REDUCING SHIFTLY CLEANING PROCESSING TIME IN PACKAGING AREA AT CIGARETTE MANUFACTURING COMPANY, WEST JAVA

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THESIS ADVISOR
RECOMMENDATION LETTER

This thesis entitled **"REDUCING SHIFTLY CLEANING PROCESSING TIME IN PACKAGING AREA AT CIGARETTE MANUFACTURING COMPANY, WEST JAVA"** prepared and submitted by **Jefferzon Leona Partty** in partial fulfillment of the requirements for the degree of Bachelor Degree in the Faculty of Engineering has been reviewed and found to have satisfied the requirements for a thesis fit to be examined. I, therefore, recommend this thesis for Oral Defense.

Cikarang, Indonesia, January 23st, 2017

Anastasia Lidya Maukar, ST.,M.Sc.,M.MT

DECLARATION OF ORIGINALITY

I declare that this thesis, entitled **"REDUCING SHIFTLY CLEANING PROCESSING TIME IN PACKAGING AREA AT CIGARETTE MANUFACTURING COMPANY, WEST JAVA"** is, to the best of my knowledge and belief, an original piece of work that has not been submitted, either in the whole or in part, to another university to obtain a degree.

Cikarang, Indonesia, January 23st, 2017

Jefferzon Leona Partty

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ABSTRACT

Shiftly cleaning processing time in Packaging area of PT XY is high. Cleaning process is reason of machine should stop and reducing output which can be produced. In Packaging area of PT XY, there are two kinds of machine, which are Packer and Wrapper machine. Cleaning processing time in Packaging area are 1,968.75 seconds for Packer and 1,579.75 seconds for Wrapper. Therefore, in order to reduce cleaning time, concept of lean manufacturing is adopted. In Lean Manufacturing, non-value added activities is considering as waste, such as cleaning activities. FPC and Flow diagram are used for explaining cleaning process. Other Lean tools also used in order to make further improvements, which is 5S for having better tools arrangement for cleaning activity. Later, new cleaning process sequence is created to reduce time and operator's motion. After making an analysis of the improvement, it was expected to reduce the shiftly cleaning time from 1,968.75 seconds to 884.37 seconds or by 44.92% for Packer machine. While, in Wrapper machine the reduction of shiftly cleaning processing time is from 1,579.75 seconds to 451.51 seconds or by 28.58%. Then the company will be able to save production loss by IDR 6,300,000,- for one day.

Keywords: *Shiftly Cleaning, Cleaning Processing Time, Lean Manufacturing, 5S, Waste, Flow Process Chart (FPC), Flow Diagram, and Production Loss*

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LIST OF TERMINOLOGIES

Shiftly Cleaning : Cleaning activity which conducted by operator in the end of shift, and it is being done in every shift

Internal Activities : Activities that must be completed while the equipment or machine is stopped

External Activities : Activities that must be completed while the equipment or machine is stopped

Hinged-lid Packet : A single carton packaging which consists of sixteen or twenty cigarettes

Slof Packet : A set of ten Hinged-lid Packets which overwrapped by a plastic film

Production Loss : Losses products which supposed to be able to produce during a certain period of time, but it is not being produced

CHAPTER I
INTRODUCTION

1.1 Problem Background

Productivity is one important aspect of the manufacturing company, especially for a multinational company, which has a big demand for its product. Therefore, each company tries many methods which can support the production process with a high output, while the input of raw material as little as possible. There are many factors which affect the productivity of production processes, such as manpower, machine, material, method, and money. When the machine is shutting down, it may reduce the productivity. The importance of productivity is reducing idle or machine breakdown. By reducing set up time, it was expected to increase the production rate (Kumar, 2013). There are some cases which required the machine to shut down or in an idle condition, either it is with a purpose or unexpectedly. If the machine is turning off due to preventive maintenance, cleaning machine, setup machine can be categorized as the machine shut down with a purpose, while the example when the machine turns off unexpectedly are corrective maintenance and machine breakdown.

PT XY is one of a leading tobacco company in Indonesia that produces various branded cigarettes both for local and international. Hence, PT XY has a large number of demands for worldwide, PT XY should conduct continuous improvement for its performance, especially in the production process. One of the ways to have continuous improvement, PT XY implements lean manufacturing in order to increase productivity and reducing waste. According to Ohno Taiichi (1988), there are eight kinds of waste; Defects, Overproduction, Waiting, Non-Utilize Talent, Transportation, Inventory, Motion, Extra-Processing (DOWNTIME).

All the production processes of PT XY are manufactured using automation. Therefore, the production rate is very high, and every single minute is very

important in this case. In the packaging area, there are two main major machines, which operate to pack the cigarette, they are Packer and Wrapper.

Since these machines are running automatically, so the cleanliness of machine should be maintained. There is cleaning process that should be done during the shift interchange. However, the cleaning process takes longer times than needed for the cleaning machines in the packaging area. The average cleaning time for Packer is about 32.81 minutes and for Wrapper is 26.33 minutes. However, this cleaning process should be done three times a day, because PT XY operates three shifts in one day, and every shift is 8 hours working time. Then, the average percentage of machine shut down – due to shiftly cleaning, compared to working hour in one day, from week 29 to week 32 is about 7.06% for Packer and 5.46% for Wrapper.

If the reduction time for cleaning time can be done, machine downtime is expected can be reduced. By reducing the machine downtime, the productivity will increase, which leads to saving the production loss.

1.2 Problem Statements

Based on the problem faced by in the production floor, there are some questions should be answered, which are:

- What is the internal and external activity of shiftly cleaning process?
- How does the packaging area reduce shiftly cleaning processing time for packer and wrapper machines?
- How much is the production loss saving after improvement of shiftly cleaning process?

1.3 Objectives

There are several objectives in order to solve the problem of this project, which are:

- To determine the internal and external activity of shiftly cleaning process.
- To reduce the shiftly cleaning processing time for packer and wrapper machines.
- To calculate the production loss saving after improvement of shiftly cleaning process.

1.4 Scopes

Due to the limitation of time and resources, there are some scopes in order to complete this project, which are:

- The data were collected from July to August 2016.
- Downtime data were only from Shiftly Cleaning, Brandchange, and Minor Stop.
- The research is only done for one production line in the packaging area.

1.5 Assumptions

Some assumption should be made in order to cover some areas, which are:

- All operators have same procedure of current cleaning process.
- The process observed only for shiftly cleaning.
- The cleaning process of packer machine is done while the wrapper machine is running and vice versa.

1.6 Research Outline

Chapter I Introduction

This chapter provides the background of problem occurred, problem statements, research objectives, scopes, assumptions, and description of research outline as an introduction for this project.

Chapter II Literature Study

This chapter contains the theoretical study, and previous study, which are books, journals, thesis used as references in order to

support this project. In this chapter, the theory of Lean Manufacturing, Single Minute Exchange of Dies, eight kinds of waste, 5S, Flow Process Chart (FPC), and Flow Diagram were explained.

Chapter III Research Methodology

This chapter delivers a detail process flow and explanation of every single step used to conduct this project starts from problem identification until the conclusion. Including the research framework which explaining the flow process of this research.

Chapter IV Data Collection and Analysis

In this chapter, the data which is taken during the project will be analyzed and processed. The result of data analysis is a new improvement and result of application improvement which is expected to reduce theshiftly cleaning processing time and save the production loss in the packaging area.

Chapter V Conclusion and Recommendation

This chapter gives the result of this project to answer the problem statements and to obtain the problem objectives as well as it provides the recommendation for future research that will have a similar topic of research.

CHAPTER II
LITERATURE STUDY

2.1 Lean Manufacturing

Lean Manufacturing or Lean Production, sometimes simplify as Lean, is a set of methodological tools, which can be used independently or combined systematically in order to reduce and eliminate the seven waste (next, will be developed into eight kinds of waste) in the production system (Wilson, 2010). Beside of to reduce the waste in a production system, the lean manufacturing was tried to lead the product into the best quality with the lowest cost, also high productivity while improving safety and morale.

Lean Manufacturing was adopted from the Japanese automobile business, which is Toyota. Therefore, lean manufacturing was adopted from Toyota Production System (TPS), which is developed by Taiichi Ohno, Toyota's chief of production and Dr. Shigeo Shingo, a Consultant of Toyota. Lean manufacturing is focusing on a customer's perspectives, which come with the conclusion to meet customer satisfaction and do it profitably.

A traditional concept of profit is where the manufacturer defines the value of profit and adds it with production cost, to sum up into the selling price.

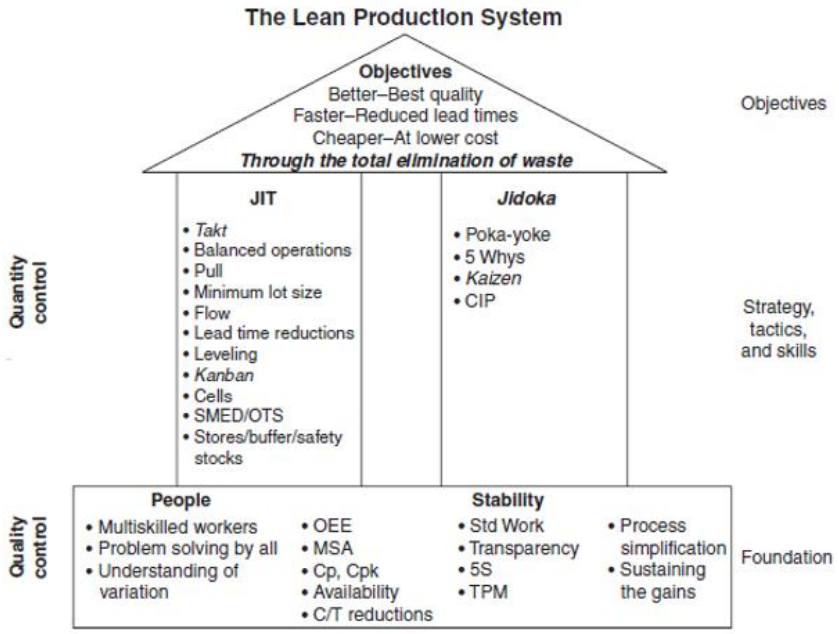
Selling Price = Profit + Costs (1)

While Taiichi Ohno argued that if the customer perceives product or service to have a specific value they will only pay accordingly. Then, If the company raises prices because of the cost is increasing but the perceived value of the product remains the same. Customers will stop buying as selling price exceeds the value that they perceive.Therefore, Taichii Ohno and Toyota look at profit and costs in the following way;

Profit = Selling Price – Costs (2)

Thus, in order to obtain more profit, Taiichi Ohno thinks how to reduce costs, which is by using Lean Manufacturing to eliminate waste that leads into non-added value to the product.

Lean manufacturing is supported by two pillars which are consisting of tools to make production system "Leaner". The two pillars are JIT (Just-In-Time) and Jidoka.



Source: (Wilson, 2010)

Figure 2.1 House of Lean

- **Just-In-Time (JIT)**

The concept of Just-In-Time system considers as Pull system where, try to get the right quantity of raw material to produce right quantity, in the right place at the right time (Mahmoud, 2015). The purpose of JIT technique is to reduce the inventory and lead time of production due to the high volume of mass production. Thus, all the material or finished good which exceeds the demand, consider as waste can be eliminated. This system is suited to the production of a low volume of different types of products. The main goals of JIT system are to balanced, smooth and fast of production flow, which is creating a condition where zero defect, zero inventory, zero set-up time, zero handling, and zero breakdowns.

- **Jidoka**

This concept was using the integration between machine and manpower, where human doing the specific task and assist by the machine to assure the quality. Therefore, the task only can be done if it is done correctly.

There are some improvement tools used in lean manufacturing, some examples are:

- SMED: Single Minute Exchange of DIE
- TPM: Total Productive Maintenance
- 5S: Visual Workplace or Visual Factory
- KanBan: Work Signaling System
- Error & Mistake-Proofing: A perfect process tool
- Level-Loading (Heijunka): For producing mixed quantities and styles of products
- Inventory Reduction
- Kaizen Events (a.k.a. Kaizen Blitzes or Improvement Events)
- Continuous Improvement (and "Lean Culture Change")

2.1.1 Single Minute Exchange of Die (SMED)

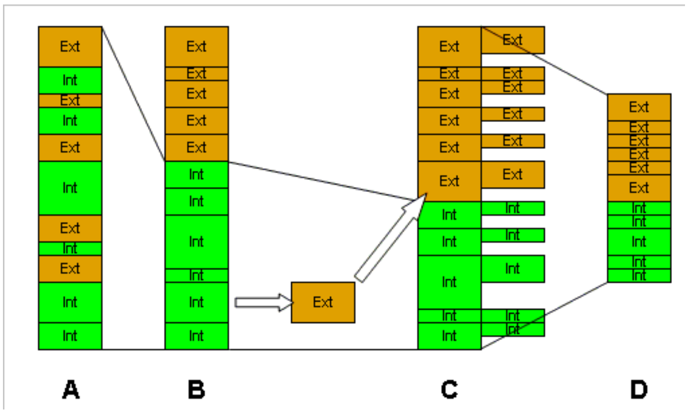
Single Minute Exchange of Die is a changeover process which has duration less or equal to 9 minutes. SMED (Single-Minute Exchange of Dies) is a system for dramatically reducing the time it takes to complete equipment or machine changeovers. The essence of the SMED system is to convert as many changeover steps as possible to "external" (performed while the machine is running) and to simplify and streamline the remaining steps. The name Single-Minute Exchange of Dies comes from the goal of reducing changeover times to the "single" digits (i.e. less than 10 minutes). With a quick changeover, it can reduce the setuptime during shift interchange, and it will reduce the waste inventory, which is Work in Process inventory (Niebel et al, 1999).

SMED was developed by Shigeo Shingo, a Japanese industrial engineer who was successfully in helping companies to reduce their changeover times. His

pioneering work led to documented reductions in changeover times averaging 94% (e.g. from 90 minutes to less than 5 minutes) across a wide range of companies.

In SMED, changeovers are made up of steps that are termed “elements”. There are two types of elements:

- Internal Elements (elements that must be completed while the equipment/machine is stopped)
- External Elements (elements that can be completed while the equipment/machine is running)



(Source: https://en.wikipedia.org/wiki/Single-Minute_Exchange_of_Die)

Figure 2.2 SMED Steps

In doing SMED, there are three main basic steps to be implemented, which are:

1. SMED step 1 (A to B)

   SMED step 1 is a process from Mixed Phase (A) into Split Phase (B), this is a process of separating the internal and external elements. Mixed Phase is an origin condition where the internal and external elements are not differentiated. The manufacturing process usually stops during the setup are done. Either tools or fixtures are not maintained, checked and prepared earlier. Tools are not moved to working area or machine, and tools are not kept neatly.

Split phase is a phase where the internal and external elements are separated. During the machine still running, all the preparation needed is done. Maintenance, inspection, and preparation of tools are done as an external element, while the production or manufacturing process is stopped only for doing the external activity.

2. SMED step 2 (B to C)

   The second step of SMED is a process of transferring as many as possible of internal activity to the external activity. The Transfer Phase (C) is a condition where the internal elements are already transferred to external elements. Some tools and fixtures have been standardized in order to make all the external elements can be done before the machine stops running and only the internal elements are done during setup up.

3. SMED step 3 (C to D)

   SMED step 3, is the process of Transfer Phase into Improved Phase. In this step, all the internal and external elements should be improved so that the total changeover time can be reduced. In the improved phase, all the internal and external elements have been minimized. One of the ways to minimize it, by do the standardization of tool size. Using hydraulic, pneumatic, and magnetic tools will help to minimize the internal and external elements.

Having SMED method in the production will give some benefit, besides of reducing the changeover time. They are

- Reducing lead time, where it may affect the manufacturer to be more responsive to customer's demands
- Flexibility to face the variety of

2.1.2 Eight Kinds of Waste

Waste or in Japanese *Muda/Mura/Muri* is a problem which has to remove from production process in Lean Manufacturing. There are eight kinds of mudas and

can be shortened as DOWNTIME (Defect, Overproduction, Waiting, Non-utilized Talent, Transportation, Inventory, Excess Processing). Formerly, According to Ohno (1988), there are only seven kinds of waste, but recently on the theory of Lean Six Sigma, waste can be defined into eight types (Mcgee-Abe, 2015).

(Source: https://goleansixsigma.com/8-wastes/)

Figure 2.3 Eight Kinds of Waste

The eight kinds of wastes of Lean Manufacturing are;

- Defects

  The defect product is waste which causes by the poor quality of the internal process. Producing defective product will spend additional cost and time to fix it. The extra cost consists of material, manpower, facilities, and conveyance measures.

- Overproduction

  There is two type of overproduction, which are producing over quantity or producing too early. Overproduction leads to the high number of inventory. The Toyota Production System is also referred to as "Just in Time" (JIT) because every item is made just as it is needed. By producing too much, it also causes theproblem of waste in, extra raw material, increasing storage space, increasing labor cost due to higher labor working hour.

- Waiting

  Waiting can be caused by any delay of production process due to breakdown, changeover, poor layout or working sequence. Short preventive maintenance time and rapid changeover, may increase productivity. Elimination of waiting in work sequence is also able to improve the production process.
- Non-Utilized Talent

  This type of waste is seen frequently this recent day of business. People's talent, skill, and knowledge are not utilized maximum.
- Transportation

  It can be a transportation of products or material. In the condition of bad layouts and facility design, it may cause the transportation is more than required. Later on, it will affect to inefficient of the production system.
- Inventory

  Work in Progress (WIP) is a direct result of overproduction and waiting. Excess inventory tends to be an unrealized problem in production floor. Over quantity of inventory increases lead times consumes production floor space, and delays during the distribution.
- Motion

  This waste is related to ergonomics and is seen in all instances of bending, stretching, walking, lifting, and reaching. Also, the motion of manpower is exceeded than the required.
- Excess-Processing

  Over-processing occurs any time more work is done on a piece other than what is required by the customer.

2.1.3 5S

5S is one of Lean Manufacturing tools for organizing the working area to keep clean and based on the standard in order to increase the productivity. By implementing the 5S, it enables to reduce the waste which leads to unnecessary

activities which can be wasteful. 5S is standardized tools which can be documented into Standard Operating Procedures (SOP). The 5S consists of:

1. Seiri/Sort: Separate between tools needed and not for the operation. The tools that are not used will be removed from the working area.
2. Seiton/Set in Order: The needed items should be arranged in ergonomic order to ease the user when they need the tools. All item should be clearly identified, so it will help people to find it and return it when the job is done.
3. Seiso/Shine: Clean the tools and working area on a regular period in order to maintain the cleanliness and ensure everything returns to as new.
4. Seiketsu/Standardize: Repeat the first three step of 5S in order to obtain the best practices in the workplace and standardize it for the workplace.
5. Shitsuke/Sustain: Maintain the best standards in order to have all the tools in the right place by doing continuous improvement.

