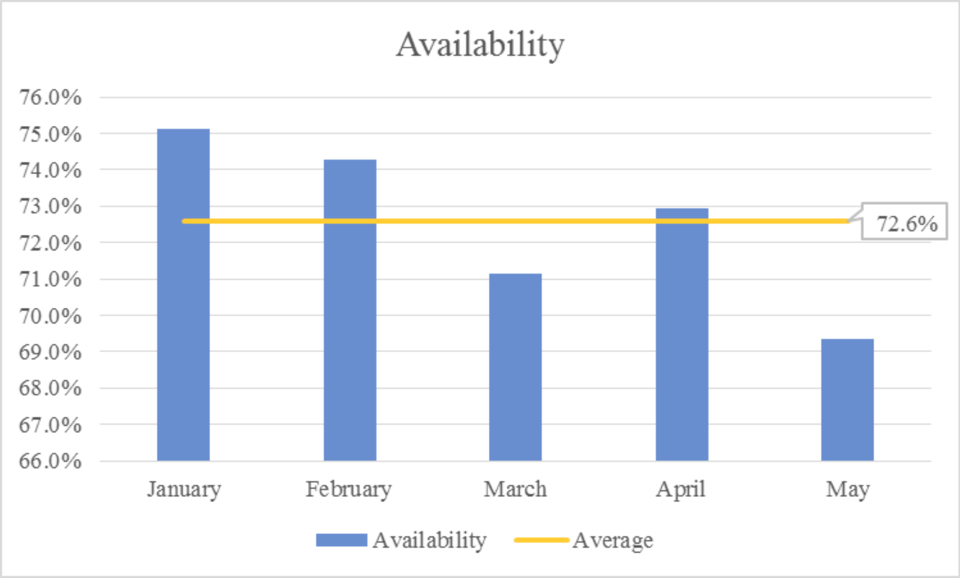

Figure 4.13 Availability Percentage Chart

The picture above shows that the average time spent by the workers in contributing effectively is equal to 72.6%, means that there is wasteful in terms of time that is equal to 27.4%% in the production process. Waste of the time that occurs during the production process have an impact on decreasing the number of the production by the company. From the image also seen the performance peak is in February, and a decline in performance until it reaches the lowest performance in May.

b. Performance

At this observation, this indicator is not counted as a problem, given every worker is pegged to produce 4,000 rods per day, and the rise and fall of production per month are caused by other factors, such as the absence of workers, the number of defects that need to rework or products that intentionally diverted to other types of products for the needs of the market.

c. Quality

Quality calculation is based on the percentage of the non-defective and meet the standard products that can be produced by the production process of the company. Below is the calculation table.

Table 4.35 Quality Calculation

Month	Production	Defect	Non-defective Product	Quality Percentage
January	2,736,000	507,130	2,228,870	81.5%
February	3,244,000	537,615	2,706,385	83.4%
March	2,864,000	513,643	2,350,357	82.1%
April	3,660,000	625,664	3,034,336	82.9%
May	2,532,000	579,059	1,952,941	77.1%
Average Quality Percentage				81.4%

So, here is the calculation of its performance

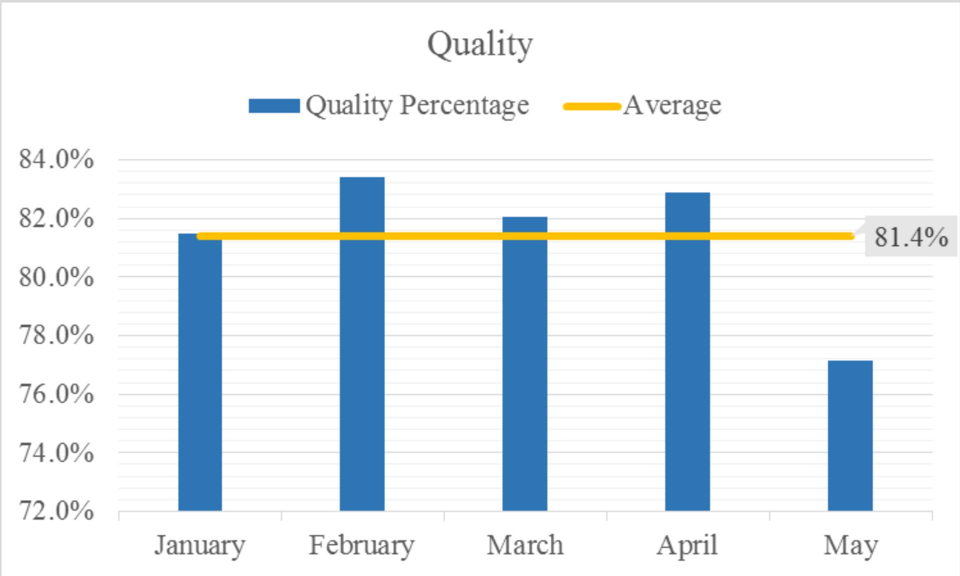

Figure 4.14 Quality Percentage Chart

The picture above shows that the average quality is equal to 81.4%, means that the percentage of non-defective products that can be sold in the market is equal to 81.4% of the production output without rework. It also shows that there is a drastic decline in quality performance in May. So, here is the calculation of the performance of the production process.

Table 4.36 Initial OLE Calculation

Month	Availability	Quality	OLE
January	75.1%	81.5%	61.21%
February	74.3%	83.4%	61.98%

Table 4.36 Initial OLE Calculation (Continued)

Month	Availability	Quality	OLE
March	71.1%	82.1%	58.39%
April	73.0%	82.9%	60.48%
May	69.4%	77.1%	53.50%
Percentage			59.11%

So, here is the calculation of its performance

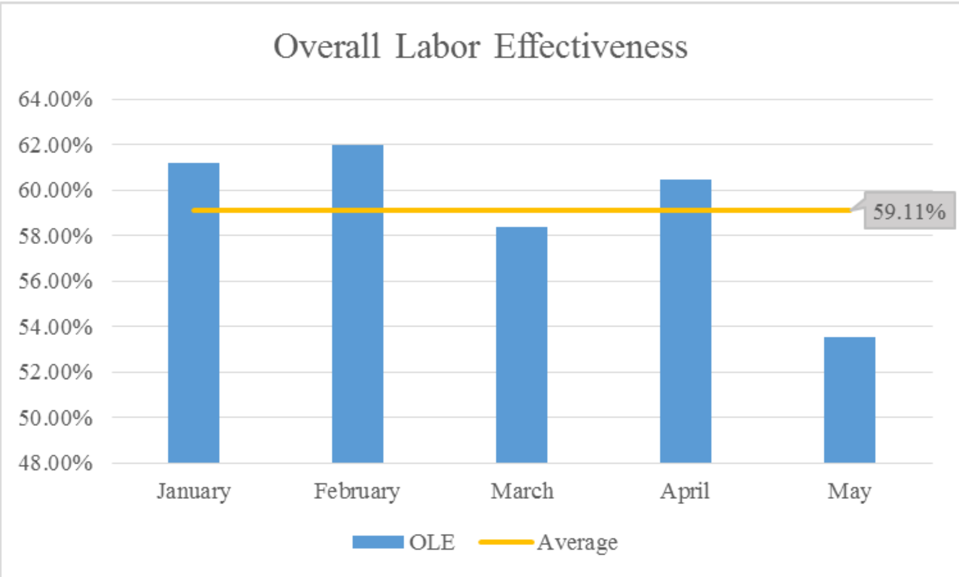

Figure 4.15 Overall Labor Effectiveness Percentage

On average OLE measurement result shown in the picture above has only reached 59.11%. This means the company is only able to convert 59.1% of its potential, especially its labor potential of the production process to be a decent and profitable output. OLE performance of 59.11% means the company suffered a loss of 40.89% due to the high number of working hours loss and output loss because of the output does not meet the standards.