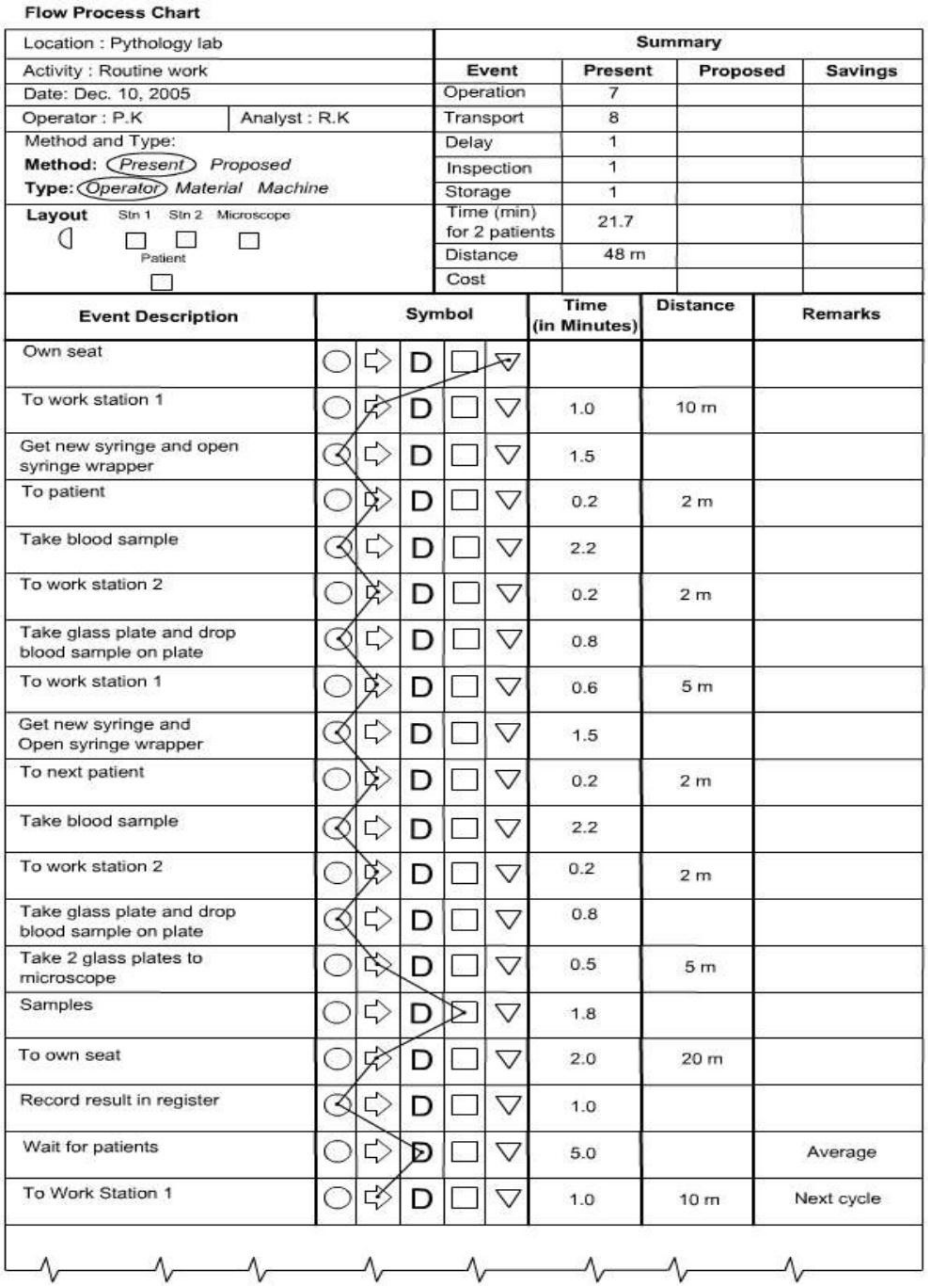
2.2 Flow Process Chart

Flow Process Chart (FPC) is one of the tools for time study analysis. FPC shows the sequence of flow processing of any activities in production floor. According to Satwikanigrum (2006), Flow Process Chart is a systematical and clear tool for communicates the process and giving the detail information which can be improved in a working process. Therefore, Flow Process Chart or FPC a tool for recording an activity and analyzing working process systematically. From the Flow process chart, it shows some information for a working process. The information is:

1. Detail activities of a specific operation which been observed.
2. Type of activities that being done in FPC
3. Operation time and distance of each operation, sometimes the quantity is also recorded.
4. Machine capacity or working capacity, and so on.

There is two type of Flow Process Chart that commonly used.

1. Material Flow Process Chart: This flow chart records the activities of the operator.
2. Man Flow Process Chart: This flow chart identifies the process of material, how a material being treated by a machine or a man.



Flow Process Chart

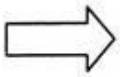
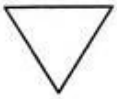
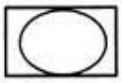
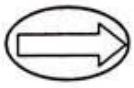
Location : Pythology lab	Summary			
Activity : Routine work	Event	Present	Proposed	Savings
Date: Dec. 10, 2005	Operation	7		
Operator : P.K / Analyst : R.K	Transport	8		
Method and Type:	Delay	1		
Method: (Present) Proposed	Inspection	1		
Type: (Operator) Material Machine	Storage	1		
Layout: Stn 1, Stn 2, Microscope, Patient	Time (min) for 2 patients	21.7		
	Distance	48 m		
	Cost			

Event Description	Symbol	Time (in Minutes)	Distance	Remarks
Own seat				
To work station 1		1.0	10 m	
Get new syringe and open syringe wrapper		1.5		
To patient		0.2	2 m	
Take blood sample		2.2		
To work station 2		0.2	2 m	
Take glass plate and drop blood sample on plate		0.8		
To work station 1		0.6	5 m	
Get new syringe and Open syringe wrapper		1.5		
To next patient		0.2	2 m	
Take blood sample		2.2		
To work station 2		0.2	2 m	
Take glass plate and drop blood sample on plate		0.8		
Take 2 glass plates to microscope		0.5	5 m	
Samples		1.8		
To own seat		2.0	20 m	
Record result in register		1.0		
Wait for patients		5.0		Average
To Work Station 1		1.0	10 m	Next cycle

(Source: http://www.slideshare.net/rahulmeshram14/example-flow-process-charts)

Figure 2.4 Flow Process Chart

In Flow process chart there are five basic symbols that indicate thetype of activity. The symbols are decided from ASME (American Society of Mechanical Engineering). They are circle indicates operation, a square indicates inspection, the arrow indicates motion, a half circle indicates delay, and a triangle indicates storage. Sometimes, there are more than one working element should be done together, therefore the activity can be mixed. For example inspection and operation are done together or operation and transport activity being done together. Detail of the explanation for each activity can be seen in Figure 3.2.

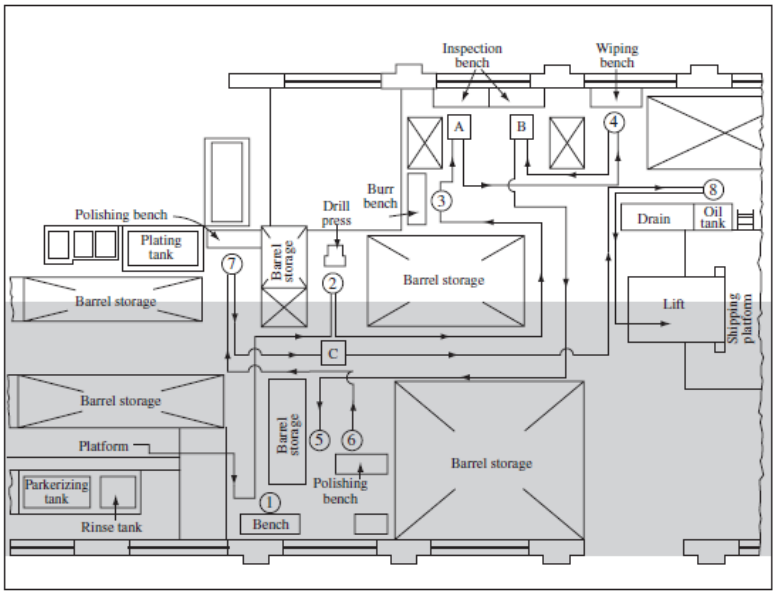
Event/ Motion	Symbol	Explanation
Operation		Operation means an action. It is one of the steps in the procedure. Any operation for making, altering or changing the job is said to be an operation. Eg. Cutting and shaping the wood in the manufacture of furniture.
Inspection		It represents checking for quality and quantity of the items. Eg. Weight check or quantity check or hardness during drug preparations.
Transport		Movement or travel of workers or materials from one location to another. Eg. Steel rods being sent to machine shops from stores.
Delay or Temporary Storage		Delay means the process has stopped due to some reason. It is a temporary halt. Eg. Power failure or waiting for the lift.
Storage		It is the stage of a finished good or raw material waiting for an action. Eg. A finished product in a stock room.
Operation and Inspection		A product is being weighed when it is repacked. Eg. In an automatic process where a milk tin is weighed.
Operation cum Transportation		Products are made and ready for travel. Eg. Washing a product when it is being transported.

(Source: http://www.economicsdiscussion.net/engineering-economics/charts-used-in-motion-study-5-types/21703)

Figure 2.5 Symbols are used in FPC

2.3 Flow Diagram

Although the Flow Process Chart gives the specific information of a whole working process, it does not provide the visualization of each working element in the production floor (Niebel and Freivalds, 1999). Therefore, the best way to provide the visualization information is using Flow Diagram. In the Flow Diagram, it was illustrated the production floor and followed by the flow lines that describes the movement of material or workers from one activity to the next activity. Flow Diagram will be useful for creating a new method for working process. For example, by creating a new layout or new working sequence in order to shorten the distance travel of man or material handling. The symbol in flow process chart will be drawn into the flow diagram for the detail of operation in production floor. It will have the same symbol from ASME.



(Source: Niebel, 1999)

Figure 2.6 Flow Diagram

2.4 Anthropometry

Anthropometry is a study of human body measurement in term of the dimension of bone, muscle, and adipose (fat) tissue (Friyar, 2010), and according to sex, age, etc. According to Surya (2013)**,** data anthropometry applicable for making a new design, which area:

- Designing working area (workstation, car's interior)
- Designing working tools (machine, rack cabinet, etc).
- Designing consumptive product (clothes, chair, table)
- Designing physical working area

The measurement of anthropometry is necessary for designing the ergonomic tools for the human body. Therefore in this research in order to create the tools cabinet design, it will be based one of data Anthropometric Survey of U.S. Personel: Summary Statistics Interim Report (Gordon, et. al. 1988), the summary of body measurement is shown in Appendix 4.

There are six anthropometry data measurements as references for designing tools cabinet:

- Elbow Rest High, Standing
- Elbow – Center of Grip Length
- Forearm – Forearm Breadth
- Forearm – Hand Length
- Functional Grip Reach
- Span

CHAPTER III
RESEARCH METHODOLOGY

Figure 3.1is a Research Methodology that explains the activity done for each phase of the research.

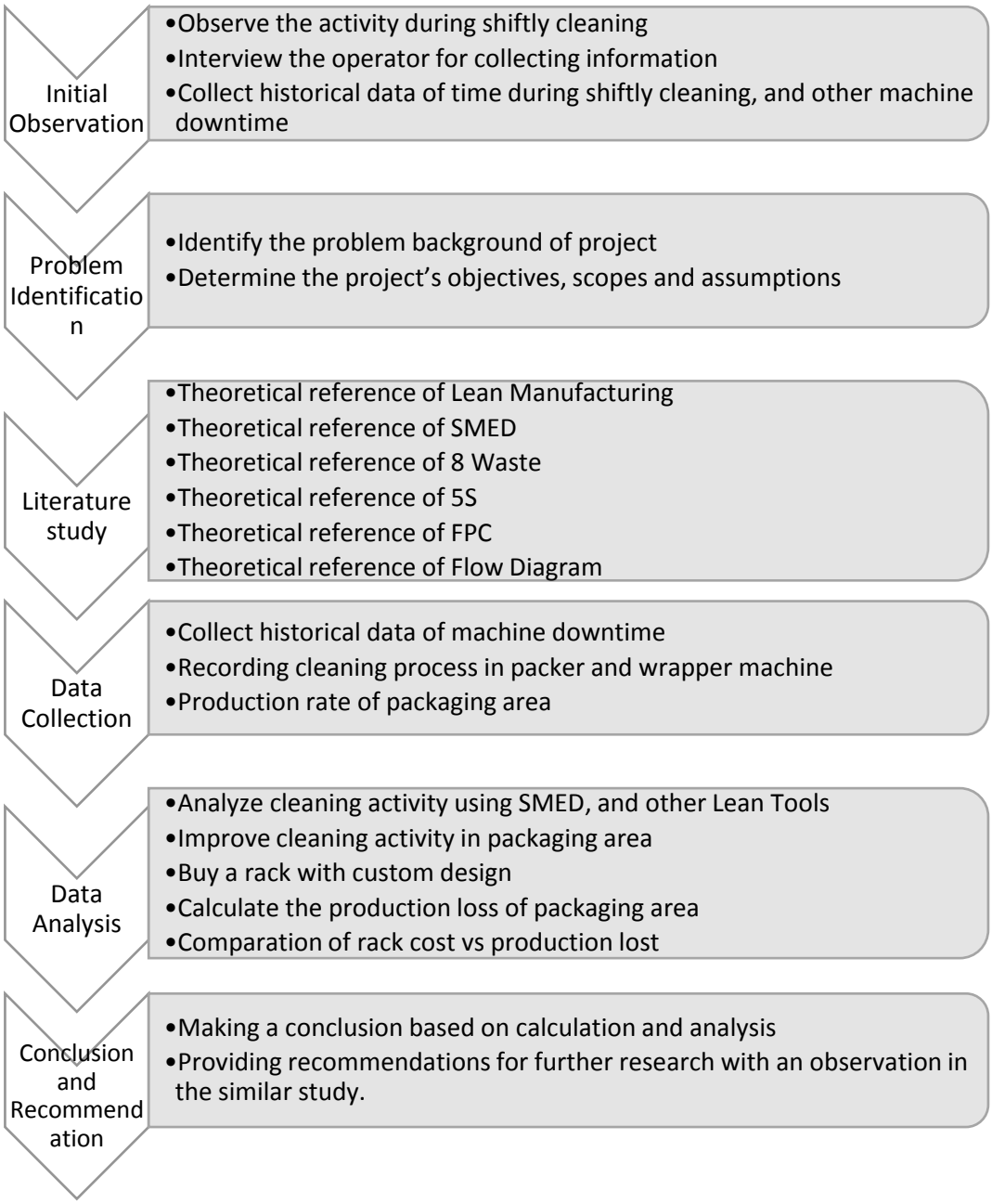


Figure 3.1 Theoretical Framework

3.1 Initial Observation

The initial observation is done by observing the shiftly cleaning process during the shift interchange. The shiftly cleaning process in packaging area is done for both Packer machine and Wrapper machine. The observation is started from the machine stops to conduct the shiftly cleaning until the machine switches on again to continue production. All the activity during the machine stops should be listed and record the time required for each activity. After the activity recorded, the activity will be informed to the operator to be confirmed. After collecting data of cleaning time, as one of the causes of machine downtime, the other data of machine downtime was collected to evaluate the major problem. Since, the shiftly cleaning should be done every time shift turnover, which means three times a day. It is a large number of frequent for this identical operation, compared to other operation. Therefore, shiftly cleaning is being the main focus of this research.

3.2 Problem Identification

The problems of this research have been identifying from the observation of shifty cleaning activity for Packer machine and Wrapper machine. After knowing the main problem of this research, the objectives are determined. The main objective of this research isto determine the internal and external activity of shiftly cleaning process, to reduce shiftly cleaning processing time for Packer machine, and to increase productivity and reduce the production loss caused by the long shiftly cleaning process. Later, corresponding to the result of analysis, some actions should be done to make an improvement for reducing the shiftly cleaning processing time. This research will implement the lean manufacturing theory in order to make the improvement.

In addition, the scopes and assumptions of this research are determined, the purpose of scopes and assumptions is to limit the research, so the result of research is valid and acceptable. The scope is there are two different machines being observed, packer machine and wrapper machine, and the assumption is all operators have same procedure of current cleaning process and the process observed only for shiftly cleaning.

3.3 Literature Study

In this section, the theoretical references are collected in order to support this research. The theories will be used for guiding the researcher to conduct the research. The resources can be gathered from Books, Journals, Websites, and previous researches which are related to this topic.

There are several important points needed to support this research. The first is about lean manufacturing. Lean manufacturing is the basic knowledge of reducing waste in the production process, and being the base for the problem in this research. Several lean manufacturing tools will be used to reduce the shiftly cleaning processing. Next one is a theory of Single Minute Exchange of Die (SMED). This theory is the tools of lean manufacturing, which will be implemented for this research in order to reduce the shiftly cleaning processing time, as one of the waste in packaging process of cigarette packaging. Then, 5S will help to manage tools which needed and used for the cleaning process. Flow Process Chart (FPC) and Flow Diagram will be used for show the overview of the cleaning process on the production floor and identify waste of motion.

3.4 Data Collection

In this step of methodology, the process of collecting data is done. All the data collected is the shiftly cleaning process which is done by the operators. The data is collected from observation, recording, and interview to the operators, and then the data will use to be analyzed in this research. The data that needed to collect for this research are:

- Activity and time of shiftly cleaning for packer machine and wrapper machine.
- Historical data of machine downtime due to shiftly cleaning, brandchange, and minor stop from week 29 – week 32 in the year 2016.
- The production rate of packer machine and wrapper machine.

3.5 Data Analysis

After all the data and information required is collected, next step is to analyze the gathered data. Data of cleaning activity is converted into FPC and to identify every single process of cleaning activity. After the FPC is created, SMED method is adopted to make time reduction for the shiftly cleaning process. In the first step of SMED, the activity during machine stop has to be separated as internal and external elements. Then all the possible internal elements/activities should be transferred to external elements (SMED Step 2), so the activity which cannot be done while machine stop is reducing and the machine stop duration reduce. In the third step of SMED, 5S will be used in order to manage the tools needed for cleaning operation, so all the tool will have its own place and ease operator to find it. The rack should be created in order to conduct 5S. Next, the sequence of cleaning operation will be re-arrange in order to match the design of the machine, with the purpose to reduce the traveling time and traveling distance. After, lean manufacturing methods are implemented (SMED, 8Waste, 5S) and re-arrange operation are done. In addition, the effectiveness of the improvement should be measured by comparing the total shiftly cleaning processing time between before and after improvement. It should be evaluated the result of time reduction, by calculated the possible production loss compare to cost of cabinet tools.

3.6 Conclusion and Recommendation

The last step of this research is to make conclusion and recommendation. The conclusion is given in order to achieve the research objectives. A whole process of the research will be summarized in the conclusion, also the problem statements will be answered in this section. The improvement and result after improvement will be delivered in the conclusion for this research.

After the conclusion is given, it must be followed by giving a commendation. The aim of recommendation is to deliver a suggestion and advice for the readers or those who would like to do some research with the similar field of this research in the future.

3.7 Detail Framework

Figure 3.2 shows the detailed framework of this research from start until finish.

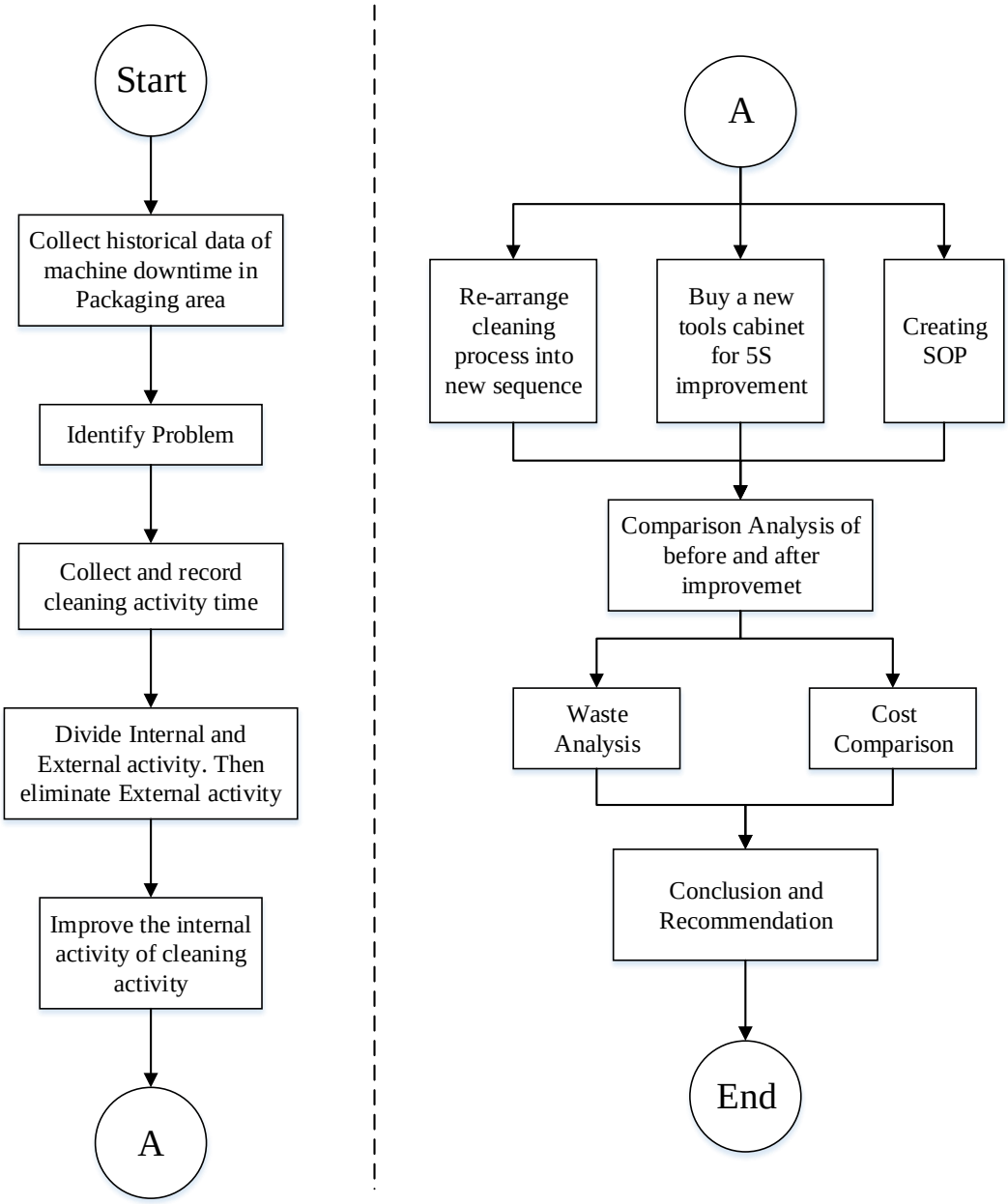


Figure 3.2 Detail Framework

The first step of this research is collecting historical data of machine downtime in the packaging area. The data of machine downtime is consist of three kinds of a machine breakdown. They are shiftly cleaning, brandchange, and minor stop. While the packaging area is consist of two machines in one production line. Next step is analyzing the historical data to find out the problem in this research, which

are the high shiftly cleaning time for Packer and Wrapper machine. Since shiftly cleaning has a high contribution on machine breakdown, then activities of shiftly cleaning in Packer machine and Wrapper machine was observed. The observation is conducted four times to collect the time for each activity of shiftly cleaning. Then, the average time is used for further analysis. Next analysis is conducted in order to reduce the time of shiftly cleaning, SMED method is used.

The first step of SMED method is separating the entireactivities into internal and external activity. External activities will be transferred or done during the machine operating. After external activities are eliminated, the next step of SMED is to improved the cleaning process by using other lean tools. In this case, there are three kinds of improvement to make the internal activity leaner, the first one is to re-arrange the cleaning activities in order to reduce the movement of the operator during the cleaning process. The second one to implement 5S by having a tool cabinet for keeping tools for shiftly cleaning, by having the new tool cabinet, there will be cost needed to buy it. The last one is by creating the SOP in order to assure the operator follow the new sequence of cleaning activity.

A comparison analysis is required to find out the whether the proposed improvement is successfully reducing the cleaning time or not. The comparison analysis of current condition and after improvement is evaluated from two aspects, which are waste and cost. The waste will be analyzed using 8 kinds of waste analysis. The waste analysis is to find out the waste of time and motion from the current cleaning process. A cost analysis will calculate the production loss from reducing the time of packaging area. Then, the production loss saving will be compared to the cost spent for implementation of the 5S condition. The final step of this research is giving the conclusion based on the analysis and recommendation for future research or company for being better.

CHAPTER IV
DATA COLLECTION AND ANALYSIS

4.1 Current Condition

In order to analyze this research, some historical data and current situation were observed. Since the observation is done in the packaging area, the data of machine downtime was collected. There are three major reasons the machine turns off, they are Machine Setup, Shiftly Cleaning, and Daily Minor Stop. In this term, Machine Setup is Brand Change. Brand Change is a machine setting for different kinds of a product brand since the machine can be used for several types of products. Therefore, the setup machine was conducted based on the production schedule. Shiftly Cleaning is one of routine maintenance to keep the cleanliness of the machine after operation shift, which means there is three times cleaning process in one day.

4.1.1 Machines in Packaging Area

In packaging area of PT XY, there are two main automation machines which doing packaging for each production line. They are Packer and Wrapper machine. Figure 4.1 shows the Packer machine. Packer machine is the flow of packaging process of cigarette. In packer machine, some cigaretteswill join together and packed into hinged-lid cigarette packet. The packaging process of machine packer starts when the cigarettes flow into the machine from theconveyor, then the cigarettes are arranged over the innerframe material and it will be covered by alufoil. Then, it will be wrapped up using packaging carton or it is called as blank. After the cigarettes are packed by blank, then thehinged-lid packet is given the manufacturing code in coding unit of Packer machine.In the end, thehinged-lidcigarette packet will be handling to next packaging process in Wrapper machine. Packer machine is able to produce 168 hinged-lid packets per minute.

Figure 4.1 Packer Machine

Figure 4.2 is a visualization of Wrapper machine in one of packaging area. Wrapper is a machine which wraps the hinged-lid packet using film plastic and next, overwraps several packets with the bigger size of film plastic into a slof, which consist of eight or ten packets. Packaging process in Wrapper machine starts when the hinged-lid packets are coming to the Wrapper machine, then the hinged-lid packet will be applied the stamp and each of the packets will be overwrapped by the film plastic with the tear-tape. Next, the hinged-lid packets with film plastic will be arranged into two rows with five packets each row, will be covered by a bigger film plastic, and a slof of cigarette packaging is finished.Wrapper machine may produce 14 slofs per minute.

Figure 4.2 Wrapper Machine

4.1.2 Layout of Packaging Area

Figure 4.3 shows the layout of packaging area, which consists of Packer Machine, Wrapper Machine, and operator table.

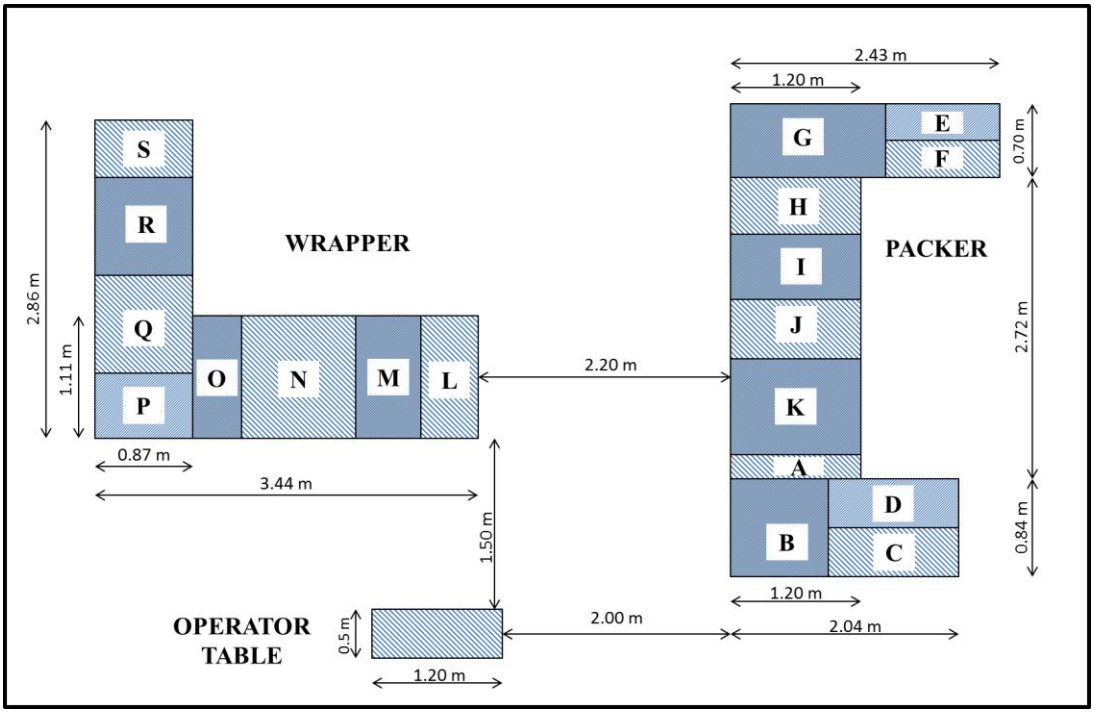


Figure 4.3 Layout of Packaging Area

However, in the cleaning process, the operator will move in several areas around the machines. Therefore, the detail area of the machine will be shown in Table 4.1 for Packer, there are 11 areas and 8 areas for the Wrapper.

Table 4.1 Detail Area of Machines

Initial	Area
A	Control Panel Packer
B	Foil Unit
C	Innerframe Area
D	Behind Innerframe
E	Extractor
F	Coding Unit
G	Coding Unit Side
H	Wheel Area (3,4 & 5)
I	Drum Blank Area
J	Glue Area
K	Distributor Area

Initial	Area
L	Control Panel Wrapper
M	CN Area
N	Front Machine Wrapper
O	Rotating Head Area
P	Unwinding Film Area
Q	TTR Packet Area
R	Sealing Wheel Area
S	TTR Slof Area

4.1.3 Data Downtime

4.1.3.1 Data Downtime of Packer Machine

Table 4.2 is a data summary of total downtime in Packer machine from week 29 until week 32, 2016. Details of the data downtime can be seen in Appendix 1.

The range of Packer shiftly cleaning is 30 – 37 minutes (Appendix 1) for each cleaning operation. In a week, the total time needed for cleaning is 700 minutes for week 29, 709 minutes for week 30, 717 minutes for week 31 and 720 minutes for week 32.

PT XY operates seven days in a week and has three shifts in one day. While, there are eight hours for each shift. Therefore, in a week PT XY has total working time 10,080 minutes in a week.

Calculation for a total working hour is:

Total Working Hour in a week = 7 days * 3 shifts * 8 hours * 60 minutes
= 10,080 minutes

Table 4.2 Downtime Summary of Packer Machine (Week 29 – Week 32, 2016)

	Week 29	Week 30	Week 31	Week 32	Average
Total Brandchange time (min)	437	444	450	470	450.25
Total Shiftly Cleaning time (min)	700	709	717	720	711.5
Total Minor Stop time (min)	67	87	87	84	81.25
Total time M/C Off (min)	1,204	1,240	1,254	1,274	1,243
Total Working Time (min)	10,080	10,080	10,080	10,080	10,080
Brandchange DT (%)	4.34%	4.40%	4.46%	4.66%	4.47%
Shiftly Cleaning DT (%)	6.94%	7.03%	7.11%	7.14%	7.06%
Minor stop DT (%)	0.66%	0.86%	0.86%	0.83%	0.80%
Total DT (%)	11.94%	12.30%	12.44%	12.64%	12.33%

Figure 4.4 is a visualization of downtime in Packer machine from week 29 until week 32 in 2016. It shows the highest machine downtime due to the shiftly

cleaning process, which is 711.5 minutes for during these four weeks. 7.06% of total average downtime (12.33%) is coming from Shiftly cleaning.

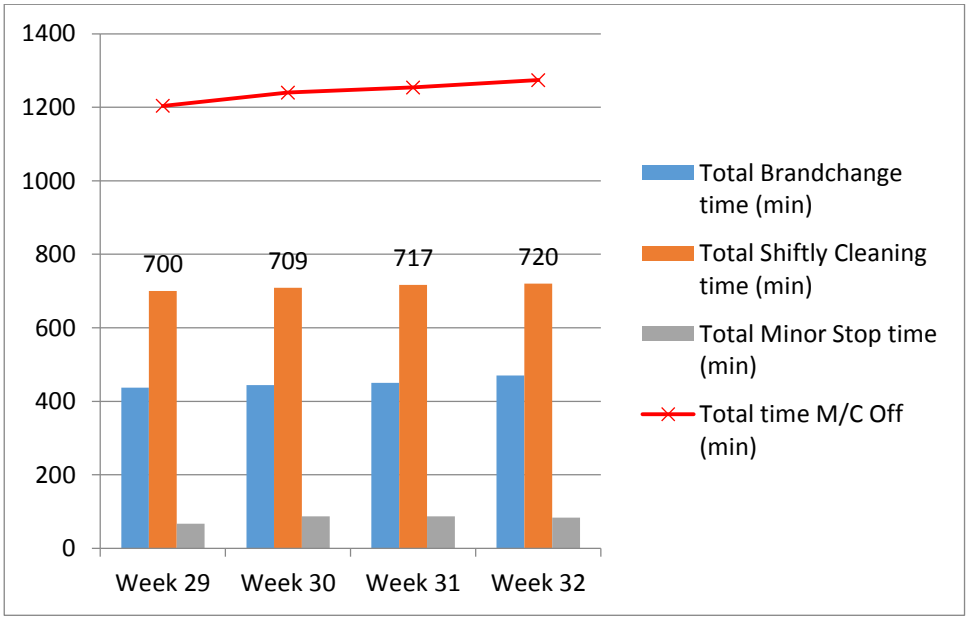


Figure 4.4 Bar Chart of Packer Machine's Downtime

4.1.3.2 Data Downtime of Wrapper Machine

Table 4.3 is a summary of downtime of Wrapper machine from week 29 until week 32. Detail of data downtime in Wrapper machine also can be seen in Appendix 1.The range of shiftly cleaning in Wrapper is 23 – 29 minutes for once operation. Total shiftly cleaning in a week is 541 minutes in week 29, 564 minutes in week 30, 553 minutes in week 31 and 543 minutes in week 32 in 2016.

Table 4.3 Downtime Summary of Wrapper Machine Week 29 – Week 32 2016

	Week 29	Week 30	Week 31	Week 32	Average
Total Brandchange time (min)	452	462	458	455	456.75
Total Shiftly Cleaning time (min)	541	564	553	543	550.25
Total Minor Stop time (min)	72	73	63	64	68.00
Total time M/C Off (min)	1,065	1,099	1,074	1,062	1,075
Total Working Time (min)	10,080	10,080	10,080	10,080	10,080
Brandchange DT (%)	4.48%	4.58%	4.54%	4.51%	4.53%
Shiftly Cleaning DT (%)	5.37%	5.60%	5.49%	5.39%	5.46%
Minor stop DT (%)	0.71%	0.72%	0.63%	0.63%	0.67%
Total DT (%)	10.57%	10.90%	10.65%	10.54%	10.67%

Figure 4.5 shows a visualization of downtime in Wrapper. Same as Packer machine, the major downtime also comes from shiftly cleaning, because of this operation. It shows that 5.46% of 10.67% total downtime is shiftly cleaning.

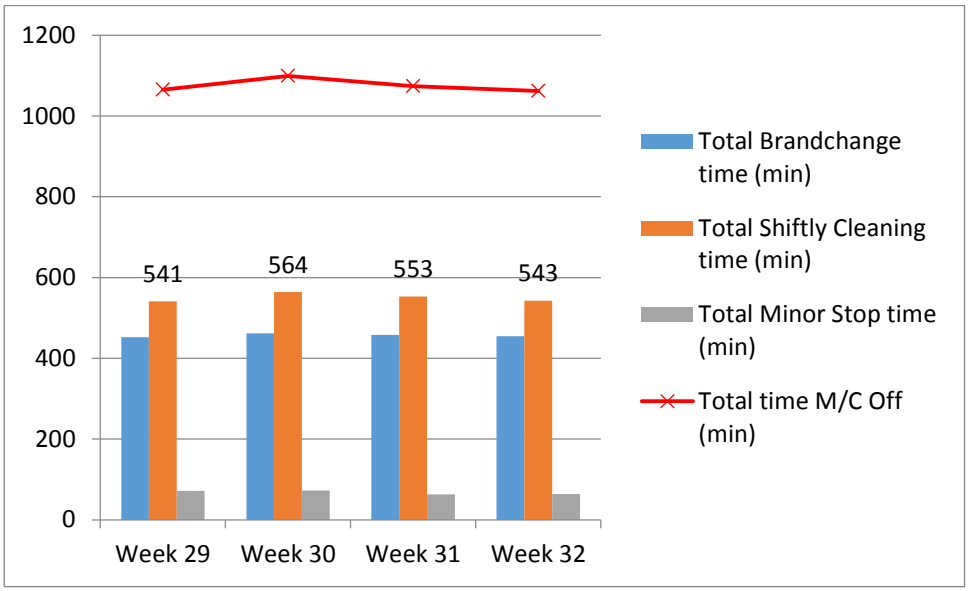


Figure 4.5 Bar Chart of Wrapper Machine's Downtime

4.1.4 Shiftly Cleaning Process

After downtime dataare collected, it was found that the major downtime due to long shiftly cleaning time. Therefore, the activity for shiftly cleaning was observed and time require for each operation was recorded. In order to have a better approximation time, four times observation was conducted to collect time for each of activities.

4.1.4.1 Current Shiftly Cleaning in Packer

The data observation time of each cleaning activities in Packer shows in Appendix 2. While in Table 4.4 is the average of four observation time. For each cleaning activity in Table 4.4, it also shows the area and tools for cleaning activity. There are 44 activities should be done during shiftly cleaning in Packer machine, with a total time 32.813 minutes, or 1968.75 seconds.