4.5 Waste Selection

After the waste measurement has been done, then the next step is to determine the critical waste that needs to be analyzed further in the next chapter. Based on the calculations that have been done, following is the impact of the financial losses that have been sequenced from the waste varieties.

Table 4.37 Waste Selection based on Financial Loss

Waste	Loss
Defect	690,777,750
EHS	399,000,000
Overproduction	220,106,563
Waiting	114,486,203
Excess Processing	27,631,110
Not Utilizing Employee Knowledge	-
Transportation	-
Inventory	-
Motion	-

Another consideration is the impact of waste on the OLE that indicates the workers' performance of the company, given the increase in performance is one of the objectives of the study. Based on the performance identification and calculation, there is some waste that is the cause of low worker performance of the production process. Here is the recap.

Table 4.38 Waste Selection based on impact on OLE

Waste	Impact on OLE
Defect	V
EHS	V
Excess Processing	V
Waiting	-
Overproduction	-

Based on the table, found no difference between the waste that impact the biggest loss for the company financially and waste which cause the low worker performance. Where it can be seen from the top two waste, which is highlighted in yellow. Both results indicate that the top two waste is the same, namely the defect waste and EHS waste.

Based on these results it can proceed to the analyze phase, with the critical waste based on the result of the data calculation and observation, which are:

- Defect waste
- EHS (Environmental, Health, and Safety) waste

This page is intentionally left blank.

CHAPTER V

ANALYSIS AND IMPROVEMENT

This chapter describes the analysis of the causes of the problems and improvements to the company. So, in this chapter uses Six Sigma methodology, namely the analyze phase, improvement and control.

5.1 Analyze Phase

This analyze phase consists of two activities that seek the root causes that lead to the critical waste and look for the most critical cause of the occurrence of critical waste.

5.1.1 Root Cause Analysis (RCA)

Root Cause Analysis (RCA) is a method used to find the root cause of the problems. Where in this study, RCA is used to find the root cause of critical waste in the company. The tool used to find the cause of the waste problem is the 5 Whys tool. In obtaining information in compiling the 5 Whys table, the author conducted direct observation on the production floor as well as do brainstorming with the employees.

5.1.1.1 RCA Defect Waste

In this section look for the root cause of the problems of the defect waste. Based on the Pareto chart of defect products in the previous chapter, known the most critical defect types are non-perishable, uneven cutting and unequal size. Here is the 5 Whys table that has been compiled in this study.

Table 5.1 RCA of Defect Waste

Waste	Sub waste	Why-1	Why-2	Why-3	Why-4	Why-5	Why-6
Defect	Uneven cutting on its ends	Because there is uneven mixed tobacco fiber in cigarette ends	Because scissor that used to cut is already dull	Because of repeated use without maintenance or renewal			
			Because the worker is unaware of the cutting result	Because there is no such process or tool to evaluate the result by the worker			
			Because the concentration loss of cutting by the worker	Because the worker is exhausted	Because the majority of workers are old		
					Because the chairs are less comfortable		
					Because of unfavorable environment	Because the production floor is hot and humid	
				Because the worker is chatting too much with the others	Because of the lack of warning from the foreman	Because the foreman is doing too much non-value added things when there is no cigarette to be inspected	

Table 5.1 RCA of Defect Waste (Continued)

Waste	Sub waste	Why-1	Why-2	Why-3	Why-4	Why-5	Why-6
				Because the cutting process is regarded as the easiest job	Because there are no evaluation and warning from the foreman that the cutting process accounts for the largest defective products		
	Uneven size and shape	Oval shaped tail	Because at the time of cutting activities there are some tobacco pulled out from the cigarette rod	Because the use of dull scissor on the cutting activity, so it is not cut the tobacco, but instead pull out the tobacco	Because scissor that used to cut is already dull	Because of repeated use without maintenance or renewal	
			Because the worker tying the cigarette rods too hard on the binding process makes the tail to be oval	Because there is no tool to collect the cigarette rods properly			
				Because the worker is too hasty on binding	Because the binding process is the final activity of the workers, many workers underestimate this activity	Lack of attention and warnings from the foreman	

Table 5.1 RCA of Defect Waste (Continued)

<table>
<tr><th>Waste</th><th>Sub waste</th><th>Why-1</th><th>Why-2</th><th>Why-3</th><th>Why-4</th><th>Why-5</th><th>Why-6</th></tr>
<tr><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3"></td><td rowspan="3">Because of less tobacco on the tail at the time of rolling activity</td><td>Because the rolling tool has been already loose</td><td>Bolts on the tool already loose</td><td>Less maintenance of the rolling tool</td><td></td></tr>
<tr><td rowspan="2">Because the concentration loss of the workers</td><td rowspan="2">Because the worker is exhausted</td><td>Because the majority of workers are old</td><td></td></tr>
<tr><td>Because the chairs are less comfortable</td><td></td></tr>
<tr><td></td><td></td><td>Uneven surface</td><td>Because the contents of mixed tobacco that are less organized on the Ambri paper</td><td></td><td></td><td>Because of unfavorable environment</td><td>Because the production floor is hot and humid</td></tr>
</table>

Table 5.1 RCA of Defect Waste (Continued)

Waste	Sub waste	Why-1	Why-2	Why-3	Why-4	Why-5	Why-6
					Because the worker is chatting too much with the others	Because of the lack of warning from the foreman	Because the foreman is doing too much non-value added things when there is no cigarette to be inspected

Table 5.1 RCA of Defect Waste (Continued)

Waste	Sub waste	Why-1	Why-2	Why-3	Why-4	Why-5	Why-6
			Because of uneven gluing on the *Ambri* paper	Because of low level of glue adhesion	Because the glue used is too long not to be replaced		

Table 5.1 RCA of Defect Waste (Continued)

Waste	Sub waste	Why-1	Why-2	Why-3	Why-4	Why-5	Why-6
					Because the glue was mixed with tobacco before it is used	Because the position of the materials on the table are less organized	
					Because the glue is left open in the free air while the worker doing other activities		

Table 5.1 RCA of Defect Waste (Continued)

<table>
<tr><th>Waste</th><th>Sub waste</th><th>Why-1</th><th>Why-2</th><th>Why-3</th><th>Why-4</th><th>Why-5</th><th>Why-6</th></tr>
<tr><td rowspan="6"></td><td rowspan="6">Deflated</td><td rowspan="6">Because the composition of the mixed tobacco in the cigarette is less dense in the middle part of the cigarette rod</td><td rowspan="3">Because the amount of tobacco, which continued to Ambri paper from rolling tool is less than the standard</td><td>Because the wrong point of putting the Ambri paper</td><td>Because workers determine the putting point of Ambri paper based on instinct</td><td>Because the absence of indicator of putting point</td><td></td></tr>
<tr><td>Because the rolling tool has been already loose</td><td>Bolts on the tool already loose</td><td>Less maintenance of the rolling tool</td><td></td></tr>
<tr><td rowspan="4">Because the concentration loss of the workers</td><td>Because the worker is chatting too much with the others</td><td>Because of the lack of warning from the foreman</td><td>Because the foreman is doing too much non-value added things when there is no cigarette to be inspected</td></tr>
<tr><td rowspan="3">Because the majority of mixed tobacco is not drawn in the rolling process</td><td rowspan="3">Because the worker is exhausted</td><td>Because the majority of workers are old</td><td></td></tr>
<tr><td>Because the chairs are less comfortable</td><td></td></tr>
<tr><td>Because of unfavorable environment</td><td>Because the production floor is hot and humid</td></tr>
</table>

Based on the table above is known that on average the cause of the defect is a loss of concentration by the workers, that caused by the physical exhaustion of the workers and too much chatting between the workers. Also found several problems in terms of lack of supporting tools and facilities, as well as the supervision from the foreman.