Table 4.4 Shiftly Cleaning Process in Packer Machine

No	Activities	Area	Tools	Time (sec)
1	Switch the packer from running mode into clearing mode. Machine stops automatically when it's cleared	Control Panel		29.25
2	Turn off the vacuum button	Control Panel		13.75
3	Turn off the compressed air button	Control Panel		8.50
4	Take out cigarette rejection box	Foil unit		17.25
5	Open the upper guard	Control Panel		19.25
6	Take out lower right guard and lower center guard	Wheel 5		16.25
7	Release Alufoil from valve	Foil unit		33.50
8	Search roller brush	Operator table		90.25
9	Open the Alufoil cutting valve and clean it using roller brush	Foil unit	Roller brush	100.50
10	Assembly alufoil cutting valve	Foil unit		29.25
11	Open innerframe cutting and notching and clean it using roller brush	Innerframe area	Roller brush	38.75
12	Open extractor guard	extractor		18.25
13	Take out the vacuum tube and clean it using compressed air	Extractor	Air gun compressor	56.50
14	Extend air gun compressor	Coding unit side		30.75
15	Shut down the laser marker vacuum	Coding unit		28.00
16	Search vacuum cleaner	Behind innerframe		101.00
17	Clean dust in filter manually	Extractor	Airgun compressor	54.75
18	Clean the carousal pocket using compressed air	Extractor	Air gun compressor	46.00
19	Compressed air - foil valve	Foil unit	Air gun compressor	43.50
	Compressed air - 3rd wheel	Wheel 3	Air gun compressor	55.25
	Compressed air - 4th wheel	Wheel 4	Air gun compressor	47.50
	Compressed air - 5th wheel	Wheel 5	Air gun compressor	39.75
	Compressed air - 3rd drum	Foil unit	Air gun compressor	47.75
	Compressed air - 2nd drum	Foil unit	Air gun compressor	42.75
	Compressed air - dry beam and extractor	Extractor	Air gun compressor	41.25
20	Take out 1st-5th wheel guide	Wheel 5		70.25
21	Search scraper and dust clothes	Operator table		79.00
22	Clean folding hopper 5th wheel using scraper and dust cloth	Wheel 5	Scraper& dust cloth	47.00

Table 4.4 Shiftly Cleaning Process in Packer Machine (continued)

No	Activities	Area	Tools	Time (sec)
23	Clean fixed guide 5th wheel using dust cloth	Wheel 5	Dust cloth	40.75
24	Clean the guide with dust cloth	Wheel 5	Dust cloth	38.50
25	Clean distributor unit using scraper and dust cloth	Distributor Area	Scraper& dust cloth	52.75
26	Clean packet exit plate using scraper and dust cloth	Distributor Area	Scraper& dust cloth	53.25
27	Clean 5th wheel pocket using dust cloth	Wheel 5	Dust cloth	33.00
28	Clean blank pusher using dust cloth	Drum blank	Dust cloth	20.25
29	Clean mobile elements using dust cloth	Drum blank	Dust cloth	22.50
30	Clean 3rd blank drum using dust cloth	Drum blank	Dust cloth	20.00
31	Search brass brush	Operator table		131.25
32	Clean 2nd blank drum using dust cloth and brass brush	Drum blank	Dust cloth & Brass Brush	22.00
33	Clean blank platform and guide using dust cloth	Wheel 5	Dust cloth	19.50
34	Take out the glue pot	Glue area		12.75
35	Open pot cover	Glue area		13.00
36	Search tweezers	Operator table		27.50
37	Clean glue pot cover using tweezers, scraper and dust cloth	Glue area	Tweezers, Scraper and dust cloth	31.50
	Clean roller using brass brush and dust cloth	Glue area	Dust cloth & Brass Brush	23.25
	Clean glue pot using tweezers, scraper and dust cloth	Glue area	Tweezers, Scraper& dust cloth	22.75
38	Putting back glue pot and 5th wheel	Glue area		22.50
39	Put glue pot and set it to "ready" mode	Glue area		6.75
40	Check glue level	Glue area		32.75
41	Turn On Vacuum	Control Panel		11.00
42	Re-Treading Alufoil	Foil unit		21.00
43	Put back guard (upper, central, right lower and extractor)	Control Panel		31.25
44	Switch machine to running mode	Control Panel		13.25
Total (in sec)				**1,968.75**
Total (in min)				**32.813**

This cleaning operation is a shiftlycleaning process, which is conducted three times a day since there are three shifts a day in PT XY. However, the cleaning

process in packer is done in several areas of the machine. There are eleven areas should be cleaned by the operator. The process of cleaning process started when the operator switches the machine into clearing mode and the machine will stop automatically. Next, the operator should turn off the vacuum and compressed air button. After that, theoperator takes out the cigarette rejection box in order to clean the rejected product during the previous production product. All the guards (lower right and lower center) should be opened in order to cleaning process can be done.

Next, the operator starts to clean the foil unit area, which releases the material of alufoil from the valve, and disassemble the alufoil cutting valve then clean it. After the alufoil cutting valve has cleaned, operators assemble it into the machine.Afterwards, the operator will continue cleaning process to the innerframe area, operator disassembles innerframe cutting and notching and clean it. Then operator goes to extractor area, opens the guard, take out the vacuum tube and clean it.Later on, the coding unit laser marker must be shut down. Then, in order to clean the dust and waste of tobacco, the area of extractor, foil unit and wheel are cleaned using air gun compressor. Next, in the wheel area, the operator takes out 1st-5th wheel guide and clean the crust of glue and waste of tobacco in folding hopper, fixed guide of the5th wheel, and guide of the wheel.

Afterwards, the area of distributor unit is cleaned by the operator, continued by the area of drum blank area using dust cloth.However, during the cleaning process in distributor and drum blank area, the operator is also going back to wheel area to clean 5th wheel pocket and blank platform. It makes the operator going more than once to one area. The last, glue area are clean by the operator to clean the pot of glue and add or replace glue if necessary. After the all cleaning process are done, the operator will turn off the vacuum and re-treading alufoil in foil unit. In the end, the machine is ready to start the production when all the guards are lock and machine switch on. More detail of part and cleaning operation are shown on Table 4.4.

4.1.4.2 Current Shiftly Cleaning in Wrapper

The data observation time of each cleaning activities in Packer shows in Appendix 2. While in Table 4.5 is the average of four observation time. There are 33 activities should be done during the shiftly cleaning in Wrapper machine with average operation time is 1,579.75 seconds or 26.329 minutes.

Table 4.5 Shiftly Cleaning Process in Wrapper Machine

No	Activities	Area	Tools	Time (sec)
1	Stop machine	Control Panel		8.75
2	Search air gun compressor and dust cloth	Packer Area		39.50
3	Emptying Rejection Box	Front Machine area		98.25
4	Open the left and right guard	Front Machine area		15.00
5	Search Combination wrench 32 mm	Operator table		69.25
6	Open rotating head using Combination wrench 32 mm	Rotating Head	Combination wrench 32 mm	36.25
7	Clean rotating head using compressed air and dust cloth, then put it back to machine	Rotating Head	Air gun compressor & dust cloth	52.50
8	Use compressed air - Belt Infeed Spider	Rotating Head	Air gun compressor	31.75
	Use compressed air - CN Stamper	Rotating Head	Air gun compressor	33.50
	Use compressed air - Rotating Head	Rotating Head	Air gun compressor	23.25
	Use compressed air - Sensor Stamp	Rotating Head	Air gun compressor	27.00
	Use compressed air - Infeed Screw	Rotating Head	Air gun compressor	29.50
9	Search drill 2 mm and dust cloth	Operator table		119.75
10	Clean the hole of applicator CN unit using dust cloth and drill 2 mm	CN area	Dust cloth and drill 2 mm	42.75
11	Clean the holes from glue storage using tweezers, scraper and dust cloth	CN area	Tweezers, scraper, and dust cloth	36.00
12	Clean notch and slitting drum using dust cloth	CN area	Dust cloth	32.00
13	Clean the nozzle tip using dust cloth	CN area	Dust cloth	45.50
14	Search scraper	glue area of packer		120.50

Table 4.5 Shiftly Cleaning Process in Wrapper Machine (continued)

No	Activities	Area	Tools	Time (sec)
15	Clean spongeand rubber using scraper and dust cloth	CN area	Scraper&dust cloth	41.50
16	Clean glue pot from deposit using dust cloth and scraper	CN area	Dust cloth And scraper	42.25
17	Disassemble stamp basket and clean it using dust cloth	Rotating Head	Dust cloth	47.50
18	Clean rotating folder using dust cloth	Rotating Head	Dust cloth	39.50
19	Clean parallel pusher	Rotating Head	Dust cloth	47.25
20	Clean lug belt using dust cloth	Rotating Head	Dust cloth	33.25
21	Clean packet guides using dust cloth and scraper, and assemble stamp basket	Rotating Head	Dust cloth and scraper	38.25
22	Clean unwinding roller and contrast using dust cloth	unwinding film area	Dust cloth	40.25
23	Clean half ring using dust cloth	unwinding film area	Dust cloth	55.25
24	Clean folding block using dust cloth	unwinding film area	Dust cloth	45.00
25	Clean bottom side of folder using dust cloth	unwinding film area	Dust cloth	55.25
26	Clean TTR packet roller using dust cloth	TTR packet area	Dust cloth	43.25
27	Clean heating drum using dust cloth	Sealing wheel area	Dust cloth	52.75
28	Clean TTR slof roller using dust cloth	TTR slof area	Dust cloth	39.50
29	Clean vacuum tube in CN/stamper using compressed air	CN area	Air gun compressor	39.75
30	Reactive all vacuum and air pressure in the machine	Control Panel		10.75
31	Re-threading film	unwinding film area		27.25
32	Put back guard (left & right guard)	Front Machine area		13.50
33	Switch on the machine	Control Panel		6.75
Total (in sec)				**1,579.75**
Total (in min)				**26.329**

In Wrapper machine there is eight area which should be clean by the operator. Shiftly cleaning activity started when the operator stops the machine, then operator cleans up the reject products by emptying the rejection box in thefront area. Later, the left and right guard are open. Then operator moves to a rotating head area for cleaning some parts such as rotating head, belt infeed spider, CN

stamper, sensor stamps and infeed screw using air gun compressor in order to rotating head from dust and waste material.

Next, theoperator goes to CN area in order to clean the rest of glue in some part in CN area. Operator cleans the hole of applicator and hole from glue storage from rest of glue which may cause jam during the production process if it is not cleaned. The operator also cleans the sponge & rubber, and aglue pot. Then, the operator going back to rotating head area, the operator disassembles stamp basket and clean it and another part in rotating head, which are rotating folder, parallel pusher, lug belt, and packet guide.Afterwards, the operator cleans unwinding film area's parts, which are unwinding roller & contrast, half ring, folding block, and bottom side of the folder from any dirt.

Then, operator goes ahead to clean TTR packet roller in TTR packet area, continue to heating drum in sealing wheel area, and clean TTR slof roller in TTR slof area. The last operation of cleaning operator moves back to CN area to clean vacuum tube. After cleaning activity finish, the operator goes to control panel in order to switch on the vacuum and air pressure and go to unwinding area to re-threading film, after that all the guard should be put back in the lock position. The machine is clear to run the production activity, which is the end of the shiftly cleaning process. Table 4.5 also shows detail operation of the cleaning process for each part in areas of Wrapper machine.

4.1.5 Tools for Cleaning Process

In the operation of the cleaning process in the packaging area, there are some tools needed. These tools will be used to clean Packer and Wrapper machine. Table 4.6 show all item for cleaning activities.

Table 4.6 Tools for Cleaning Operation

No	Equipment
1	Dust Cloth
2	Scraper
3	Tweezers
4	Combination wrench 32 mm
5	Round brush

No	Equipment
6	Brass brush
7	Air gun compressor
8	Vacuum cleaner
9	Drill 2mm

In the current situation, these tools are scattered in several areas and it is in a mess with the other tools and item not needed. Then, after the operator used tools, they put it at random place after they finish in one area. Therefore, they forget where the last time they put those tools.

4.2 Analysis on Current Process

After the all important data were collected, data will be analyzed to make improvement for shiftly cleaning process in the Packaging area. As mention before in Chapter III, Single Minute Exchange of Dies (SMED) method is chosen to make improvement as one of the lean manufacturing methods. Data of shiftly cleaning process was converted into Flow Process Chart (FPC) in order to see more detail of each operation.

4.2.1 Analysis on Current Process of Packer Machine

Shiftly Cleaning activity in Table 4.4 and Table 4.5 will be turned into Flow process chart. Table 4.7 shows Flow Process Chart of cleaning activity in Packer machine for the current process. Since, in order to reduce the shiftly cleaning processing time,Therefore, SMED as one of the tools of lean manufacturing was conducted. In the flow process chart, the activities are separated into internal activity and external activity.

At the top of flow process chart in Table 4.7, there is a summary of the cleaning process in the Packer machine. All the activity of cleaning process is separated for each operation, and there is additional activity of operators movement in the FPC. Then, the total activity of shiftly cleaning in Packer is 83 activities, which is consist of 51 activities of operation, 31 activities of transport, and 1 operation of inspection. From a total of operation cleaning time, which is 1,968.75 seconds or equal to 32.8125 minutes, the external activities take 487.64 seconds (8.1273 minutes) and the rest of 1,481.11seconds (24.6852 minutes) is internal activities. During 31 activities of transportation, operator has to travel as long as 115.16 meters.

From current flow process chart, it shows that the non-value added or external activities are operator looking for the tools for cleaning activity. Still, there is another activity which may be done before the machine stops, which is clear the rejection box from rejected product, since it will not affect the production, while the Packer machine running. Seeing further to the external activities, some of the operator transportation can be transferred to external activity also. Since the movement to search the tools. For example in activities number 12, 13, and 14. These are external activities, in activity 13,operator was looking for roller brush. Therefore, if the activity 13 can be transferred to external activity, then activities 12 and 14 may be transferred to external activity.

However, the searching tools activities due to there are no preparation and no proper location to keep the tools. Therefore, the operator should search for the tools which scattered around the packaging area. In order to solve this problem, the should be the proper place to keep the tool and have a label for each tool to ease the operator when they need a tool. A rack will be bought in order to solve this as an improvement action. This may includeto Lean manufacturing tool, which is 5S. Later it will be explained in sub-chapter 4.3.2.

For the current Flow Process Chart in Table 4.7, it shows the area of operation and activity name. Also, it shows method and type of activity, where the method is for present activity and type of activity is an operation that is done by the operator of packaging area to clean Packer Machine during shift interchange.

The purpose of SMED method is to seperate the internal and external activities, meanwhile, in the current operation of shiftly cleaning in Packer machine is still mixed between the internal and external activity. Figure 4.6 shows the time bar chart of the cleaning process in Packer. The chart indicates that the external activities are spread out across current shiftly cleaning process.

Table 4.7 Current FPC of Cleaning in Packer

Location: Packaging Area		**Summary**			
Activity: Shiftly Cleaning of Packer Machine		**Event**	**Present**	**Proposed**	**Savings**
Date:		Operation	**51**		
Operator:	**Analyst:**	Transport	**31**		
Circle appropriate Method and Type:		Delay			
Method: *Present* *Proposed*		Inspection	**1**		
Type: *Worker* *Material* *Machine*		Storage			
Remarks:		Time (sec)	**1,968.75**		
		Distance (m)	**115.16**		
		Cost			

No	**Activities**	**Operation**	**Transport**	**Inspection**	**Delay**	**Storage**	**Distance (meter)**	**Est. time (Sec)**	
								Internal	**External**
1	Switch the packer from running mode into clearing mode. Machine stops automatically when it's cleared	●	⇨	□	D	▽		29.25	
2	Turn off the vacuum button	●	⇨	□	D	▽		13.75	
3	Turn off the compressed air button	●	⇨	□	D	▽		8.50	
4	Operator moves to foil unit	○	➡	□	D	▽	1.29		0.92
5	Take out cigarette rejection box	●	⇨	□	D	▽			16.33
6	Operator moves to control panel	○	➡	□	D	▽	1.29		0.92
7	Open the upper guard	●	⇨	□	D	▽		18.33	

Table 4.7 Current FPC of Cleaning in Packer (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
8	Operator moves to wheel 5	○	⇨	□	D	▽	2.34	1.67	
9	Take out lower right guard and lower center guard	●	⇨	□	D	▽		14.58	
10	Operator moves to foil unit	○	⇨	□	D	▽	3.63	2.59	
11	Release Alufoil from valve	●	⇨	□	D	▽		30.91	
12	Operator moves to operator table	○	⇨	□	D	▽	3.07		2.20
13	Search roller brush	●	⇨	□	D	▽			88.05
14	Operator moves to foil unit	○	⇨	□	D	▽	3.07		2.20
15	Open the Alufoil cutting valve and clean it using roller brush	●	⇨	□	D	▽		98.30	
16	Assembly alufoil cutting valve	●	⇨	□	D	▽		29.25	
17	Operator moves to innerframe area	○	⇨	□	D	▽	1.02	0.73	
18	Open innerframe cutting and notching and clean it using roller brush	●	⇨	□	D	▽		38.02	
19	Operator moves to extractor	○	⇨	□	D	▽	8.48	6.05	

Table 4.7 Current FPC of Cleaning in Packer (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
20	Open extractor guard	●	⇨	□	D	▽		12.20	
21	Take out the vacuum tube and clean it using compressed air	●	⇨	□	D	▽		56.50	
22	Operator moves to coding unit	○	➡	□	D	▽	3.03		2.16
23	Extend air gun compressor	●	⇨	□	D	▽			28.59
24	Operator moves to coding unit side	○	➡	□	D	▽	5.53	3.95	
25	Shut down the laser marker vacuum	●	⇨	□	D	▽		24.05	
26	Operator moves to foil unit	○	➡	□	D	▽	13.72		9.80
27	Search vacuum cleaner	●	⇨	□	D	▽			91.20
28	Operator moves to extractor	○	➡	□	D	▽	11.22	8.00	
29	Clean dust in filter manually	●	⇨	□	D	▽		46.74	
30	Clean the carousal pocket using compressed air	●	⇨	□	D	▽		46.00	
31	Operator moves to foil unit	○	➡	□	D	▽	7.46	5.33	

Table 4.7 Current FPC of Cleaning in Packer (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
32	Compressed air - foil valve	●	⇨	□	D	▽		38.17	
33	Operator moves to wheel 3	○	➡	□	D	▽	3.93	2.81	
34	Compressed air - 3rd wheel	●	⇨	□	D	▽		52.44	
35	Compressed air - 4th wheel	●	⇨	□	D	▽		47.50	
36	Compressed air - 5th wheel	●	⇨	□	D	▽		39.75	
37	Operator moves to foil unit	○	➡	□	D	▽	3.93	2.81	
38	Compressed air - 3rd drum	●	⇨	□	D	▽		44.94	
39	Compressed air - 2nd drum	●	⇨	□	D	▽		42.75	
40	Operator moves to extractor	○	➡	□	D	▽	7.46	5.33	
41	Compressed air - dry beam and extractor	●	⇨	□	D	▽		35.92	
42	Operator moves to wheel 5	○	➡	□	D	▽	3.53	2.52	

Table 4.7 Current FPC of Cleaning in Packer (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
43	Take out 1st-5th wheel guide	●	⇨	□	D	▽		67.73	
44	Operator moves to operator table	○	➡	□	D	▽	3.94		2.81
45	Search scraper and dust clothes	●	⇨	□	D	▽			76.19
46	Operator moves to wheel 5	○	➡	□	D	▽	3.94		2.81
47	Clean folding hopper 5th wheel using scraper and dust cloth	●	⇨	□	D	▽		44.19	
48	Clean fixed guide 5th wheel using dust cloth	●	⇨	□	D	▽		40.75	
49	Clean the guide with dust cloth	●	⇨	□	D	▽		38.50	
50	Operator moves to distributor area	○	➡	□	D	▽	1.96	1.40	
51	Clean distributor unit using scraper and dust cloth	●	⇨	□	D	▽		51.35	
52	Clean packet exit plate using scraper and dust cloth	●	⇨	□	D	▽		53.25	
53	Operator moves to wheel 5	○	➡	□	D	▽	1.96	1.40	
54	Clean 5th wheel pocket using dust cloth	●	⇨	□	D	▽		31.60	

Table 4.7 Current FPC of Cleaning in Packer (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
55	Operator moves to Drum Blank	○	⇨	□	D	▽	0.61	0.44	
56	Clean blank pusher using dust cloth	●	⇨	□	D	▽		19.81	
57	Clean mobile elements using dust cloth	●	⇨	□	D	▽		22.50	
58	Clean 3rd blank drum using dust cloth	●	⇨	□	D	▽		20.00	
59	Operator moves to operator table	○	⇨	□	D	▽	3.47		2.48
60	Search brass brush	●	⇨	□	D	▽			128.77
61	Operator moves to Drum Blank	○	⇨	□	D	▽	3.47		2.48
62	Clean 2nd blank drum using dust cloth and brass brush	●	⇨	□	D	▽		19.52	
63	Operator moves to wheel 5	○	⇨	□	D	▽	0.61	0.44	
64	Clean blank platform and guide using dust cloth	●	⇨	□	D	▽		19.06	
65	Operator moves to glue area	○	⇨	□	D	▽	1.13	0.81	
66	Take out the glue pot	●	⇨	□	D	▽		11.94	

Table 4.7 Current FPC of Cleaning in Packer (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
67	Open pot cover	●	⇨	□	D	▽		13.00	
68	Operator moves to operator table	○	➡	□	D	▽	3.12		2.23
69	Search tweezers	●	⇨	□	D	▽			25.27
70	Operator moves to glue area	○	➡	□	D	▽	3.12		2.23
71	Clean glue pot cover using tweezers, scraper and dust cloth	●	⇨	□	D	▽		29.27	
72	Clean roller using brass brush and dust cloth	●	⇨	□	D	▽		23.25	
73	Clean glue pot using tweezers, scraper and dust cloth	●	⇨	□	D	▽		22.75	
74	Putting back glue pot and 5th wheel	●	⇨	□	D	▽		22.50	
75	Put glue pot and set it to "ready" mode	●	⇨	□	D	▽		6.75	
76	Check glue level	○	⇨	■	D	▽		32.75	
77	Operator moves to control panel	○	➡	□	D	▽	1.29	0.92	
78	Turn On Vacuum	●	⇨	□	D	▽		10.24	

Table 4.7 Current FPC of Cleaning in Packer (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
79	Operator moves to foil unit	○	➡	□	D	▽	1.29	0.92	
80	Re-Treading Alufoil	●	⇨	□	D	▽		19.00	
81	Operator moves to control panel	○	➡	□	D	▽	1.29	0.92	
82	Put back guard (upper, central, right lower and extractor)	●	⇨	□	D	▽		31.25	
83	Switch machine to running mode	●	⇨	□	D	▽		13.25	
Total							**115.16**	**1481.11**	**487.64**

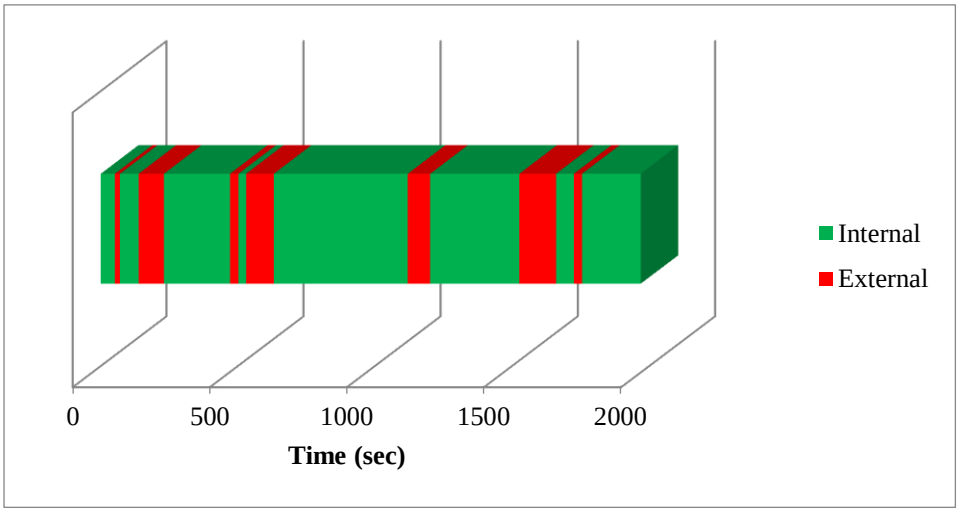


Figure 4.6 Internal vs External Activity Time in Packer Machine

Table 4.8 is a summary of external activities in Packer machine, it shows that there are 19 of 83 activities are belong to external activity. The total distance of external activities is 46.53 meters, and total time is 487.64 seconds (8.1273 minutes). These are waste according to lean manufacturing theory and will be reduced when transferred to external activity.

Table 4.8 External Activities Summary of Packer Cleaning Process

No	Activities	Distance (meter)	Time (sec)
4	Operator moves to foil unit	1.29	0.92
5	Take out cigarette rejection box		16.33
6	Operator moves to control panel	1.29	0.92
12	Operator moves to operator table	3.07	2.20
13	Search roller brush		88.05
14	Operator moves to foil unit	3.07	2.20
22	Operator moves to coding unit	3.03	2.16
23	Extend air gun compressor		28.59
26	Operator moves to foil unit	13.72	9.80
27	Search vacuum cleaner		91.20
44	Operator moves to operator table	3.94	2.81
45	Search scraper and dust clothes		76.19
46	Operator moves to wheel 5	3.94	2.81
59	Operator moves to operator table	3.47	2.48
60	Search brass brush		128.77
61	Operator moves to Drum Blank	3.47	2.48
68	Operator moves to operator table	3.12	2.23
69	Search tweezers		25.27
70	Operator moves to glue area	3.12	2.23
Total		**46.53**	**487.64**

The cause of the high shiflty cleaning time in Packer machine is so many back and forth movement of the operator. It is because of the operator has not finished clean one area, but he moves to another area, meanwhile the previous area has not finished clean by operator. For example, in activity 9, operator takes out the guard at wheel area, but before clean the other parts in wheel area (activity 34, 35, 36, 43, 47, 48, 49, 54, and 64), he already moves to other areas and later he will have to moves back to wheel area. During these activities, the operator also moves to another area, which means the time and distance travel increasing.

However, one of waste in 8 waste theory according to Ohno Taiichi (1988), is transportation, related to operator movement. In order to see the movement of theoperator during cleaning process in packaging area, Flow Diagram is created. Figure 4.7 is a flow diagram of the cleaning process in packer area. In the flow diagram, the operator starts the motion in control panel when operator switches the machine into clearing mode. The last operation also finishes in the control panel, in activity 82 and 83.

The sequence of operator motion is: Control Panel (A) (activity 1-3) → Foil Unit (B) (activity 5) → Control Panel (A) (activity 7) → Wheel (H) (activity 9) → Foil Unit (B) (activity 11) → Operator Table (activity 13) → Foil Unit (B) (activity 15-16) → Innerframe Area (C) (activity 18) → Extractor (E) (activity 20-21) → Coding Unit Side (G) (activity 23) → Coding Unit (F) (activity 25) → Behind Innerframe (D) (activity 27) → Extractor (E) (activity 29-30) → Foil Unit (B) (activity 32) → Wheel (H) (activity 34-36) → Foil Unit (B) (activity 38-39) → Extractor (E) (activity 41) → Wheel (H) (activity 43) → Operator Table (activity 45) → Wheel (H) (activity 47-49) → Distributor Area (K) (activity 51-52) → Wheel (H) (activity 54) → Drum Blank (I) (activity 56-58) → Operator Table (activity 60) → Drum Blank (I) (activity 62) → Wheel (H) (activity 64) → Glue Area (J) (activity 66-67) → Operator Table (activity 69) → Glue Area (J) (activity 71-76) →Control Panel (A) (activity 78) → Foil Unit (B) (activity 80) → Control Panel (A) (activity 82-83).

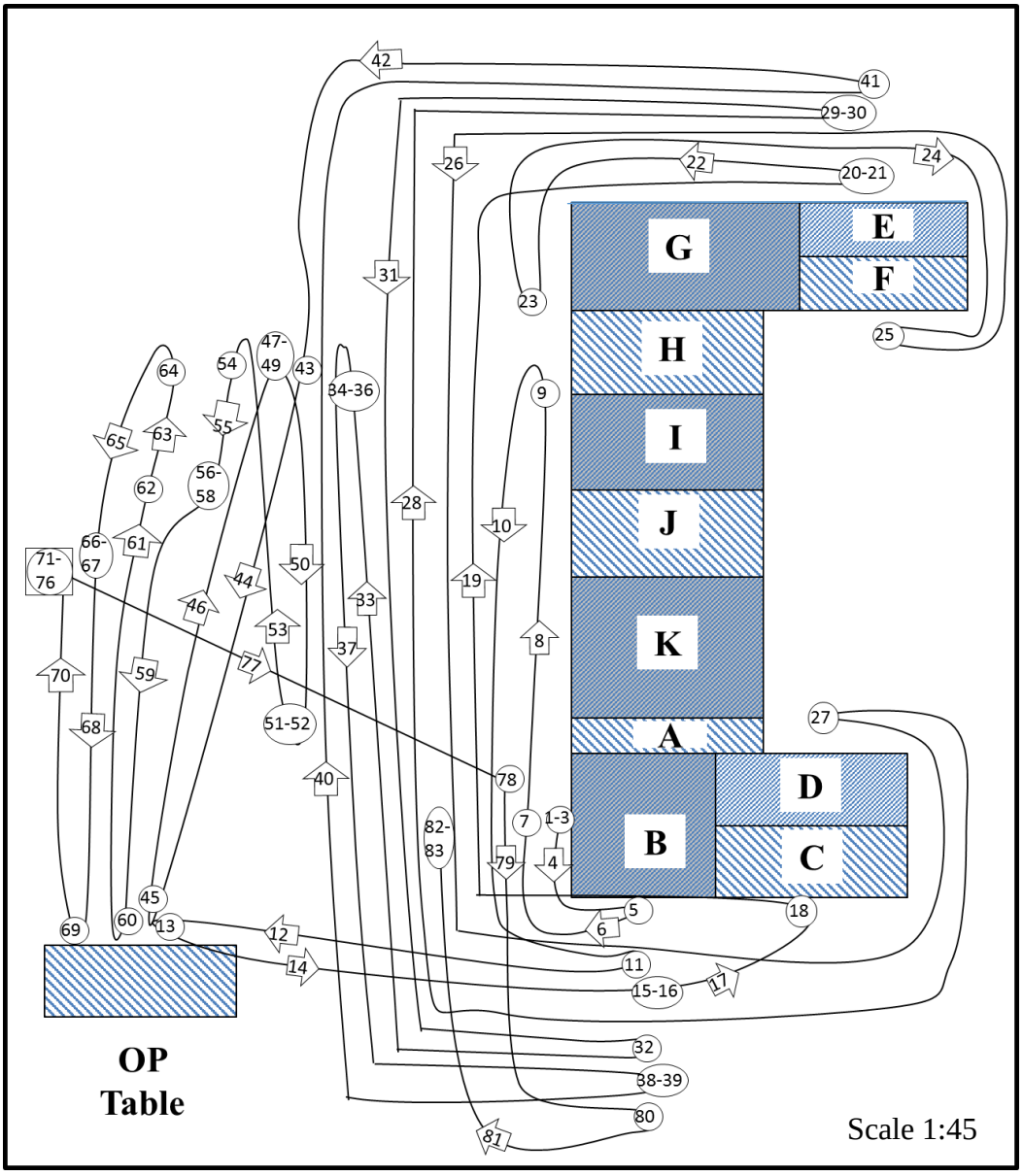


Figure 4.7 Current Flow Diagram of Packer Cleaning Process

Area of themachine is shown by alphabet letter A to K for Packer machine, and the name of thearea can be seen in Table 4.1.

4.2.2 Analysis on Current Process of Wrapper Machine

Next, Table 4.9 is a flow process chart of the current shiftly cleaning process in Wrapper machine. In this process, there are 55 activities which are 37 operation activities and 18 transportation activities.In this FPC also the activities are seperated into internal and external activity.

This whole activity takes 1579.75 seconds (26.33 minutes). Meanwhile, the internal activity only takes 1134.79 seconds (18.91 minutes) and 444.96 seconds (7.42 minutes) can be saved from external activity when it is done before machine running. Then, the operator should travel 42.67 meters around packaging area to finish the cleaning process.

Table 4.9 Current FPC of Cleaning in Wrapper

Location: Packaging Area		**Summary**			
Activity: Shiftly Cleaning of Wrapper Machine		**Event**	**Present**	**Proposed**	**Savings**
Date:		Operation	**37**		
Operator:	**Analyst:**	Transport	**18**		
Circle appropriate Method and Type:		Delay			
Method: *Present* *Proposed*		Inspection			
Type: *Worker* *Material* *Machine*		Storage			
Remarks:		Time (sec)	**1,579.75**		
		Distance (m)	**42.67**		
		Cost			

No	**Activities**	**Operation**	**Transport**	**Inspection**	**Delay**	**Storage**	**Distance (meter)**	**Est. time (Sec)**	
								Internal	**External**
1	Stop machine	●	⇨	□	D	▽		8.75	
2	Operator moves to packer machine area	○	➡	□	D	▽	3.38		2.41
3	Search air gun compressor and dust cloth	●	⇨	□	D	▽			37.09
4	Operator goes to front machine of wrapper machine	○	➡	□	D	▽	6.17	4.40	
5	Emptying Rejection Box	●	⇨	□	D	▽			93.85

Table 4.9 Current FPC of Cleaning in Wrapper (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
6	Open the left and right guard	●	⇨	□	D	▽		15.00	
7	Operator moves to operator table	○	➡	□	D	▽	1.66		1.19
8	Search Combination wrench 32 mm	●	⇨	□	D	▽			68.06
9	Operator moves to rotating head	○	➡	□	D	▽	2.43	1.74	
10	Open rotating head using Combination wrench 32 mm	●	⇨	□	D	▽		34.51	
11	Clean rotating head using compressed air and dust cloth, then put it back to machine	●	⇨	□	D	▽		52.50	
12	Use compressed air - Belt Infeed Spider	●	⇨	□	D	▽		31.75	
13	Use compressed air - CN Stamper	●	⇨	□	D	▽		33.50	
14	Use compressed air - Rotating Head	●	⇨	□	D	▽		23.25	
15	Use compressed air - Sensor Stamp	●	⇨	□	D	▽		27.00	
16	Use compressed air - Infeed Screw	●	⇨	□	D	▽		29.50	
17	Operators moves to operator table	○	➡	□	D	▽	2.43		1.74

Table 4.9 Current FPC of Cleaning in Wrapper (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
18	Search drill 2 mm and dust cloth	●	⇨	□	D	▽			118.01
19	Operator moves to CN area	○	➡	□	D	▽	1.18	0.84	
20	Clean the hole of applicator CN unit using dust cloth and drill 2 mm	●	⇨	□	D	▽		41.91	
21	Clean the holes from glue storage using tweezers, scraper and dust cloth	●	⇨	□	D	▽		36.00	
22	Clean notch and slitting drum using dust cloth	●	⇨	□	D	▽		32.00	
23	Clean the nozzle tip using dust cloth	●	⇨	□	D	▽		45.50	
24	Operator moves to glue area of packer	○	➡	□	D	▽	2.95		2.11
25	Search scraper	●	⇨	□	D	▽			118.39
26	Operator moves to CN area	○	➡	□	D	▽	2.95		2.11
27	Clean sponge and rubber using scraper and dust cloth	●	⇨	□	D	▽		39.39	
28	Clean glue pot from deposit using dust cloth and scraper	●	⇨	□	D	▽		42.25	
29	Operator moves to Rotating Head	○	➡	□	D	▽	1.76	1.25	

Table 4.9 Current FPC of Cleaning in Wrapper (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
30	Disassemble stamp basket and clean it using dust cloth	●	⇨	□	D	▽		46.25	
31	Clean rotating folder using dust cloth	●	⇨	□	D	▽		39.50	
32	Clean parallel pusher	●	⇨	□	D	▽		47.25	
33	Clean lug belt using dust cloth	●	⇨	□	D	▽		33.25	
34	Clean packet guides using dust cloth and scraper and assemble stamp basket.	●	⇨	□	D	▽		38.25	
35	Operator moves to Unwinding film area	○	➡	□	D	▽	1.55	1.10	
36	Clean unwinding roller and contrast using dust cloth	●	⇨	□	D	▽		39.15	
37	Clean half ring using dust cloth	●	⇨	□	D	▽		55.25	
38	Clean folding block using dust cloth	●	⇨	□	D	▽		45.00	
39	Clean bottom side of folder using dust cloth	●	⇨	□	D	▽		55.25	
40	Operator moves to TTR packet area	○	➡	□	D	▽	0.73	0.52	
41	Clean TTR packet roller using dust cloth	●	⇨	□	D	▽		42.73	

Table 4.9 Current FPC of Cleaning in Wrapper (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
42	Operator moves to seal wheel area	○	⇨	□	D	▽	0.88	0.63	
43	Clean heating drum using dust cloth	●	⇨	□	D	▽		52.12	
44	Operator moves to TTR slof area	○	⇨	□	D	▽	0.7	0.50	
45	Clean TTR slof roller using dust cloth	●	⇨	□	D	▽		39.00	
46	Operator moves to CN area	○	⇨	□	D	▽	5.61	4.01	
47	Clean vacuum tube in CN/stamper using compressed air	●	⇨	□	D	▽		35.74	
48	Operator Moves to Control Panel	○	⇨	□	D	▽	0.57	0.40	
49	Reactive all vacuum and air pressure in the machine	●	⇨	□	D	▽		10.35	
50	Operator moves to Unwinding film area	○	⇨	□	D	▽	3.87	2.76	
51	Re-threading film	●	⇨	□	D	▽		24.49	
52	Operator Moves to front machine area	○	⇨	□	D	▽	2.47	1.76	
53	Put back guard (left & right guard)	●	⇨	□	D	▽		11.74	

Table 4.9 Current FPC of Cleaning in Wrapper (continued)

No	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)	
								Internal	External
54	Operator moves to Control Panel	○	⇨	□	D	▽	1.40	1.00	
55	Switch on the machine	●	⇨	□	D	▽		5.75	
Total							**42.67**	**1134.79**	**444.96**

Table 4.9 shows that some of external activities in Wrapper machine are also operator look for the tools, same as in the Packer machine. Therefore, these activities can be defined as an external activity. The external activities are operation process and transportation process since the external activity is searching tools some operator transportation can be eliminated too. For example, in activity number 3 the operator should move to packer machine to take dust cloth adn air gun compressor since the tools are not prepared when the machine still running. Therefore, if activity 3 is an external activity then the acivity number 2 can be eliminated as the operator does not need to go to Packer machine area.

Figure 4.8 shows the bar chart of thecleaning process in Wrapper machine. From the figure, can be seen that the external activity still mixed in thewhole process of cleaning during machine stop.

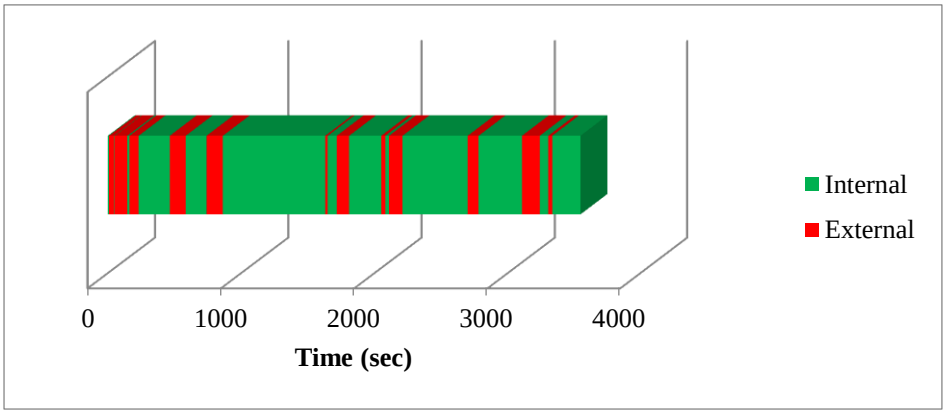


Figure 4.8 Internal vs External Activity Time in Wrapper Machine

Table 4.10 is a summary of external activities of the cleaning process in Wrapper machine. There are 10 external activities which consume 444.96 sec (7.42 minutes) and opertor non-value added transportation as far as 13.37 meter.