5.1.1.2 RCA EHS Waste

In this section look for the root cause of the problems of EHS waste. Based on the Pareto chart of illness types in the previous chapter, known the most critical problems are non-perishable, uneven cutting and unequal size. Here is the 5 Whys table that has been compiled in this study.

Table 5.2 RCA of EHS Waste

<table>
<tr><th>Waste</th><th>Sub waste</th><th>Why-1</th><th>Why-2</th><th>Why-3</th><th>Why-4</th><th>Why-5</th></tr>
<tr><td rowspan="7">EHS</td><td rowspan="7">Headache or dizziness</td><td rowspan="6">Because of continuous fatigue</td><td>Because the workers rarely do exercise or sport</td><td>Because of unavailability of activities that aim to maintain the health and fitness of the workers</td><td></td><td></td></tr>
<tr><td rowspan="3">Because less supportive work environment</td><td>Because of poor communication between employees</td><td></td><td></td></tr>
<tr><td rowspan="2">Because of unfavorable environment</td><td rowspan="2">Because the production floor is hot and humid</td><td>Because of the absence of adequate ventilation in the production floor</td></tr>
<tr><td>Lack of cooling devices</td></tr>
<tr><td rowspan="2">Because of uncomfortable chairs</td><td>Because of there is no backrest</td><td></td><td></td></tr>
<tr><td>Because of the hard seat cushion</td><td></td><td></td></tr>
<tr><td>Because of working monotony</td><td>Because the workers bored with the routine</td><td>Because the workers rarely get entertainment</td><td>The absence of music on the production floor</td><td></td></tr>
</table>

Table 5.2 RCA of EHS Waste (Continued)

Waste	Sub waste	Why-1	Why-2	Why-3	Why-4	Why-5
	Muscle disorders	Because of unsafe working position	Because of uncomfortable chairs	Because of there is no backrest		
				Because of the hard seat cushion		
		Because of lack of muscle stretching of the workers	Because the workers rarely do exercise or sport	Because of unavailability of activities that aim to maintain the health and fitness of the workers		
	Respiratory disorders	Because a lot of dust coming out of mixed tobacco inhaled by the workers	Because the workers do not use mask			

Table 5.2 RCA of EHS Waste (Continued)

Waste	Sub waste	Why-1	Why-2	Why-3	Why-4	Why-5
		Because of the production floor is less clean	Because a lot of dust everywhere, especially at the table and working tools	Because the company cannot maximize the cleaning service	Because lack of attention to the cleanliness of the production floor by the company	
		Because of poor air flow on the production floor	Because of the absence of adequate ventilation in the production floor			

From the table above, obtained various types of problems that led to the occurrence of various diseases that cause the EHS waste. The headache or dizziness problems occur more due to fatigue caused by routine work, while muscle disorders problems caused by the poor ergonomics of the chair used by the worker, and the respiratory problems caused by the lack of response of both workers and the company against the dust out from the tobacco.

5.1.2 FMEA (Failure Mode and Effect Analysis)

After the root causes of problems for critical waste are obtained, then the next step is to choose the most critical cause of the problem based on Severity, Occurrence, and Detection criteria. The first step is to make a table of ranking criteria and assessment for each criteria. The next is to enter the root causes of the problems as a failure in the FMEA form. The causes of these problems will be used to determine the magnitude impact and failure detection capability. Assessment to obtain the value of severity, occurrence, and detection of all failure forms is done by doing brainstorming with the production supervisor of the CV. Cempaka.

5.1.2.1 FMEA of Defect Waste

To be able to conduct an assessment of the causes of the potential failure, it is necessary to identify the severity assessment, occurrence, and detection criteria, as follows:

Table 5.3 Severity Criteria of Defect Waste FMEA

Level	Degree of Severity	Effect
1	No effect on product	No Effect
2	Consumer more likely will not notice failure	Very Slight Effect
3	Consumer slightly annoyed	Slight Effect
4	Consumer experience minor nuisance	Minor Effect
5	Consumer experiences some dissatisfaction	Moderate Effect
6	Consumer experiences discomfort. Product performance degraded.	Significant Effect
7	Consumer dissatisfied. Major effect on process.	Major Effect

Table 5.3 Severity Criteria of Defect Waste FMEA (Continued)

Level	Degree of Severity	Effect
8	Consumer very dissatisfied. Extreme effect on process.	Extreme Effect
9	Able to stop product. Safety related.	Serious Effect
10	Stop product. Safety related. Sudden failure.	Hazardous Effect

Table 5.4 Occurrence Criteria of Defect Waste FMEA

Level	Degree of Occurrence	Occurrence
1	Failures unlikely. History shows no failures.	Almost impossible
2	Rare number of failures likely	Remote
3	Very few failures likely	Very Slight
4	Few failures likely	Slight
5	Occasional number of failures likely	Low
6	Medium number of failures likely	Medium
7	Moderately high number of failures likely	Moderately High
8	High number of failures likely	High
9	Very high number of failures likely	Very High
10	Failure almost certain. History of failures exist from previous or similar design	Almost Certain

Table 5.5 Detection Criteria of Defect Waste FMEA

Likelihood of Detection	Criteria	Rank
Almost certain	Almost certain detection	1
Very high	Very high chance of detection	2
High	High chance of detection	3
Moderately high	Moderately high chance of detection	4
Moderate	Moderate chance of detection	5
Low	Low chance of detection	6
Very Low	Very low chance of detection	7
Remote	Remote chance of detection	8
Very Remote	Very remote chance of detection	9
Absolute uncertainty	No chance of detection	10

After the criteria for assessment of the severity, occurrence, and detection are obtained, then the assessment can be done against all types of failures. Here is the result of the assessment of potential failures to defect types.

Table 5.6 FMEA Determination of Defect Waste

Potential Failure Mode	Potential Effect	Potential Cause	Control	S	O	D	RPN
Uneven cutting on its ends	The cigarette rod rejected, there is uneven mixed tobacco fiber in cigarette ends, due to an error during the cutting activity	Because of repeated use of scissor without maintenance or renewal	Preventive Maintenance	6	8	5	240
		Because there is no such process or tool to evaluate the result by the worker	Conducting further analysis	6	5	6	180
		Because the majority of workers are old	Conducting further analysis	6	2	5	60
		Because the chairs are less comfortable	Conducting further analysis	6	4	8	192
		Because the production floor is hot and humid	Conducting further analysis	6	3	9	162
		Because the foreman is doing too much non-value added things when there is no cigarette to be inspected	Field supervision	6	3	4	72
		Because there are no evaluation and warning from the foreman that the cutting process accounts for the largest defective products	Field supervision	6	3	7	126

Table 5.6 FMEA Determination of Defect Waste (Continued)

Potential Failure Mode	Potential Effect	Potential Cause	Control	S	O	D	RPN
Uneven size and shape	Oval shaped tail, because at the time of cutting activities there are some tobacco pulled out from the cigarette rod	Because of repeated use without maintenance or renewal	Preventive Maintenance	5	7	5	175
	Oval shaped tail, because the worker tying the cigarette rods too hard on the binding process makes the tail to be oval	Because there is no tool to collect the cigarette rods properly	Conducting further analysis	5	8	7	280
		Lack of attention and warnings from the foreman	Field supervision	5	3	4	60
	Oval shaped tail, because of less tobacco on the tail at the time of rolling activity	Less maintenance of the rolling tool	Preventive Maintenance	5	6	8	240
		Because the majority of workers are old	Conducting further analysis	5	2	5	50
		Because the chairs are less comfortable	Conducting further analysis	5	3	8	120
		Because the production floor is hot and humid	Conducting further analysis	5	3	9	135

Table 5.6 FMEA Determination of Defect Waste (Continued)

Potential Failure Mode	Potential Effect	Potential Cause	Control	S	O	D	RPN
		Because the foreman is doing too much non-value added things when there is no cigarette to be inspected	Field supervision	5	3	4	60
	Uneven surface because the contents of mixed tobacco that are less organized on the *Ambri* paper	Because the majority of workers are old	Conducting further analysis	5	2	5	50
		Because the chairs are less comfortable	Conducting further analysis	5	3	8	120
		Because the production floor is hot and humid	Conducting further analysis	5	3	9	135
		Because the foreman is doing too much non-value added things when there is no cigarette to be inspected	Field supervision	5	3	4	60
	Uneven surface because of uneven gluing on the *Ambri* paper	Because the glue used is too long not to be replaced	Preventive Maintenance	5	5	7	175
		Because the position of the materials on the table are less organized	Visual Inspection	5	6	7	210
		Because the glue is left open in the free air while the worker doing other activities	Conducting further analysis	5	7	5	175

Table 5.6 FMEA Determination of Defect Waste (Continued)

Potential Failure Mode	Potential Effect	Potential Cause	Control	S	O	D	RPN
Deflated	The cigarette rod because the composition of the mixed tobacco in the cigarette is less dense in the middle part of the cigarette rod	Because the absence of indicator of putting point	Conducting further analysis	7	8	5	280
		Less maintenance of the rolling tool	Preventive Maintenance	7	6	5	210
		Because the foreman is doing too much non-value added things when there is no cigarette to be inspected	Field supervision	7	3	4	84
		Because the majority of workers are old	Conducting further analysis	7	2	5	70
		Because the chairs are less comfortable	Conducting further analysis	7	3	8	168
		Because the production floor is hot and humid	Conducting further analysis	7	3	9	189

Based on the FMEA table above, it was found that the most critical causes of the defect problem in the company are the lack of tool maintenance and the need for improvement in the aspect of tool for several critical activities. It can be seen from the value of RPN for each cause of failure or RPN. Where the highest RPN value (red) is the most critical causes of failure. The critical causes are problems with the value of RPN above 200.

5.1.2.2 FMEA of EHS Waste

To be able to conduct an assessment of the causes of the potential failure, it is necessary to identify the severity assessment, occurrence, and detection criteria, as follows:

Table 5.7 Severity Criteria of EHS Waste

Level	Degree of Severity	Effect
1	No effect	No Effect
2	Slight effect on health	Very Slight Effect
3	There is impact on health, but it can be ignored	Slight Effect
4	Likely to cause small damage to the product	Minor Effect
5	Likely to cause medium damage to the product	Moderate Effect
6	Likely to cause major damage to the product	Significant Effect
7	Causing worker(s) to absent for more than 1 day	Major Effect
8	Causing worker(s) to absent for more than 3 days	Extreme Effect
9	Causing worker(s) to absent for more than 5 days	Serious Effect
10	Causing disability	Hazardous Effect

Table 5.8 Occurrence Criteria of EHS Waste

Level	Degree of Occurrence	Occurrence
1	Failures unlikely. History shows no failures.	Almost impossible
2	Rare number of failures likely	Remote
3	Very few failures likely	Very Slight
4	Few failures likely	Slight
5	Occasional number of failures likely	Low
6	Medium number of failures likely	Medium
7	Moderately high number of failures likely	Moderately High
8	High number of failures likely	High
9	Very high number of failures likely	Very High
10	Failure almost certain.	Almost Certain

Table 5.9 Detection Criteria of EHS Waste

Likelihood of Detection	Criteria	Rank
Almost certain	Almost certain detection	1
Very high	Very high chance of detection	2
High	High chance of detection	3
Moderately high	Moderately high chance of detection	4
Moderate	Moderate chance of detection	5
Low	Low chance of detection	6

Table 5.9 Detection Criteria of EHS Waste (Continued)

Likelihood of Detection	Criteria	Rank
Very Low	Very low chance of detection	7
Remote	Remote chance of detection	8
Very Remote	Very remote chance of detection	9
Absolute uncertainty	No chance of detection	10

After obtaining the criteria for severity, occurrence, and detection criteria, then the assessment can be done against all types of failures. Here are the results of the assessment of potential failure for EHS type of waste.

Table 5.10 FMEA Determination of EHS Waste

Potential Failure Mode	Potential Effect	Potential Cause	Potential Control	S	O	D	RPN
Headache or Dizziness	Because of continuous fatigue	Because the unavailability of activities that aim to maintain the health and fitness of the workers	Conducting further analysis	5	7	6	210
		Because of poor communication between employees	Field supervision	5	3	6	90
		Because of the absence of adequate ventilation in the production floor	Conducting further analysis	5	4	4	80
		Lack of cooling devices	Conducting further analysis	5	4	5	100
		Because of there is no backrest	Conducting further analysis	5	7	5	175
		Because of the size is too small	Conducting further analysis	5	6	5	150
		Because of the hard seat cushion	Conducting further analysis	5	7	5	175

Table 5.10 FMEA Determination of EHS Waste (Continued)

Potential Failure Mode	Potential Effect	Potential Cause	Potential Control	S	O	D	RPN
	Because of working monotony	The absence of music on the production floor	Conducting further analysis	5	5	4	100
Musculoskeletal	Because of unsafe working position	Because of there is no backrest	Conducting further analysis	6	7	5	210
		Because of the size is too small	Conducting further analysis	6	6	5	180
		Because of the hard seat cushion	Conducting further analysis	6	7	5	210
	Because of lack of muscle stretching of the workers	Because of unavailability of activities that aim to maintain the health and fitness of the workers	Conducting further analysis	7	4	6	168
Respiratory	Because a lot of dust coming out of mixed tobacco inhaled by the workers	Because the workers do not use mask	Field supervision	8	7	4	224
	Because of the production floor is less clean	Because lack of workers awareness to maintain cleanliness of the production floor	Field supervision	6	6	5	180
	Because of poor air flow on the production floor	Because of the absence of adequate ventilation in the production floor	Conducting further analysis	6	4	4	96

Based on the FMEA table above, it was found that the most critical causes of the EHS problem in the company are the worker who do not use mask while working, poor ergonomic of the working chair, and unavailability of activity that aim to maintain the workers' health. It can be seen from the value of RPN for each cause of failure or RPN. Where the highest RPN value (red) is the most critical causes of failure. The critical causes are problems with RPN values above 200.

5.2 Improve

After the FMEA analysis and the value of RPN for each root causes have been obtained, the next is to make improvements for the company. Improvement is based on the chosen RPN, which are the RPN with values above 200.

5.2.1 Improvement Alternatives

From the FMEA results, obtained the improvement alternatives for each of its root causes. The following is a recapitulation of root cause analysis.

Table 5.11 Improvement Alternatives Identification

Waste	Root Cause	Maintenance	Tool Improvement	Additional Tool	Chair Replacement	Wearing Mask	Health Activities
Defect	Because of repeated use without maintenance or renewal	V					
	Because there is no tool to collect the cigarette rods properly		V				

Table 5.11 Improvement Alternatives Identification (Continued)

Waste	Root Cause	Maintenance	Tool Improvement	Additional Tool	Chair Replacement	Wearing Mask	Health Activities
	Because the absence of putting point indicator			V			
	Because of less maintenance of the rolling tool	V					
EHS	Because of there is no backrest				V		
	Because of the hard seat cushion				V		
	Because the workers do not use masks					V	
	Because the unavailability of activities that aim to maintain the health and fitness of the workers						V

On the classification of critical root cause analysis, improvement alternatives to be built are associated with four things: maintenance, tool improvement, ergonomic chair, and mask. Therefore, alternatives that will be used to carry out improvement are:

1. Doing periodic maintenance and provide backup tool

   At CV. Cempaka, maintenance is only carried out on machines, not made to the working tools used by workers. The company assumes that the working tools are the responsibility of the workers themselves, while the workers seem indifferent to their tools, which are becoming less and less reliable. Having observed that there are problems with the tools used, primarily many dull scissors and rolling tool that less reliable. So it is necessary for the company to conduct maintenance.