Also, current cleaning process makes the operator moves back and forth since theoperator has not cleaned all the part when he is in a certain area of the machine. For example in rotating head area, the operator starts cleaning process in this area in activity 10 until activity 16, but later on the operator moves to CN area during ativity 19 until 28, and goes back to rotating head area in activity 29. Thus, the operator should travel twice to rotating head area, which means non-value added motion and should be eliminated.

Table 4.10 External Activity Summary of Wrapper Cleaning Process

No	Activities	Distance (meter)	Time (sec)
2	Operator moves to packer machine area	3.38	2.41
3	Search air gun compressor and dust cloth		37.09
5	Emptying Rejection Box		93.85
7	Operator moves to operator table	1.66	1.19
8	Search Combination wrench 32 mm		68.06
17	Operators moves to operator table	2.43	1.74
18	Search drill 2 mm and dust cloth		118.01
24	Operator moves to glue area of packer	2.95	2.11
25	Search scraper		118.39
26	Operator moves to CN area	2.95	2.11
Total		**13.37**	**444.96**

Detail of operator movement for shiftly cleaning process of Wrapper machine is shown in Figure 4.9. The operator first opertion (activity 1) starts in the control panel area in order to stop the machine and the last operation (activity 55) also finish on control panel area. This is the sequence of operator movement for cleaning Wrapper machine: Control Panel (L) (activity 1) → Packer Area (activity 3) → Front Machine of Wrapper (N) (activity 5-6) → Operator Table (activity 8) → Rotating Head (O) (activity 10-16) → Operator Table (activity 18) → CN Area (M) (activity 20-23) → Glue Area of Packer (J) (activity 25) → CN Area (M) (activity 27-28) → Rotating Head (O) (activity 30-34) → Unwinding Film Area (P) (activity 36-39) → TTR Packet Area (Q) (activity 41)→ Sealing Wheel Area (R) (activity 43) → TTR Slof Area (S) (activity 45) → CN Area (M) (activity 47)→ Control Panel (L) (activity 49) → Unwinding Film Area (P) (activity 51) → Front Machine of Wrapper (N) (activity 53) → Control Panel (L) (activity 55). Figure 4.9 is on the next page.

Table 4.11 is a summary of analysis result from the problem in this research. It also shows the goals which desire to achieve and how to achieve it by making some improvements.

Table 4.11 Summary of the Analysis Result and Proposed Improvement

Problem	Goals	Improvement	Control
High shiflty cleaning time in packaging area	To reduce shiftly cleaning processing time	Remove several the external activities during machine shut down	
	To reduce operator motion during shiftly cleaning process	Re-arrange cleaning process sequence	Creating New SOP for cleaning Packer Machine and Wrapper Machine
Bad management of tools for cleaning activity	To have right, tidy and clean place for tools when needed	Buy a new tool cabinet as 5S improvement	

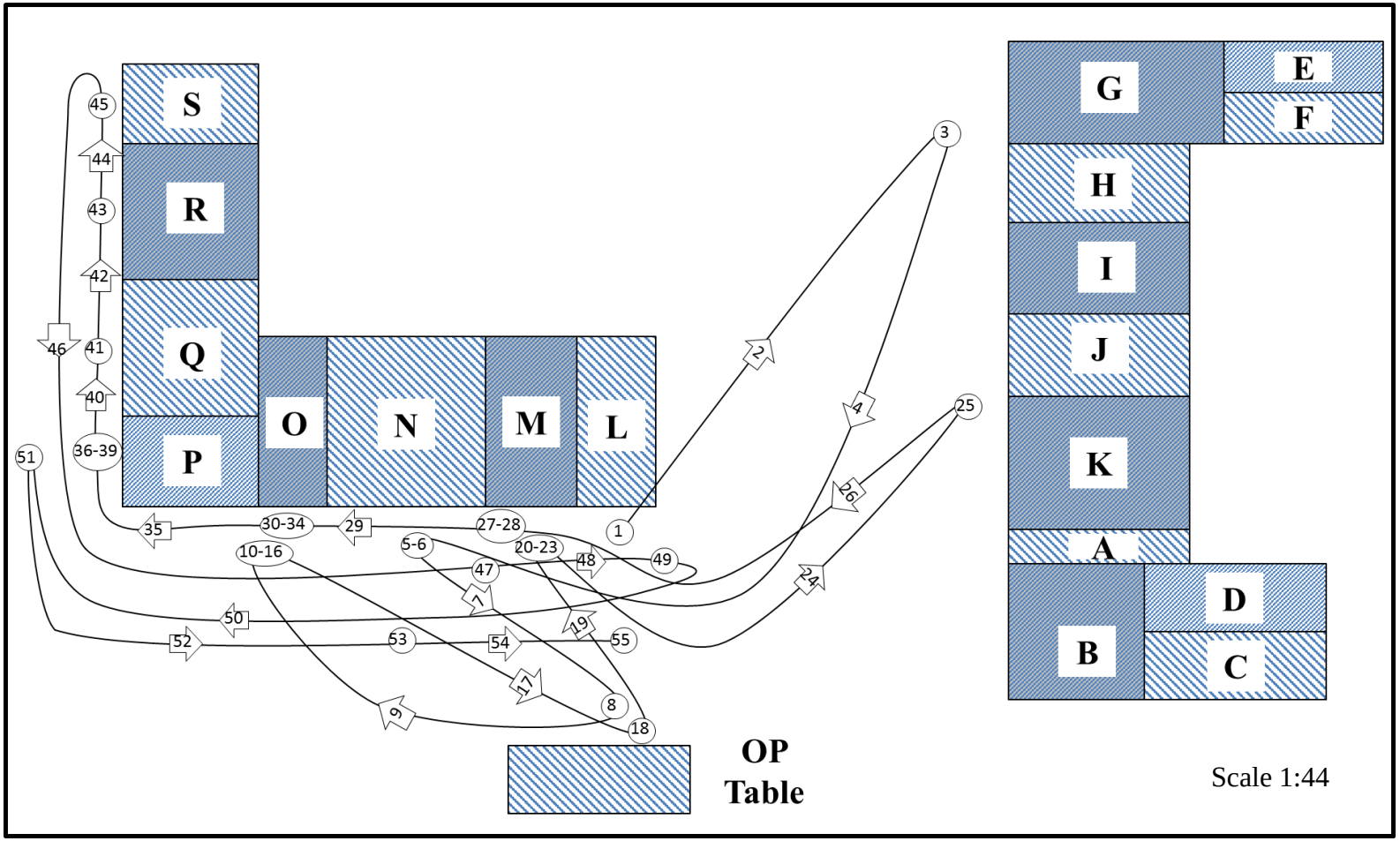


Figure 4.9 Current Flow Diagram of Wrapper Cleaning Process

4.3 Proposed Improvement

4.3.1 Re-arrange Cleaning Process Sequences

After separating between internal and external activity, and the external activity is done before the machine stop. It is able to reduce some times for cleaning process. However, another problem of thecurrent cleaning process is the sequence of cleaning process has a lot of operator movement. In SMED method, after eliminating the external activity to be done before the machine stop, next step is to improve the internal activity in order to minimize shiftly cleaning processing time. In this case, the things that can be done is to re-arrange the sequence of the cleaning process, since the operator have to move several times in the same area, which actually can be removed. This is due to the operator has not completed the cleaning process in one area, but he moves to another area to clean it. Then, he will move back to the previous area to clean the rest part which has not clean.

Therfore, a new sequence of cleaning process after all the external activity transferred is created. Table 4.12 is flow process chart of Packer cleaning processin new sequences. In new sequence, the number of activity can be reduced 25 activity, which 7 activities belong to the operation and 18 activities are transportation. Therefore, the new cleaning process only has 58 activities (44 operations, 13 transportation, and 1 inspection) with total required time 1084.38 seconds (18.073). More time can be reduced by a new sequence of the cleaning process, which is 884.37 seconds (14.74 minutes). Then, operator movement also reduces as much as 82.66 meters, while by removing the external activity, the operator transportation may only reduce 46.53 meters. Summary of the current process and new sequence process can be seen in Table 4.12.

In a new sequence of the cleaning process, it can be seen the unnecessary motion of operator has been removed and the back and forth motion of operator have been minimized. The operator moves to one area several times only due to the next operation can not be done if the operator does not do it in the correct order. The operator should move to control panel for activating the vacuum first before re-threading the alufoil, and back to control panel to turn the machine on.

Table 4.12 New Sequence FPC of Cleaning in Packer

Location: Packaging Area									**Summary**			
Activity: Shiftly Cleaning of Packer Machine									**Event**	**Present**	**Proposed**	**Savings**
Date:									Operation	**51**	**44**	**7**
Operator:			**Analyst:**						Transport	**31**	**13**	**18**
Circle appropriate Method and Type:									Delay			
Method:	*Present*	*Proposed*							Inspection	**1**	**1**	**0**
Type:	*Worker*	*Material*	*Machine*						Storage			
Remarks:									Time (sec)	**1,968.75**	**1,084.38**	**884.37**
									Distance (m)	**115.16**	**32.50**	**82.66**
									Cost			

Old Seq	**New Seq**	**Activities**	**Operation**	**Transport**	**Inspection**	**Delay**	**Storage**	**Distance (meter)**	**Est. time (Sec)**
1	1	Switch the packer from running mode into clearing mode. Machine stops automatically when it's cleared	●	⇨	□	D	▽		29.25
2	2	Turn off the vacuum button	●	⇨	□	D	▽		13.75
3	3	Turn off the compressed air button	●	⇨	□	D	▽		8.50
7	4	Open the upper guard	●	⇨	□	D	▽		18.33
8	5	Operator moves to wheel 5	○	➡	□	D	▽	2.335	1.67
9	6	Take out lower right guard and lower center guard	●	⇨	□	D	▽		14.58
43	7	Take out 1st-5th wheel guide	●	⇨	□	D	▽		67.73

Table 4.12 New Sequence FPC of Cleaning in Packer (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
47	8	Clean folding hopper 5th wheel using scraper and dust cloth	●	⇨	□	D	▽		44.19
48	9	Clean fixed guide 5th wheel using dust cloth	●	⇨	□	D	▽		40.75
49	10	Clean the guide with dust cloth	●	⇨	□	D	▽		38.50
54	11	Clean 5th wheel pocket using dust cloth	●	⇨	□	D	▽		31.60
64	12	Clean blank platform and guide using dust cloth	●	⇨	□	D	▽		0.44
55	13	Operator moves to drum blank	○	➡	□	D	▽	0.61	0.44
56	14	Clean blank pusher using dust cloth	●	⇨	□	D	▽		19.81
57	15	Clean mobile elements using dust cloth	●	⇨	□	D	▽		22.50
58	16	Clean 3rd blank drum using dust cloth	●	⇨	□	D	▽		20.00
62	17	Clean 2nd blank drum using dust cloth and brass brush	●	⇨	□	D	▽		19.52
-	18	Operator moves to glue area	○	➡	□	D	▽	0.52	0.37
66	19	Take out the glue pot	●	⇨	□	D	▽		11.94

Table 4.12 New Sequence FPC of Cleaning in Packer (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
67	20	Open pot cover	●	⇨	□	D	▽		13.00
71	21	Clean glue pot cover using tweezers, scraper and dust cloth	●	⇨	□	D	▽		29.27
72	22	Clean roller using brass brush and dust cloth	●	⇨	□	D	▽		23.25
73	23	Clean glue pot using tweezers, scraper and dust cloth	●	⇨	□	D	▽		22.75
74	24	Putting back glue pot and 5th wheel	●	⇨	□	D	▽		22.50
75	25	Put glue pot and set it to "ready" mode	●	⇨	□	D	▽		6.75
76	26	Check glue level	○	⇨	■	D	▽		32.75
-	27	Operator moves to distributor area	○	➡	□	D	▽	0.83	0.59
51	28	Clean distributor unit using scraper and dust cloth	●	⇨	□	D	▽		51.35
52	29	Clean packet exit plate using scraper and dust cloth	●	⇨	□	D	▽		53.25
-	30	Operator moves to foil unit	○	➡	□	D	▽	2.07	1.47
11	31	Release Alufoil from valve	●	⇨	□	D	▽		30.91

Table 4.12 New Sequence FPC of Cleaning in Packer (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
15	32	Open the Alufoil cutting valve and clean it using roller brush	●	⇨	□	D	▽		98.30
16	33	Assembly alufoil cutting valve	●	⇨	□	D	▽		29.25
17	34	Operator moves to innerframe area	○	➡	□	D	▽	1.02	0.73
18	35	Open innerframe cutting and notching and clean it using roller brush	●	⇨	□	D	▽		38.02
-	36	Operator moves to coding unit	○	➡	□	D	▽	10.98	7.84
25	37	Shut down the laser marker vacuum	●	⇨	□	D	▽		24.05
-	38	Operator moves to extractor	○	➡	□	D	▽	2.5	1.78
20	39	Open extractor guard	●	⇨	□	D	▽		12.20
21	40	Take out the vacuum tube and clean it using compressed air	●	⇨	□	D	▽		56.50
29	41	Clean dust in filter manually	●	⇨	□	D	▽		46.74
30	42	Clean the carousal pocket using compressed air	●	⇨	□	D	▽		46.00
41	43	Compressed air - dry beam and extractor	●	⇨	□	D	▽		35.92

Table 4.12 New Sequence FPC of Cleaning in Packer (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
42	44	Operator moves to wheel 5	○	⇨	□	D	▽	3.53	2.52
36	45	Compressed air – 5th wheel	●	⇨	□	D	▽		39.75
35	46	Compressed air - 4th wheel	●	⇨	□	D	▽		47.50
34	47	Compressed air – 3rd wheel	●	⇨	□	D	▽		52.44
37	48	Operator moves to foil unit	○	⇨	□	D	▽	3.93	2.81
32	49	Compressed air - foil valve	●	⇨	□	D	▽		38.17
38	50	Compressed air - 3rd drum	●	⇨	□	D	▽		44.94
39	51	Compressed air - 2nd drum	●	⇨	□	D	▽		42.75
-	52	Operator moves to control panel	○	⇨	□	D	▽	1.29	0.92
78	53	Turn On Vacuum	●	⇨	□	D	▽		10.24
79	54	Operator moves to foil unit	○	⇨	□	D	▽	1.29	0.92
80	55	Re-Treading Alufoil	●	⇨	□	D	▽		19.00

Table 4.12 New Sequence FPC of Cleaning in Packer (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
81	56	Operator moves to control panel	○	⇨	□	D	▽	1.29	0.92
82	57	Put back guard (upper, central, right lower and extractor)	●	⇨	□	D	▽		31.25
83	58	Switch machine to running mode	●	⇨	□	D	▽		13.25
Total								**32.50**	**1,084.38**

While Table 4.13 is the new sequence flow process chart in Wrapper machine. In this proposed improvement there is only 43 activities for cleaning process in Wrapper machine, which is 32 for operation activity and 11 activities for transportation. Then, this proposed improvement can save time 451.51 seconds (7.525 minutes) because the new cleaning process only required 1,128.24 seconds (18.804 minutes) to finish cleaning for Wrapper machine. Then, reduction of operator movement is 22.59 meters.

Table 4.13 New Sequence FPC of Cleaning in Wrapper

Location: Packaging Area				**Summary**			
Activity: Shiftly Cleaning of Wrapper Machine				**Event**	**Present**	**Proposed**	**Savings**
Date:				Operation	**37**	**32**	**5**
Operator:	**Analyst:**			Transport	**18**	**11**	**7**
Circle appropriate Method and Type:				Delay			
Method:	*Present*	*Proposed*		Inspection			
Type:	*Worker*	*Material*	*Machine*	Storage			
Remarks:				Time (sec)	**1,579.75**	**1,128.24**	**451.51**
				Distance (m)	**42.67**	**20.08**	**22.59**
				Cost			

Old Seq	**New Seq**	**Activities**	**Operation**	**Transport**	**Inspection**	**Delay**	**Storage**	**Distance (meter)**	**Est. time (Sec)**
1	1	Stop machine	●	⇨	□	D	▽		8.75
-	2	Operator moves to front machine area	○	➡	□	D	▽	1.395	0.99
6	3	Open the left and right guard	●	⇨	□	D	▽		15.00
-	4	Operator moves to rotating head	○	➡	□	D	▽	0.925	0.66
10	5	Open rotating head using Combination wrench 32 mm	●	⇨	□	D	▽		34.51
11	6	Clean rotating head using compressed air and dust cloth, then put it back to machine	●	⇨	□	D	▽		52.50
12	7	Use compressed air - Belt Infeed Spider	●	⇨	□	D	▽		31.75
13	8	Use compressed air - CN Stamper	●	⇨	□	D	▽		33.50

Table 4.13 New Sequence FPC of Cleaning in Wrapper (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
14	9	Use compressed air - Rotating Head	●	⇨	□	D	▽		23.25
15	10	Use compressed air - Sensor Stamp	●	⇨	□	D	▽		27.00
16	11	Use compressed air - Infeed Screw	●	⇨	□	D	▽		29.50
30	12	Disassemble stamp basket and clean it using dust cloth	●	⇨	□	D	▽		46.25
31	13	Clean rotating folder using dust cloth	●	⇨	□	D	▽		39.50
32	14	Clean parallel pusher	●	⇨	□	D	▽		47.25
33	15	Clean lug belt using dust cloth	●	⇨	□	D	▽		33.25
34	16	Clean packet guides using dust cloth and scraper and assemble stamp basket	●	⇨	□	D	▽		38.25
35	17	Operator moves to unwinding film area	○	➡	□	D	▽	1.545	1.10
36	18	Clean unwinding roller and contrast using dust cloth	●	⇨	□	D	▽		39.15
37	19	Clean half ring using dust cloth	●	⇨	□	D	▽		55.25
38	20	Clean folding block using dust cloth	●	⇨	□	D	▽		45.00
39	21	Clean bottom side of folder using dust cloth	●	⇨	□	D	▽		55.25

Table 4.13 New Sequence FPC of Cleaning in Wrapper (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
40	22	Operator moves to TTR packet area	○	⇨	□	D	▽	0.7325	0.552
41	23	Clean TTR packet roller using dust cloth	●	⇨	□	D	▽		42.73
42	24	Operator moves to sealing wheel area	○	⇨	□	D	▽	0.8775	0.63
43	25	Clean heating drum using dust cloth	●	⇨	□	D	▽		52.12
44	26	Operator moves to TTR slof area	○	⇨	□	D	▽	0.7	0.50
45	27	Clean TTR slof roller using dust cloth	●	⇨	□	D	▽		39.00
46	28	Operator moves to CN area	○	⇨	□	D	▽	5.61	4.01
20	29	Clean the hole of applicator CN unit using dust cloth and drill 2 mm	●	⇨	□	D	▽		41.91
21	30	Clean the holes from glue storage using tweezers, scraper and dust cloth	●	⇨	□	D	▽		36.00
22	31	Clean notch and slitting drum using dust cloth	●	⇨	□	D	▽		32.00
23	32	Clean the nozzle tip using dust cloth	●	⇨	□	D	▽		45.50
27	33	Clean sponge and rubber using scraper and dust cloth	●	⇨	□	D	▽		39.39
28	34	Clean glue pot from deposit using dust cloth and scraper	●	⇨	□	D	▽		42.25