Improvement steps:

- The tool checks every certain period of time.
- Fixing less reliable or damaged tools.
- Provide backup tool that is already in good condition as a substitute for a damaged tool from the worker.
- Make regulations for workers to ask for tool substitution when the reliability of the tool is reduced or damaged.

2. Tool making

From the RCA – FMEA result, it was found that there are defects in the form of oval tail cigarette, which is caused by too hard binding. Once observed, the use of paper as a binder is allowing workers to tie up too hard, because when workers are not hard in binding, it would cause the cigarette rods fell from the bonds. Therefore, improvements that can be done is to create a new binding tool that can minimize the occurrence of defects at the time of binding activity, but not slow down the work.

Results of research and brainstorming with the company produce an idea which is the adoption of the packaging process, the idea is to create a wooden box with the length corresponding to the length of a cigarette rod and can hold 50 cigarette rods in a box, the box can be opened and closed, and perforated at the end of the rod so as not to complicate the inspection process. The figure of the tool can be found in the appendix.

Besides minimizing defective products in binding activity, this tool will also be able to simplify and accelerate the work of the workers, where workers only need to open the box, put the cigarette rods and then close it, instead of collecting the cigarette rods, take a paper that has been glued and then tie it.

3. Tool improvement

From observations conducted, found that the tool that exist on the production floor can still be developed to facilitate the workers, which in general will improve the worker performance. From the results of root cause analysis found that one of the causes of defective products are deflated cigarette rod, which is caused by the amount of tobacco that is passed to the *Ambri* paper is less than the standard, one of which is caused by the worker who put the *Ambri* paper at the wrong point. During this time, the worker does paper positioning is only based on instinct, so when the worker loses concentration, many such events occur. Therefore, it is important to develop the rolling tools, where workers can put in a right and fixed point.

Results of brainstorming with the company led to the idea of giving an indicator line on each rolling tool, so that the paper can be put in right and fixed point.

4. Chair replacement

   From the observations, it was found that there is a problem, poor ergonomic chairs used by workers. From the Root Cause Analysis carried out, this problem adversely affects the performance of the workers. The absence of the backrest and seat cushion makes the seat less comfortable for workers. After observation and brainstorming with the company, it is necessary to make improvement regarding to this problem. An improvement that can be done is to replace the chairs with new chairs that have backrest and cushion. To evaluate and mitigate the occurrence of other problems related to the workers seat, it will be necessary also to hire an ergonomic consultant.

5. Wearing mask at work

   Tobacco dust can cause occupational illness. If the tobacco dust is inhaled by workers, it can cause lung function disorders characterized by decreased lung function. (Widyawati, 2004). It is less noticed by the company. Absences that were caused by respiratory diseases, such as flu, asthma, and cough, become an indication that the workers who did not use masks at work is one of the causes of low performance of the company. Therefore, the improvement that can be done is to facilitate and obligate the workers to wear masks at work.

6. Applying morning exercise

   From the results of interviews with some of the workers on the production floor, it was found that many workers feel headache, dizziness, aches and fatigue during the work. Of course, it greatly reduces the performance of the workers. Therefore, it needs a problem-solving so it does not continue to happen in the company. It was found that one of the root cause is the lack of workers' muscles stretched. So, the need for production floor of the company is to adopt a Japanese company's system called "morning exercise" that is conducted to support the productivity of workers. In the system, workers are required to stretch the muscles and do a little exercise together for 15-30 minutes before work.

From the result of brainstorming with company management, out of 6 alternatives, selected 3 alternatives that a company has to think twice to implement the improvement and have a major impact on the company performance. Those 3 alternatives are alternative 1, 2, and 4.

5.2.2 Alternative Selection Criteria and Weighting

In determining the improvement alternative that will be chosen, previously determine the criteria that will be used as an assessment. Criteria are selected based on the key performance indicator used in this study, namely the Overall Labor Effectiveness. Here are the selected criteria.

- Availability
- Quality

After determining the criteria to be used in the value management, then each of these criteria should be weighted. Based on the previous chapter, it is obtained that the average of availability is 74.16%, while the average of quality is 81.40%. By using the value of proportion to the overall value, the following is the weights of each of these criteria.

Availability 52%

Quality 48%

5.2.3 Alternatives Combination

Once determined the improvement alternatives, the next is to determine the combinations of all three alternatives that have been defined previously. The following table is the improvement alternatives combinations.

Table 5.12 Alternative Combination

No.	Alternatives Combination	Explanation
1	0	Existing condition
2	1	Doing periodic maintenance and provide backup tool
3	2	Make proper binding tools
4	3	Replace the seats with new seats
5	1,2	Doing periodic maintenance, provide backup tool and make proper binding tools
6	1,3	Doing periodic maintenance, provide backup tool and replace the chairs with new chairs
7	2,3	Make proper binding tools and replace the seats with new seats
8	1,2,3	Doing periodic maintenance, provide backup tool, make proper binding tools and replace the chairs with new chairs

Based on the alternative classification, obtained eight combinations of alternatives where each alternative has advantages and disadvantages, and different weighting. Weights and assessment of each alternative would be an input to the calculation of value engineering to choose the best alternative.

5.2.4 Cost Alternative

This section will explain the entire cost requirements ranging from the cost of existing company needs until the cost of alternative combinations 1, 2, 3. Calculation of the cost of this research is determined by four cost variables, which are labor costs, raw material costs, energy, and the cost of the investment in the production floor, especially the rolling and cutting process.

5.2.4.1 Cost Alternative 0

In the calculation of the production cost of existing, assumed in a month the company produces 3,457,600 cigarette rods, equivalent to 2 tons of tobacco and dry clove. So here is the calculation.

Table 5.13 Cost Alternative 0 Calculation

Cost Variable		Value
Raw Material	Tobacco	80,000,000
	Clove	100,000,000
	Sauce	46,800,000
	Other	8,644,000
Labor Cost		27,000,000
Energy		1,857,600
Total		264,301,600

Based on calculations performed, the needs of the production costs of existing condition in a month is Rp. 264,301,600.00

5.2.4.2 Cost Alternative 1

Cost calculation for alternative 1 is by adding the investment costs of a tools maintenance team to the cost of existing production, which consisted of 1 coordinator, and 3 people in tools checking and that can also work as handyman. This alternative does not require to purchase new tools, because there are a lot of unused tools that can be repaired. Here are the calculations of cost alternative 1.

Table 5.14 Cost Alternative 1 Calculation

Cost Variable	Amount	Wages	Value
Coordinator	1 people	2,546,100	2,546,100
Tools checking and repairing	3 people	1,273,050	3,819,150
Total			6,365,250

Table 5.15 Total Cost of Alternative 1 Calculation

Cost Variable	Value
Existing cost	264,301,600
Cost of maintenance team	6,365,250
Total	270,666,850

Based on calculations performed, total cost requirements for alternative 1 is Rp. 270,666,850.00

5.2.4.3 Cost Alternative 2

The cost calculation for alternative 2 is by adding the investment costs of making new binding tools to the cost of existing production. Each worker uses 40 boxes in producing 4,000 cigarette rods. So, in total the company needs 6,000 boxes. It is estimated that the price of 1 box is 15,000 dollars. Thus, the following are the calculations of the costs.