Table 4.13 New Sequence FPC of Cleaning in Wrapper (continued)

Old Seq	New Seq	Activities	Operation	Transport	Inspection	Delay	Storage	Distance (meter)	Est. time (Sec)
47	35	Clean vacuum tube in CN/stamper using compressed air	●	⇨	□	D	▽		35.74
48	36	Operator moves to control panel	○	➡	□	D	▽	0.565	0.40
49	37	Reactive all vacuum and air pressure in the machine	●	⇨	□	D	▽		10.35
50	38	Operator moves to unwinding film area	○	➡	□	D	▽	3.865	2.76
51	39	Re-threading film	●	⇨	□	D	▽		24.49
52	40	Operator moves to front machine area	○	➡	□	D	▽	2.47	1.76
53	41	Put back guard (left & right guard)	●	⇨	□	D	▽		11.74
54	42	Operator moves to control panel	○	➡	□	D	▽	1.395	1.00
55	43	Switch on the machine	●	⇨	□	D	▽		5.75
Total								**20.08**	**1128.24**

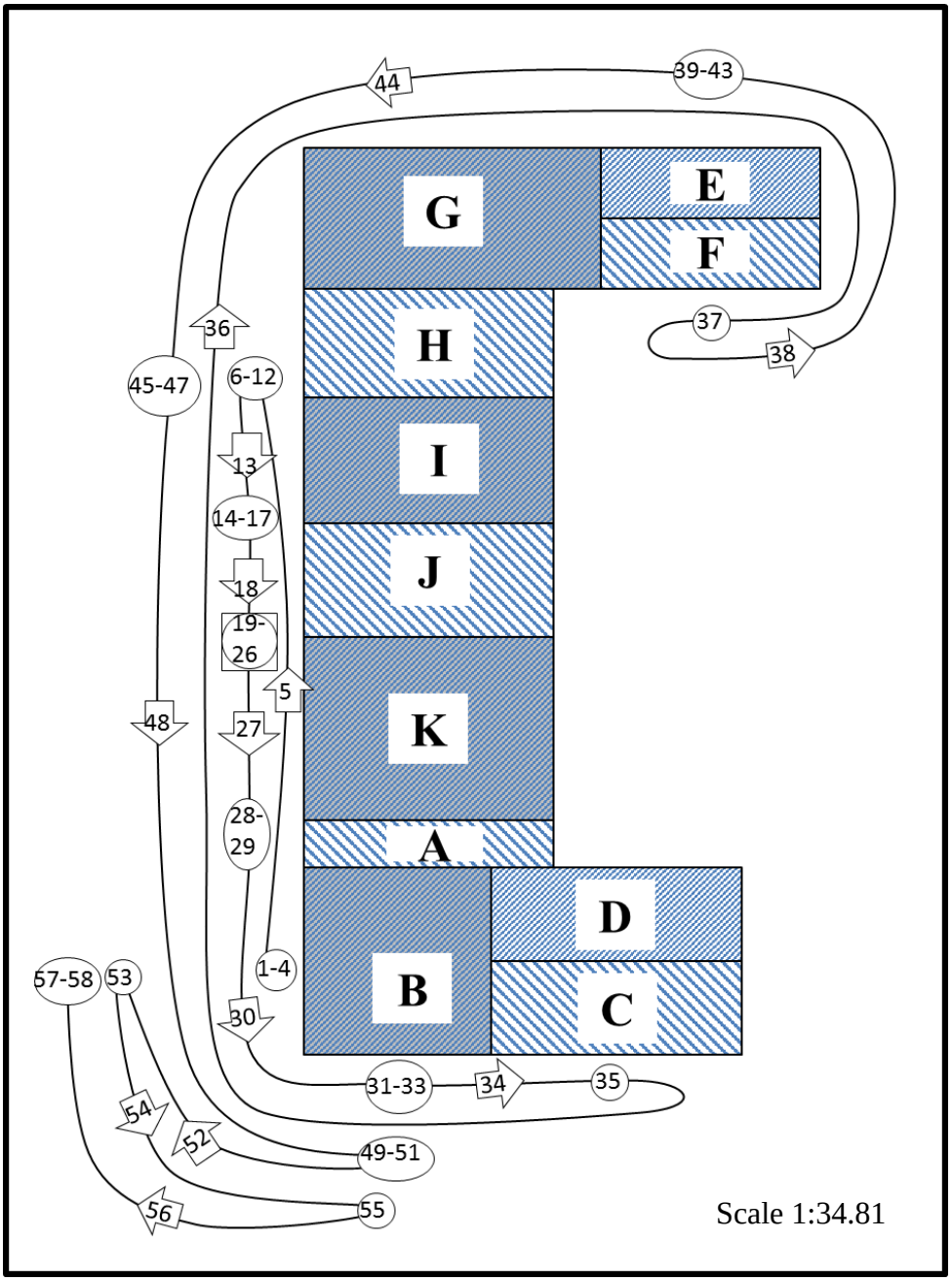


Figure 4.10 New Flow Diagram of Packer Cleaning Process

Figure 4.10 is flow diagram of new cleaning process sequence in Packer machine. It shows that the operator movement is not as much as the current process. The sequence is: Control Panel (A) (activity 1-4) → Wheel (H) (activity 6-12)→ Drum Blank (I) (activity 14-17) → Glue Area (J) (activity 19-26) → Distributor Area (K) (activity 28-29) → Foil Unit (B) (activity 31-33) → Innerframe Area (C) (activity 35) → Coding Unit (F) (activity 37) → Extractor (E) (activity 39-43) →

Wheel (H) (activity 45-47)→ Foil Unit (B) (activity 49-51) → Control Panel (A) (activity 53) → Foil Unit (B) (activity 55) → Control Panel (A) (activity 57-58).

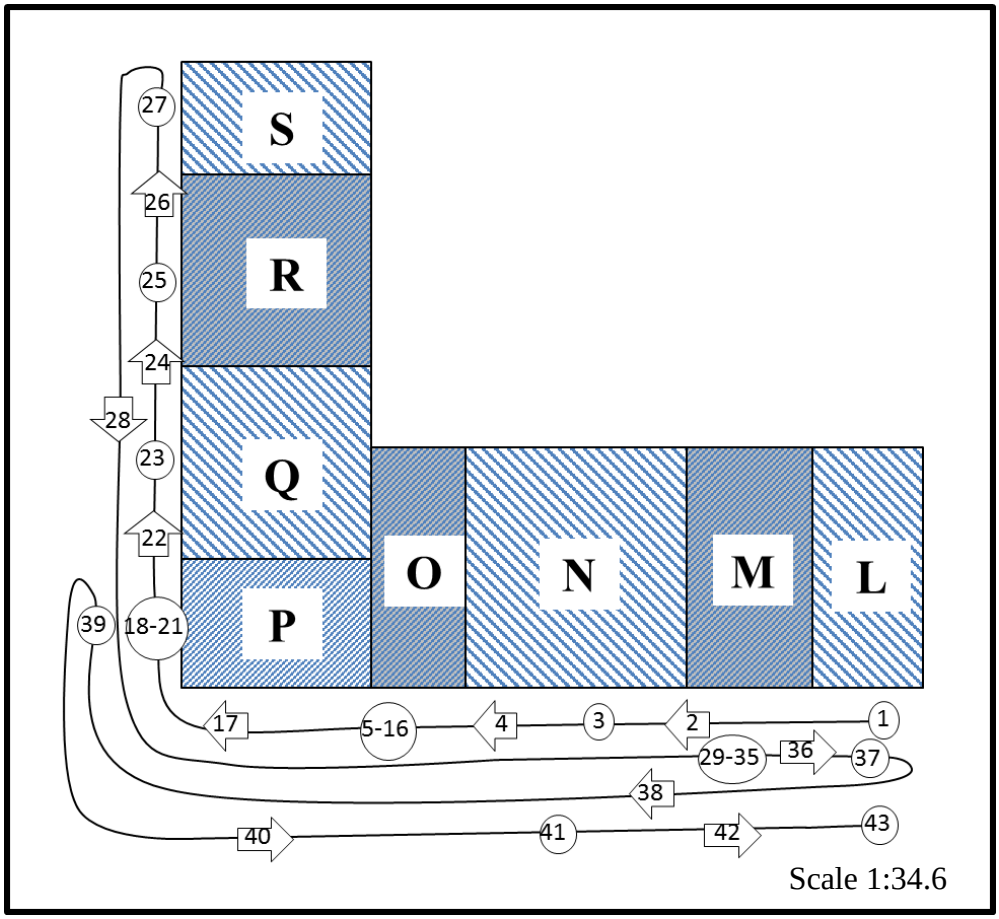


Figure 4.11 New Flow Diagram of Wrapper Cleaning Process

While Figure 4.11 is the flow diagram of proposed cleaning process movement in Wrapper machine. The operator movement sequence is: Control Panel (L) (activity 1) → Front Machine Wrapper (N) (activity 3) → Rotating Head (O) (activity 15-16) → Unwinding Film Area (P) (activity 18-21) → TTR Packet Area (Q) (activity 23) → Sealing Wheel Area (R) (activity 25) → TTR Slof Area (S) (activity 27) → CN Area (M) (activity 29-35) → Control Panel (L) (activity 37)→ Unwinding Film Area (P) (activity 39) → Front Machine of Wrapper (N) (activity 41) → Control Panel (L) (activity 43).

4.3.2 5S Improvement

One problem of the cleaning process takes time longer is the tools are scattered around the packaging area, and the operator has to search for it. In order to overcome this problem, 5S as one of the tools in lean manufacturing should be conducted by buying a tools cabinet to keep the tools for the cleaning process.

4.3.2.1 Seiri

In 5S, the first step is to sort the between used item and un-used item. For cleaning process of packaging area, the tools needed are already stated in Table 4.6. Therefore, except tools in Table 4.6 should be located to outside the tools cabinet.

4.3.2.2 Seiton

For each tool should be labeling to ease operator when need to used the tools. At the top of based plate will be put Scraper, Tweezers, Combination wrench, round brush, brass brush, and drill. While, the middle based plate is a space for keep the clean dust cloth, and the bottom based plate to dispose of the dirty dust cloth after used.

4.3.2.3 Seiso

Next, the tools should be clean after the operator used tools and put it back to its provided location. After doing shiftly cleaning process in the packaging area, the operator removes all the dirt in the working area and cleans it as before the cleaning process started. Therefore, the operator should maintain the cleanliness working area of packaging area. The cleanliness of Packaging area is significant for smoothness of next production process in packaging area, especially for Packer and Wrapper machine. It is because automation in cigarette company is sensitive from any dirt and it may affect the next production process, it the cleaning process is not cleared. In order to maintain the cleanliness of Packer and Wrapper machine, the operator should follow the instruction of cleaning process and all the sensitive area in machine should be clean carefully.

4.3.2.4 Seiketsu

After the improvement of the previous step in 5S, its improvement should be made as the new standardization. Therefore, a socialization of the rack cabinet for keeping the tools for shiftly cleaning process in packaging area should be delivered to all the operators. Then, a new standard (SOP) for shiftly cleaning process is created in order to maintain the cleanliness of Packer and Wrapper machine. The SOPs are in Appendix 5 and Appendix 6.

4.3.2.5 Shitsuke

The last step of 5S is the operator has to have a mindset that this standard (SOP) should be followed and have the discipline to maintain the standard.

Figure 4.12 is the design of tools cabinet for 5S implementation in 3 views.

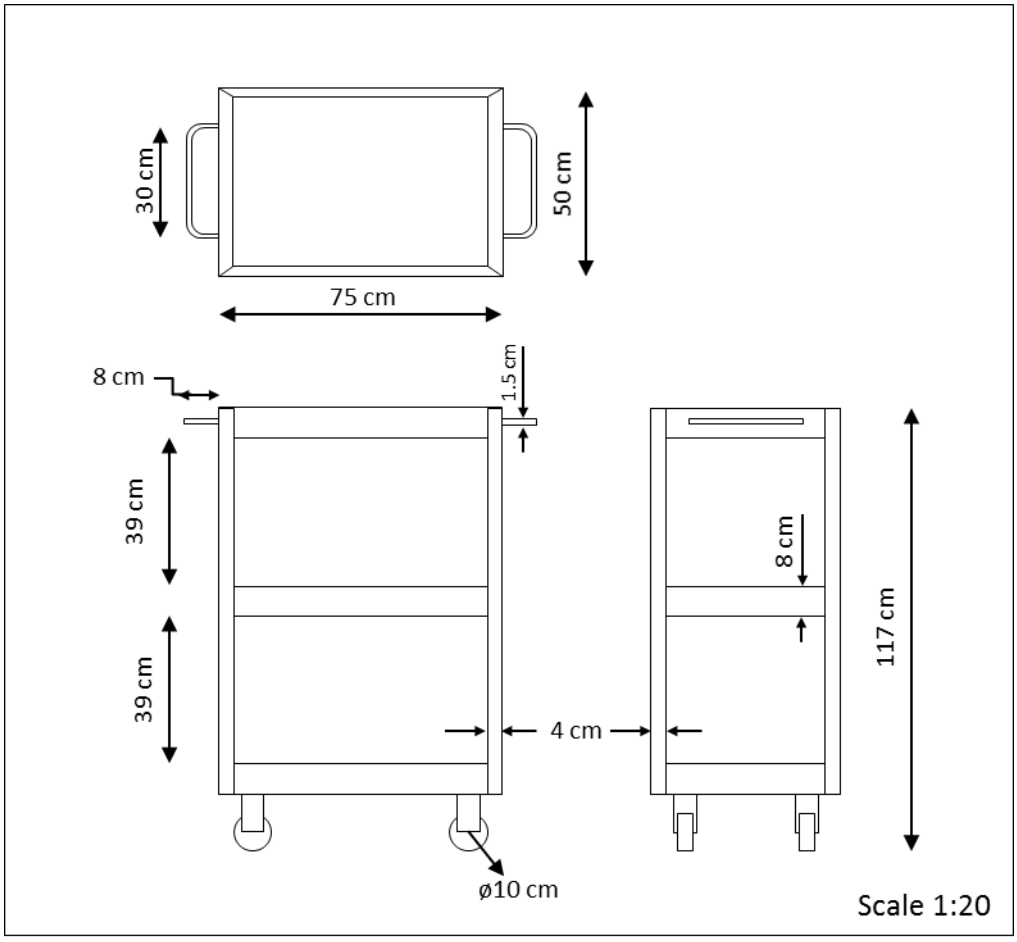


Figure 4.12 Tools Cabinet's Design

The measurement of rack dimension is referred from the anthropometric measurement of Gordon et. al (1988). The Anthropometric measurement is in Appendix 4. Inside the cabinet tools for cleaning process will be put in the cabinet rack. The rack consists of three level of based plate. While in each of based plate will be put the foam in order to ease storing process of tools and the tools will not mess up when the operator moves the cabinet.

To have the tools cabinet in the packaging area, then the management should buy the rack. There is cost should be spent. The cost is including material cost and labor cost. Since the cabinet is a custom design, then there is a fee for vendor labor who is creating the cabinet. Table 4.14 is a cost estimation needed to buy the tools rack cabinet. The total cost to buy tool cabinet is IDR 2,690,000,-

Table 4.14 Tools Cabinet Cost

No	Part	Description	Qty/(pcs)	Price/Unit (IDR)	Total Price (IDR)
1	Based Plate	Material: Steel	4	250,000	1,000,000
2	Side Frame	Material: Steel	4	150,000	600,000
3	Wheels	Trolley Wheels 10cm	4	75,000	300,000
4	Screw & Nut		60	5,000	300,000
5	Foam		3	30,000	90,000
6	Handle	Material: Steel	2	100,000	200,000
7	Vendor Labor		1	200,000	200,000
Total					**2,690,000**

4.3.3 SOP of Improved Cleaning Process

In order to make sure the operator conduct the cleaning process the same as the proposed improvement. Then, a SOP (Standard Operation Procedure) should be created. The SOP shows the flow of cleaning process which could be done by the operator in the packaging area. The purposed of the SOP is to maintain the sequence of cleaning operation, so the cleaning time in packaging area will not exceed time in proposed improvement. If the operator does not follow the SOP, it is possible for the operator to do an operation which is not necessary and it may increase either the cleaning time or operator movement. There are two SOP, SOP for shiftly cleaning of Packer machine and SOP for shiftly cleaning of Wrapper

Machine. SOPs are attached in Appendices, SOP for cleaning Packer machine is in Appendix 5 and SOP for cleaning Wrapper machine is in Appendix 6.

4.4 Analysis After Improvement

After an improvement of the shiflty cleaning process in packaging area is proposed. Then, an analysis should be conducted in order to measure the effectiveness of this improvement process.

4.4.1 Waste Analysis

The first analysis of effectiveness improvement process is waste analysis. In waste, there is 8 type of waste, which are Defects, Overproduction, Waiting, Non-Utilize Talent, Transportation, Inventory, Motion, Extra-Processing (DOWNTIME). However, in this research, there is only two kinds of waste which could be reduced. They are Waiting and Motion. Here, Waiting means the wasted time for shiftly cleaning processing time which lead to delay next production process. Meanwhile, Motion mean unnecessary motion of operator exceeds the necessary motion than required to conduct cleaning process in the packaging area.

Table 4.15 is a summary of the cleaning process in Packer machine and the waste which can be eliminated. From the elimination of external activity, it can reduce time 487.64 seconds and operator transportation 46.53 meters. While after more improvement, which is re-arrange process cleaning the waste can be reduced increasing. It becomes 884.37 seconds and 82.66 meters.

Table 4.15 Summary of Waste in Packer

	Current Process	**Elimination of External Activity**		**Re-arrange Process**	
		Improvement	**Waste**	**Improvement**	**Waste**
Operation	51	44	7	44	**7**
Transport	31	19	12	13	**18**
Delay					
Inspection	1	1		1	**0**
Storage					
Time (sec)	1968.75	1481.11	487.64	1084.38	**884.37**
Distance (m)	115.16	68.63	46.53	32.50	**82.66**

While figure 4.13 show the shiftly cleaning time in the current process, and after improvement (eliminate external activity and after re-arrange process). The first reduction is 24.77% from the current process. Then, the total percentage time reduction after re-arrange process compares to current process is 44.92%.

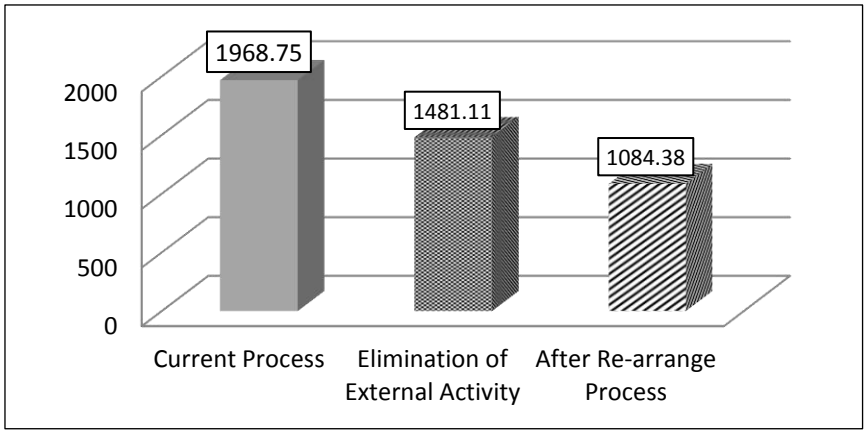


Figure 4.13 Cleaning Time Before and After Improvement in Packer

Figure 4.14 is a visualisation of operator transportation distance reduction. From the first reduction from elimination external activity, the reduction is 40.40%. After improvement when the cleaning process in Packer machine re-arrange, the distance required for the operator to move reducing by 71.78% from the current process.