Table 5.16 Cost Alternative 2 Calculation

Cost Variable	Amount	Value
New binding tools	6,000	90,000,000

Table 5.17 Total Cost of Alternative 2 Calculation

Cost Variable	Value
Existing cost	264,301,600
Cost of maintenance team	90,000,000
Total	354,301,600

Based on calculations performed, total cost requirements for alternative 2 is Rp. 354,301,600.00

5.2.4.4 Cost Alternative 3

The cost calculation for alternative 3 is by adding the investment costs of designing and buying new seats to the cost of existing production. It is estimated that the chair is made of wood with a backrest and cushions in the backrest and the seat. It is estimated that the booking and purchasing price of the chairs that will be adjusted to the proposal from the ergonomic consultant is 350,000 rupiahs per piece, while the wage of the ergonomic consultant is 3,000,000 rupiahs. So, here are the calculations of costs alternative 3.

Table 5.18 Cost Alternative 3 Calculation

Cost Variable	Amount	Value
Consultant	1	3,000,000

New chairs	150	52,500,000
Total		55,500,000

Table 5.19 Total Cost of Alternative 3 Calculations

Cost Variable	Value
Existing cost	264,301,600
Cost of designing and buying new chairs	55,500,000
Total	319,801,600

Based on calculations performed, total cost requirements for alternative 2 is Rp. 319,801,600.00

5.2.4.5 Cost of Alternatives Combination 1, 2

In the calculation of the cost of alternative combination 1, 2 is by adding the cost of existing to the cost of alternative 1, and a surcharge on the alternative 2.

Table 5.20 Cost of Alternatives Combination 1, 2 Calculation

Cost Variable	Value
Existing cost	264,301,600
Cost of maintenance team	6,365,250
Cost of new binding tools	90,000,000
Total	360,666,850

Based on the calculation performed, total cost requirements for alternatives combination of 1, 2 is Rp. 360,666,850.00

5.2.4.6 Cost of Alternatives Combination 1, 3

In the calculation of the cost of alternatives combination 1, 3 is by adding the cost of existing to the cost of alternative 1, and a surcharge on the alternative 3.

Table 5.21 Cost of Altenatives Combination 1, 3 Calculation

Cost Variable	Value
Existing cost	264,301,600
Cost of maintenance team	6,365,250
Cost of designing and buying new chairs	55,500,000
Total	326,166,850

Based on the calculation performed, total cost requirements for alternatives combination of 1, 3 is Rp. 326,166,850.00

5.2.4.7 Cost of Alternatives Combination 2, 3

In the calculation of the cost of alternatives combination 2, 3 is by adding the cost of existing cost to the cost of alternative 2, and a surcharge on the alternative 3.

Table 5.22 Cost of Alternatives Combination 2, 3 Calculation

Cost Variable	Value
Existing cost	264,301,600
Cost of new binding tools	90,000,000
Cost of designing and buying new chairs	55,500,000
Total	409,801,600

Based on the calculation performed, total cost requirements for alternatives combination of 2, 3 is Rp. 409,801,600.00.

5.2.4.8 Cost of Alternatives Combination 1, 2, 3

Calculation of the cost of alternatives combination 1, 2, 3 is by adding the cost of existing cost to the cost of alternative 1, alternative 2 and surcharge on the alternative 3.

Table 5.23 Cost of Alternatives Combination 1, 2, 3 Calculation

Cost Variable	Value
Existing cost	264,301,600
Cost of maintenance team	6,365,250
Cost of new binding tools	90,000,000
Cost of designing and buying new chairs	55,500,000
Total	416,166,850

Based on the calculation performed, total cost requirements for alternatives combination of 1, 2, and 3 is Rp. 416,166,850.00

5.2.5 Selection of Improvement Alternatives

After calculating the cost of the entire alternatives combinations, then do the improvement alternatives selection by using Value Engineering. Existing alternatives will be assessed using alternative selection criteria that has been set previously, namely the availability and quality. Assessment of those three criteria carried out by interviewing three employees with the weight of each criterion has been in proportion to the performance that has been calculated previously.

Table 5.24 Improvement Alternatives Assesment

Alternative	Availability				Quality			
	Weight = 0.52				Weight = 0.48			
	1	2	3	Total	1	2	3	Total
0	4	6	4	14	5	4	4	13
1	6	7	7	20	6	7	6	19
2	6	7	6	19	7	7	6	20
3	7	7	7	21	6	7	6	19
1,2	7	8	7	22	8	8	7	23
1,3	8	7	7	22	7	7	8	22
2,3	7	8	8	23	8	8	8	24
1,2,3	8	8	8	24	9	9	8	26

Furthermore, the number of improvement alternatives assessment will be put in the Value Engineering in accordance with predetermined criteria.

$$\text{Ratio} = \frac{\text{Alternative Cost (0)}}{\text{Alternative Performance (0)}} \quad \text{......(5.1)}$$

$$\text{Ratio} = \frac{262{,}753{,}600}{13.52} = 19{,}434{,}437.87 \quad \text{......(5.2)}$$

$$\text{Value} = \frac{\text{Performansi x Ratio}}{\text{Cost}} \quad \text{......(5.3)}$$

Table 5.25 Value Engineering

Alternative	Weight		Performance	Cost	Value
	Availability	Quality			
	0.52	0.48	19,548,934.91		
0	14	13	13.52	264,301,600	1
1	20	19	19.52	270,666,850	1.41
2	19	20	19.48	354,301,600	1.07
3	21	19	20.04	319,801,600	1.23
1,2	22	23	22.48	360,666,850	1.22
1,3	22	22	22	326,166,850	1.32
2,3	23	24	23.48	409,801,600	1.12
1,2,3	24	26	24.96	416,166,850	1.17

Here is an example of a calculation of alternatives combination 1 and 3.

Alternative Value (1, 3) = $\frac{22 \times 19{,}434{,}437.87}{324{,}618{,}850}$ = 1.32 .... (5.4)

The calculation of the performance by dividing the cost of the alternative 0 with the value of alternative performance 0. Then calculate the value for each alternative value by using the equation of the formula (5.3). Selection of the best alternative is based on the value of the highest value. Based on the calculation of Value Engineering, the highest value of all alternatives is the alternatives combination of 1.3, which has value of 1.32.

5.2.6 Analysis of Selected Alternative

Based on the calculations that have been done on Value Engineering, which is a combination of alternatives 1 and 3 with a value 1.32. After select the best alternative, it is necessary to conduct an assessment and calculation of the targets in the production process that will improve as well as waste reduction that will occur. Calculation will be done by comparing the sigma level, financial reduction and performance.

With the alternative 1, 3 that has been selected, then carried out the estimated improvement to calculate how much impact given by this improvement to the company performance. Calculation is based on the previous analyzes, i.e. FMEA, RCA, CTQ, defect waste and the performance measurement. In the alternative 1.3 proposed improvement are doing periodic maintenance, provide backup tool and replace the chairs with new chairs.

From the observations, interviews and brainstorming with the company, found that by implement the improvement, targeted to reduce the defect percentage of 66% of the initial amount of defect. In terms of EHS waste, is targeted to reduce the percentage of absent due to illness by 52%. That value is based on the influence of the improvements to the problems.

Conduct periodic maintenance and provide backup tool are highly influential on defect reduction. The results of FMEA states that these problems critically contribute to all types of defective product. In terms of health, the more reliable the tools that are used, then the fatigue caused even smaller. Meanwhile, another improvement is to replace the chairs with a more ergonomic chair. FMEA results stated that the problem of unsafe and uncomfortable chair used by the worker critically contribute to the health of the worker. It can cause musculoskeletal disorder and fatigue that lead to headache and dizziness. In addition, the fatigue caused by the uncomfortable chair also lead to concentration loss which impact on workers to produce defective products.

a. Sigma Level

- Defect waste

  Here is the calculation of the initial sigma of defect waste, which was calculated and shown in the previous chapter.

Table 5.26 Initial Sigma Level

Information	Value
Number of Output	15,036,000
Number of Defect	2,763,111
Defect per Unit	0.1838
CTQ	3
Failure rate opportunity per CTQ	0.061
DPMO	61255
Sigma Level	3.05

With the reduction of the number of defective products as much as 66%, below is the new level sigma.

Table 5.27 Improved Sigma Level

Information	Value
Number of Output	15,036,000
Number of Defect	939,458
Defect per Unit	0.0625
CTQ	3
Failure rate opportunity per CTQ	0.021
DPMO	20827
Sigma Level	3.54

New sigma level that will be obtained with the implementation of defect waste improvement is 3.54.

- EHS waste

Here is the calculation of the initial sigma of EHS waste, which was calculated and shown in the previous chapter.

Table 5.28 Initial Sigma Level

Information	Value
Number of Output	4382
Number of Illness	399
Illness per Absences	0.091
CTQ	3
Failure rate opportunity per CTQ	0.030
DPMO	30351
Sigma Level	3.38

With the reduction of the number of absences due to illness as much as 52%, below is the new level sigma.

Table 5.29 Improved Sigma Level

Information	Value
Number of Output	4382
Number of Illness	192
Illness per Absences	0.044
CTQ	3

Table 5.29 Improved Sigma Level (Continued)

Information	Value
Failure rate opportunity per CTQ	0.015
DPMO	14569
Sigma Level	3.68

New sigma level that will be obtained with the implementation of EHS waste improvement is 3.68.

b. Cost Reduction

In the implementation of the alternatives 1 and 3, it is estimated that there will be a cost reduction due to lower number of absences due to illness and number of defective products. Here are the details and explanation.

- Defect Waste

Table 5.30 Cost Comparison of Defect Waste

Information	Defect	Loss Sales
Existing	2,763,111	690,777,750
Improved	939,458	234,864,500

Of the calculation in the previous chapter, found that the amount of financial loss incurred due to the large number of defective products amounted to 690,777,750 rupiahs. While with the improvement, the company estimated the financial loss to reduce to be 234,864,500 rupiahs.

- EHS Waste

Table 5.31 Cost Comparison of EHS Waste

Information	Illness	Loss (Rods)	Value
Existing	399	1,596,000	399,000,000
Improved	192	768,000	192,000,000

Of the calculation in the previous chapter, found that the amount of financial loss incurred due to the large number of absences due to illness amounted to 399 million rupiahs. While with the improvement, the company estimated the financial loss to reduce to be 192 million rupiahs.

c. Performance Improvement

In the implementation of alternative 1 and 3, it is estimated that there will be an increase in performance due to the increase of availability and quality percentages by the OLE calculation as an indicator of performance. Here are the calculation of availability, quality and the Overall Labor Effectiveness (OLE).

- Availability

Table 5.32 Availibility Comparison

Condition	Working Days	Illness	Others	Rework	Availability
Existing	4200	399	55	691	72.7%
Improved	4200	192	55	173	90.0%

With the improvement implementation, it is estimated that the percentage of availability increased from 72.7% to 90.0%.

- Quality

Table 5.33 Quality Comparison

Condition	Production	Defect	Non-defective Product	Quality Percentage
Existing	15,036,000	2,763,111	12,272,889	81.6%
Improved	15,036,000	939,458	14,096,542	93.8%

With the improvement implementation, it is estimated that the percentage of availability increased from 81.6% to 93.8%

- Overall Labor Effectiveness

Table 5.34 OLE Comparison

Condition	Availability	Quality	OLE
Existing	72.7%	81.6%	59.4%
Improved	90.0%	93.8%	84.4%

With the improvement implementation, it is estimated that the percentage of OLE increased from 59.4% to 84.4%. So, from the results of above calculations, the implementation of improvement alternatives 1 and 3. The performance is estimated to increase to 84.4%, or an increase of 25%

CHAPTER VI
CONCLUSION AND RECOMMENDATION

In this chapter will be presented the conclusions of the research that has been conducted in the company. Additionally, it will also presented suggestions to the research that has been done.

5.3 Conclusion

Based on the results of experiments and analysis that has been done in the previous chapter, the following are the conclusions that can be drawn in this study.

1. Critical waste of the production process of Cempaka non-filter Long Size 12 are EHS and defect waste. Which of these two waste occurs in the rolling and cutting process.
2. Based on the analysis using Root Cause Analysis (RCA) and Failure Mode and Effect Analysis (FMEA), critical causes of the critical problems are the repeated use of tools without the maintenance or renewal, no tool to collect the cigarette rods properly, the absence of putting point indicator of the rolling tool, less ergonomic chairs used by the workers, the workers do not use mask while work, and the unavailability of activities that aim to maintain the health and fitness of the workers.
3. There are 3 improvement alternatives selected, that are doing periodic maintenance and provide backup tools, make proper binding tool, and chair replacement.
4. Based on the calculation of value engineering, alternatives selected in improvement are alternative combination 1 and 3 that are doing periodic maintenance and provide backup tools and chair replacement.

5.4 Recommendation

This recommendation section is divided into two, namely the recommendation for further research and recommendation for observed company.

5.4.1 Recommendation for Further Research

Given the indication that it is possible for further research from this study, the following are recommendations for further research.

1. Although the measurement of the level of the production performance has been conducted on the labor performance by using Overall Labor Effectiveness (OLE), it would be nice if future studies will be combined between OLE and Overall Equipment Effectiveness (OEE), so it can evaluate the observed object more broadly.
2. It would be nice in future studies conducted in-depth research on the relationship of the ergonomic aspects with the workers' performance, considering the number of indications of work ergonomics problems causing the decline in the workers' performance.

5.4.2 Recommendation for the Observed Company

Given that there are many problems that exist in the company's production process, the following are recommended for the observed company.

1. For the assessment of alternative solutions that have been given, it is better if these alternatives can be applied and do control. So as to know the real outcome of the advantages and disadvantages of the alternatives given.

BIBLIOGRAPHY

Antara News (2014). *Penerimaan Bea Cukai Capai Rp. 141,65 Triliun.* <URL: http://www.antaranews.com/berita/468553/penerimaan-bea-cukai-capai-rp14165-triliun>. Accessed on April 1, 2015.

Bappeda Jatim. (2014). *Jatim Bikin Moncer Perolehan Cukai Rokok Nasional.* <URL:http//bappeda.jatimprov.go.id/2014/03/18/jatim-bikin-moncer-perolehan-cukai-rokok-nasional>. Accessed on April 1, 2015.

Besterfield, D. H. (1986). *Quality Control, 2nd edition, Prentice-Hall Internasional*.

Okezone (2011). *Produksi Rokok Kretek Capai 90%*. <URL:http://economy.okezone.com/read/2011/05/13/320/456899/produksi-rokok-kretek-capai-90>. Accessed on April 1, 2015

Gaspersz, Vincent**.** (2006). *Continuous Cost Reduction Trough Lean Sigma Approach*. Jakarta: PT Gramedia Pustaka Utama.

Gaspersz, V. (2007). *Lean Six Sigma for Manufacturing and Service Industries*. Jakarta: PT. Gramedia Pustaka Utama.

Gaspersz, Vincent. (2002). *Pedoman Implementasi Program Six Sigma Terintegrasi Dengan ISO 9001:2000, MBNQA dan HACCP*. Jakarta: PT Gramedia Pustaka Utama.

George, Michael L. (2002). *Lean Six Sigma*: *Combining Six Sigma Quality With Lean Speed.* New York: McGraw-Hill.

Hines. (2000). *Going Lean* <URL:http://www.cf.ac.uk/carbs/lom/learch/centre/publications>. Accessed on April 2, 2015.

Helen, Bevan (2005). *Lean Six Sigma-the basic concepts*, NHS Institute for Innovation and Improvement<URL:http://www.nodelaysachiever.nhs.uk/.../0/RG0046LeanSixSigmathebasicconcepts.pdf>. Accessed on April 2, 2015.

Kontan. (2010). *Produksi Rokok Melambat Karena Jumlah Pabrik Kian Menyusut.* <URL: http://industri.kontan.co.id/news/produksi-rokok-

melambat-karena-jumlah-pabrik-kian-menyusut-1>. Accessed on April 2, 2015.

Kronos (2007). *Overall Labor Effectiveness (OLE): The Business Case for Labor Productivity*. Chelmsford, MA: Kronos Incorporated.

Liker , Jeffrey K. (2004). The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, McGraw-Hill.

McDermott, R., Mikulak, R. J., & Beauregard, M. (1996). *The basics of FMEA.* Productivity Press.

Neraca. (2013). *Produksi Rokok Bakal Tembus 332 Miliar Batang*. <URL: http://www.neraca.co.id/article/29234/Produksi-Rokok-Bakal-Tembus-332-Miliar-Batang>. Accessed on April 2, 2015.

Park, Sung H. (2003). *Six Sigma for Quality and Productivity Promotion*. Tokyo: Asian Productivity Organization.

Pyzdek, Thomas. (2002). *The Six Sigma Handbook.* Jakarta: Salemba Empat. Reliable Plant.

Riduwan. 2005. Belajar Mudah Penelitian Untuk Guru, Karyawan dan Peneliti Pemula, Bandung : Alfabeta.

Trisnal, Pujangkoro, S., & Huda, L. N. (2013). *Analisis Implementasi Lean Manufacturing dengan Lean Assessment dan Root Cause Analysis pada PT. XYZ.* Medan: Universitas Sumatera Utara.

Tempo. (2010). *Pendapatan Cukai Rokok Capai Rp. 62 Triliun ke Negara.* <URL:http://www.tempo.co/read/news/2010/12/21/090300604/Pendapatan-Cukai-Rokok-Capai-Rp-6214-Triliun/>. Accessed on April 2, 2015.

Wikipedia. (2015). *Overall Labor Effectiveness (OLE).* <URL: http://en.wikipedia.org/wiki/Overall_Labor_Effectiveness>. Accessed on April 2, 2011.

APPENDIX

APPENDIX A: A certificate from the related company

SIGARET KRETEK

CEMPAKA

DISUKA•KARENA•RASA

Desa Tanjungsari RT. 005 RW. 002 Kec. Boyolangu, Phone : (0355) 328987 Fax : (0355) 337110
TULUNGAGUNG - JAWA TIMUR - INDONESIA

SURAT KETERANGAN

Nomor :031/CPK/Person/VI/2015

Yang bertandatangan dibawah ini Direktur Perusahaan Rokok " CV. CEMPAKA " Tulungagung, menerangkan dengan sebenarnya bahwa :

Nama	: Auditya Danial Jiwandono
NRP	: 2511100182
Fakultas	: Teknologi Industri
Jurusan	: Teknik Industri
Nama PTN/PTS	: Institut Teknologi Sepuluh Nopember

Telah melakukan Penelitian guna penyelesaikan Skripsi Di Perusahaan Rokok " CV. CEMPAKA " Tulungagung, mulai tanggal 5 Januari 2015 sampai dengan tanggal 29 Mei 2015.

Demikian surat keterangan ini dibuat untuk dipergunakan sebagaimana mestinya.

Dikeluarkan di : Tulungagung
Tanggal : 1 Juni 2015
An. Direktur Perusahaan Rokok
" CV. CEMPAKA "Tulungagung

CV. CEMPAKA
TULUNGAGUNG

HJ. NENNY KRISTINAWATI
DIREKTUR PERSONALIA

APPENDIX B: Defective Products

APPENDIX C: Uneven Cutting Defect

APPENDIX D: Uneven Size Defect

APPENDIX E: Deflated Defect

APPENDIX F: Dull Scissors

APPENDIX G: Loose Bolt in the Rolling Tool

APPENDIX H: Less Comfortable Chair

APPENDIX I: Glue was mixed with tobacco before it is used and is left open in the free air

APPENDIX J: Binding Tool Project (1)

APPENDIX K: Binding Tool Project (2)

APPENDIX L: Binding Tool Project (3)

APPENDIX M: Interview Result for the Assessment of Value Engineering

Name	Suprih
Working in the company since	2006
Age	31

Availability										
Alternative(s)	Bad					Good				
	1	2	3	4	5	6	7	8	9	10
0				v						
1						v				
2						v				
3							v			
1.2							v			
1.3								v		
2.3							v			
1.2.3								v		

Quality										
Alternative(s)	Bad					Good				
	1	2	3	4	5	6	7	8	9	10
0					v					
1						v				
2							v			
3						v				
1.2								v		
1.3							v			
2.3								v		
1.2.3									v	

Name	Ria
Working in the company since	2011
Age	33

Availability										
Alternative (s)	Bad					Good				
	1	2	3	4	5	6	7	8	9	10
0						v				
1							v			
2							v			
3							v			
1.2								v		
1.3							v			
2.3								v		
1.2.3								v		

Quality										
Alternative (s)	Bad					Good				
	1	2	3	4	5	6	7	8	9	10
0				v						
1							v			
2							v			
3							v			
1.2								v		
1.3							v			
2.3								v		
1.2.3									v	

Name	Titin
Working in the company since	2005
Age	53

Availability										
Alternative(s)	Bad					Good				
	1	2	3	4	5	6	7	8	9	10
0				v						
1							v			
2						v				
3							v			
1.2							v			
1.3							v			
2.3								v		
1.2.3								v		

Quality										
Alternative(s)	Bad					Good				
	1	2	3	4	5	6	7	8	9	10
0				v						
1						v				
2						v				
3						v				
1.2							v			
1.3								v		
2.3								v		
1.2.3								v		

This page is intentionally left blank.

AUTHOR'S BIOGRAPHY

Auditya Danial Jiwandono was born in Tulungagung, February 27th 1993. He is the first child of the couple H.R. Janta Wiwaha, SE, MM. and Naning Kristiwinarni, SE. He was graduated from SDN Kampungdalem 1 Tulungagung in 2005, SMPN 1 Tulungagung in 2008, and SMAN 3 Padmanaba Yogyakarta in 2011. He also attended on Institut Teknologi Sepuluh Nopember (ITS) Surabaya majoring Industrial Engineering and graduated in 2015.

During his education in college, the author had the opportunity to join the Student Association of Industrial Engineering of ITS and Student Activity Units of Music during the 2012-2013 period. During become a member, the author joins the committee activities held by the organizations, both small and large scale events. In addition, the author became a member of the 1st ITS Big Band.

During the study, the author also participated in several training either in soft skill and hard skill. He joined Student Management Skill Pre-basic Level, Student Management Skill Basic Level, and Potential Development Training of Industrial Engineering Students. Besides, he also joined trainings and seminars for hard skill; 3Ds Max Training, BizCom International Seminar, and Internal Quality Auditor ISO 9001:2008 for developing hard skill.

To apply the knowledge gained in the lecture, the author has also implemented the internship at PT. United Tractors, Tbk. The author can be reached for research purposes via the phone number 087702468111 or via e-mail address danialjiwandono@gmail.com.