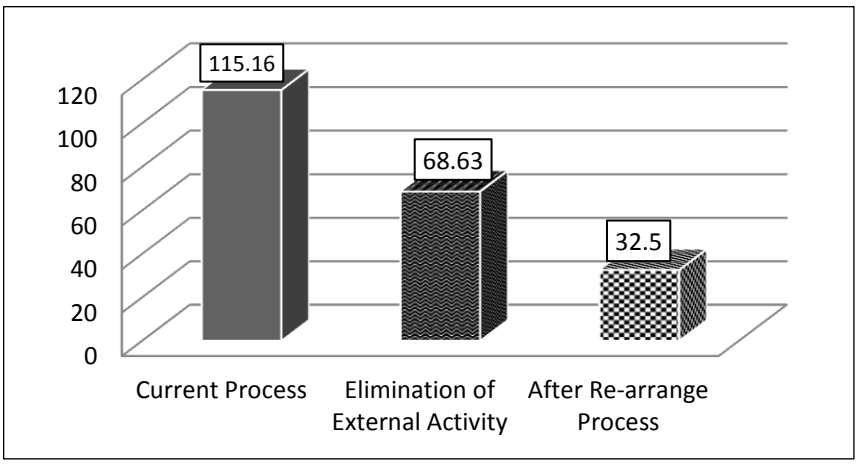


Figure 4.14 Distance Travel Before and After Improvement in Packer

From Figure 4.13 and Figure 4.14, it shows that elimination of external activities and a new arrangement of cleaning process give a significant reduction to waiting time and operator motion waste in Packer machine. This means the improvement both the external activity elimination and re-arrange new cleaning sequence is effective to reduce motion and waiting time waste.

Next, it is a waste analysis of waste in Wrapper machine. Table 4.16 is a summary of time and motion waste. Waste from external activities is 444.96 seconds and 13.37 meters. After further improvement, the total waste can be reduced are 1128.24 seconds of waiting and 22.59 meters of operator motion.

Table 4.16 Summary of Waste in Wrapper

	Current Process	**Elimination External Activity**		**Re-arrange Process**	
		Improvement	**Waste**	**Improvement**	**Waste**
Operation	37	32	5	32	**5**
Transport	18	13	5	11	**7**
Delay					
Inspection					
Storage					
Time (sec)	1579.75	1134.79	444.96	1128.24	**451.51**
Distance (m)	42.67	29.30	13.37	20.08	**22.59**

Figure 4.15 is bar chart for waiting time reduction in Wrapper machine. The percentage of time reduction by eliminating the external activity is 28.17%. While the percentage of time reduction of new sequence cleaning process is 28.58% from current cleaning procedures.

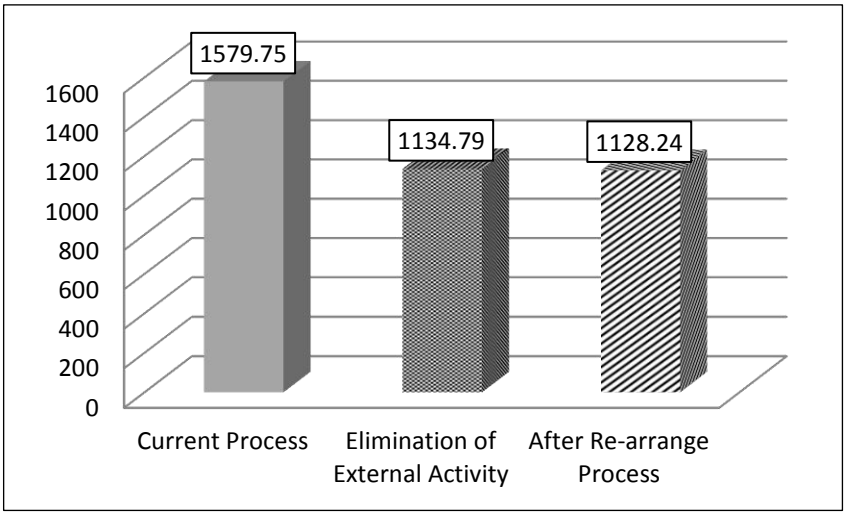


Figure 4.15 Cleaning Time Before and After Improvement in Wrapper

Figure 4.16 shows the reduction of operator distance travel during cleaning process in Wrapper machine. Elimination of external activity is able to reduce 31.33% of distance traveled by the operator. Then, the total percentage of distance reduction after cleaning process re-arrange, it can reduce up to 52.94% refers to the current cleaning process.

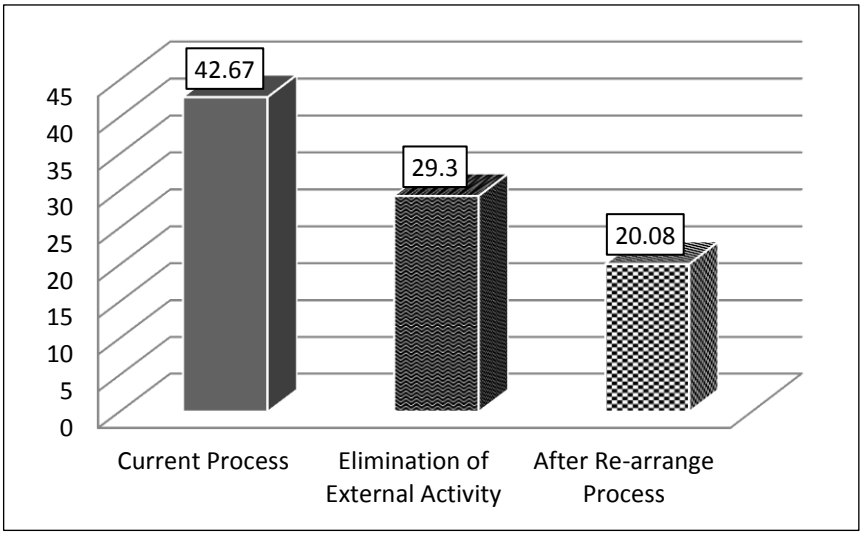


Figure 4.16 Distance Travel Before and After Improvement in Wrapper

From the bar chart in Figure 4.15 and Figure 4.16, it shows that the most problem of the long duration of the cleaning process in Wrapper machine is due to external activities rather than a bad sequence of the cleaning process. This means that the

sequence of the current cleaning process is actually already good. However, the new sequence is also able to reduce a bit of duration and distance during the cleaning process.

4.4.2 Cost Comparison

The second analysis for measure the effectiveness of this improvement is to measure from a financial aspect. Since thetime for shiftly cleaning process of packaging area is reducing, so the productivity will be increased. However, the saving time for cleaning process in Packer machine is 884.37 seconds and for Wrapper machine is 451.51 seconds. In the current cleaning process, actualy this duration is the production loss for the company.

Table 4.17 is a calculation of production loss due to a shiftly cleaning process in the packaging area. The production rate of the machine of Packer is 168 packs/minute and Wrapper is 14 slofs/minute, as stated in the Sub-chapter 4.1.1. Then, shiftly cleaning in Packer machine, after improvement it can reduce time 884.37seconds and in Wrapper is 451.51 seconds. The calculation of Production loss is:

$$\text{Production Loss for Packer} = Production\ rate * \frac{Saving\ time\ (\text{second})}{60\ second}$$

$$= 168\ packs/\min * \frac{884.37\ sec}{60\ sec}$$

$$= 2{,}476.24\ packs$$

From calculation, production loss of packer machine is 2,476 packs and Wrapper machine is 105 slofs. The number is round down in order to get integers unit of product. Next, in order to calculate the benefit which can be obtained from production loss, thequantity of production loss will be multiplied with the profit/unit. However, a manufacturer calculates the profit from its finished product and the finished product in packaging area is in theslof packet instead of a hinged-lid packet. Then, the net profit will be counted from production loss of Wrapper machine, but the have an output of one slof packet, the Wrapper machine required 10 hinged-lid packets from Packer Machine. Therefore, the quantity of production

loss in Packer is higher than the quantity needed by Wrapper machine to produce 105 slofs, production loss of Packer's output (2,476 packs) > input of production loss of Wrapper (1,050 packs). It means the output of production loss in packer will be used for net profit calculation. Profit/unit of slof is assumed as IDR 20,000,-.

The calculation of Net Profit is:

Net Profit $= Production\ Loss * Profit/unit$

$= 105 * IDR\ 20{,}000{,}-$

$= IDR\ 2{,}100{,}000{,}-$

The profit which could be obtained for one time of cleaning process is IDR 2,100,000,-.

Table 4.17 Production Loss Calculation

Machine	Production Rate	Saving Time (sec)	Production Loss (unit)	Profit/unit (IDR/slof)	Net Profit (IDR)
Packer	168 packs/min	884.37	2,476.24	-	-
Wrapper	14 slofs/min	451.51	105.35	20,000	2,100,000

Table 4.18 is a table of cummulative profit, which could be gotten by PT XY. Since the improvement is shiftly cleaning process in the packaging area, and the shiftly cleaning process will be done three times a day. Therefore, in one day, PT XY could obtain IDR 6,300,000,-, second day is IDR 12,600,000,- in cummulative. Since the cost for tools cabinet to improve 5S of shiftly cleaning in packaging area is IDR 2,600,000,-. Then, the production loss profit is able to cover the cabinet cost.

Table 4.18 Production Loss Profit vs Improvement Cost Calculation

	Cummulative Profit from Production loss (IDR)	5S Implementaon Cost (IDR)
Day 1	IDR2,100,000	
	IDR 2,100,000	
	IDR 2,100,000	
	IDR 6,300,000	**IDR2,690,000**
Day 2	IDR 2,100,000	
	IDR 2,100,000	
	IDR 2,100,000	
	IDR 12,600,000	**IDR2,690,000**
Day 3	IDR 2,100,000	
	IDR 2,100,000	
	IDR 2,100,000	
	IDR 18,900,000	**IDR2,690,000**

Figure 4.17 is a chart, that shows break even point (BEP) of spending cost for 5S tools cabinet implementation againts the profit from production cost. It shows that the break even point can be reached after the second time of shiftly cleaning.

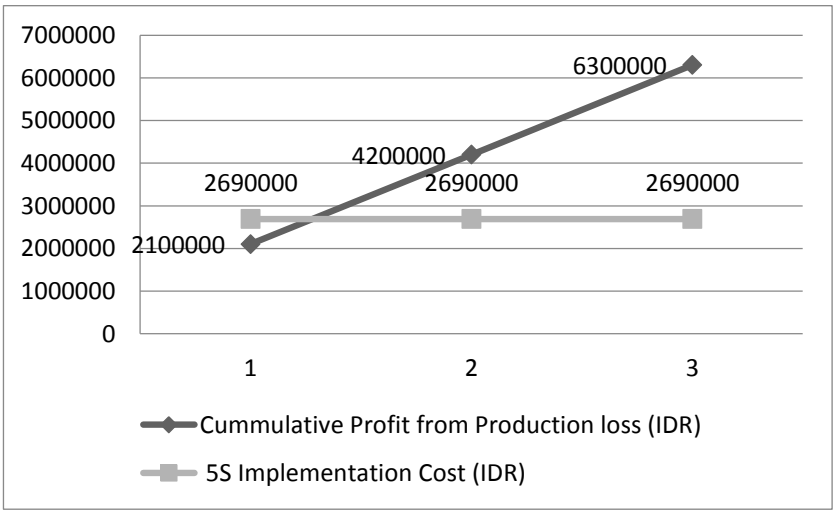


Figure 4.17 Production Loss Profit vs Improvement Cost BEP

CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The objectives of this research in PT XY regarding the reducing shiftly cleaning processing time in Packaging area is reached. The conclusion which could be sum up of the entire research are:

- From analyzing data of shiftly cleaning process in the Packaging area, which consists of Packer and Wrapper machine, using SMED approaching, the internal and external activity of cleaning process should be seperated. For cleaning process of Packer machine, there are 64 internal activities and 19 external activities with total time 1,968.75 seconds. The cleaning process of Wrapper machine has 45 internal activities and 10 external activities which take 1,579.75 seconds.
- Some improvements are made in this research for reducing cleaning processing time. The improvement made are by eliminating external activity during machine shutdown and creating a new sequence of cleaning activity. Also, in order to have better tools preparation for cleaning process, a new tool cabinet is bought, and SOPs are created to ensure the operators follow the new instruction of cleaning activity. After improvement process, the cleaning process of Packer machine only takes time 1,084.38 seconds, which means cleaning processing time of Packer machine is reducing 44.92%. Then cleaning time of Wrapper machine after improvement is 1,128.24 seconds, by reducing 28.58% from the current process.
- By creating the improvement for cleaning process of packaging area, the time for machiene breakdown due to shiftly could be shortened. Therefore, the productivity of packaging area could be increasing. One of the measurements of increasing productivity is the production loss of PT XY from the current process. After making an improvement, PT XY is expected could save the production loss as many as 150 finished goods,

which is 150 slofs or 1,500 hinged-lid packets for one time shiftly cleaning process. Therefore, PT XY could gain profit as much as IDR 6,300,000,- in one day. It is able to cover the cost of buying new tools cabinet. Which is IDR 2,690,000,-, thats mean the improvement can be conducted and will be profitable for PT XY.

5.2 Recommendation

For the recommendation for further research improvements are converting more internal activity of shiftly cleaning process into external activity because in this research, the implementation of SMED is only eliminated the external activity. There is no internal activity that changed into external and being eliminated. It can be done by having other tools, such as jigs, to ease the operator to clean machine Packer and Wrapper.

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APPENDICES

APPENDIX 1 Historical Data Downtime of Machine Packer and Wrapper

from week 29 – week 32, 2016

Week 29			
Date	**Machine off**	**Time (min)**	
		Packer	**Wrapper**
18/07/16	Shiftly Cleaning	33	26
	Brandchange	31	34
	Shiftly Cleaning	35	28
	Brandchange	37	35
	Shiftly Cleaning	32	24
	Minor stops	11	9
19/07/16	Shiftly Cleaning	34	27
	Brandchange	25	20
	Shiftly Cleaning	30	24
	Brandchange	37	31
	Shiftly Cleaning	33	25
	Minor stops	0	0
20/07/16	Shiftly Cleaning	33	26
	Brandchange	33	34
	Shiftly Cleaning	35	25
	Brandchange	38	29
	Shiftly Cleaning	34	24
	Minor stops	0	2
21/07/16	Shiftly Cleaning	31	28
	Brandchange	27	35
	Shiftly Cleaning	32	24
	Brandchange	25	36
	Shiftly Cleaning	32	25
	Minor stops	12	8
22/07/16	Shiftly Cleaning	36	27
	Brandchange	29	36
	Shiftly Cleaning	34	24
	Brandchange	29	37
	Shiftly Cleaning	36	25
	Minor stops	16	19
23/07/16	Shiftly Cleaning	36	26
	Brandchange	28	31
	Shiftly Cleaning	37	29
	Brandchange	30	28
	Shiftly Cleaning	31	26
	Minor stops	11	14

Week 30			
Date	**Machine off**	**Time (min)**	
		Packer	**Wrapper**
25/07/16	Shiftly Cleaning	36	25
	Brandchange	33	36
	Shiftly Cleaning	36	28
	Brandchange	30	34
	Shiftly Cleaning	33	25
	Minor stops	17	14
26/07/16	Shiftly Cleaning	37	29
	Brandchange	34	37
	Shiftly Cleaning	34	23
	Brandchange	34	31
	Shiftly Cleaning	30	26
	Minor stops	13	11
27/07/16	Shiftly Cleaning	34	29
	Brandchange	28	30
	Shiftly Cleaning	30	25
	Brandchange	29	37
	Shiftly Cleaning	37	29
	Minor stops	0	0
28/07/16	Shiftly Cleaning	30	27
	Brandchange	34	29
	Shiftly Cleaning	37	28
	Brandchange	31	36
	Shiftly Cleaning	34	25
	Minor stops	18	13
29/07/16	Shiftly Cleaning	33	29
	Brandchange	28	37
	Shiftly Cleaning	30	27
	Brandchange	31	28
	Shiftly Cleaning	37	29
	Minor stops	6	4
30/07/16	Shiftly Cleaning	33	29
	Brandchange	36	37
	Shiftly Cleaning	31	29
	Brandchange	34	30
	Shiftly Cleaning	32	28
	Minor stops	17	16

APPENDIX 1 Historical Data Downtime of Machine Packer and Wrapper from week 29 – week 32, 2016 (continued)

Week 29			
Date	Machine off	Time (min)	
		Packer	Wrapper
24/07/16	Shiftly Cleaning	31	27
	Brandchange	34	36
	Shiftly Cleaning	30	23
	Brandchange	34	30
	Shiftly Cleaning	35	28
	Minor stops	17	20
Total Brandchange time		437	452
Total Shiftly Cleaning time		700	541
Total Minor Stop time		67	72

Week 30			
Date	Machine off	Time (min)	
		Packer	Wrapper
31/07/16	Shiftly Cleaning	37	26
	Brandchange	32	29
	Shiftly Cleaning	36	24
	Brandchange	30	31
	Shiftly Cleaning	32	24
	Minor stops	16	15
Total Brandchange time		444	462
Total Shiftly Cleaning time		709	564
Total Minor Stop time		87	73

Week 31			
Date	Machine off	Time (min)	
		Packer	Wrapper
01/08/16	Shiftly Cleaning	31	28
	Brandchange	29	36
	Shiftly Cleaning	34	23
	Brandchange	37	29
	Shiftly Cleaning	34	25
	Minor stops	17	12
02/08/16	Shiftly Cleaning	34	25
	Brandchange	37	30
	Shiftly Cleaning	36	28
	Brandchange	28	32
	Shiftly Cleaning	31	27
	Minor stops	0	0
03/08/16	Shiftly Cleaning	32	29
	Brandchange	32	28
	Shiftly Cleaning	37	29
	Brandchange	35	33
	Shiftly Cleaning	34	28
	Minor stops	19	11
04/08/16	Shiftly Cleaning	36	24
	Brandchange	30	31
	Shiftly Cleaning	37	27
	Brandchange	34	30
	Shiftly Cleaning	33	24

Week 32			
Date	Machine off	Time (min)	
		Packer	Wrapper
08/08/16	Shiftly Cleaning	37	26
	Brandchange	37	33
	Shiftly Cleaning	35	25
	Brandchange	30	36
	Shiftly Cleaning	35	27
	Minor stops	16	9
09/08/16	Shiftly Cleaning	35	24
	Brandchange	35	35
	Shiftly Cleaning	37	29
	Brandchange	34	28
	Shiftly Cleaning	35	27
	Minor stops	15	11
10/08/16	Shiftly Cleaning	33	26
	Brandchange	32	29
	Shiftly Cleaning	35	26
	Brandchange	37	33
	Shiftly Cleaning	35	27
	Minor stops	17	16
11/08/16	Shiftly Cleaning	34	28
	Brandchange	31	35
	Shiftly Cleaning	31	27
	Brandchange	36	33
	Shiftly Cleaning	36	26

APPENDIX 1 Historical Data Downtime of Machine Packer and Wrapper

from week 29 – week 32, 2016 (continued)

Week 31			
Date	**Machine off**	**Time (min)**	
		Packer	**Wrapper**
	Minor stops	11	8
05/08/16	Shiftly Cleaning	36	29
	Brandchange	29	34
	Shiftly Cleaning	34	24
	Brandchange	35	36
	Shiftly Cleaning	33	28
	Minor stops	19	14
06/08/16	Shiftly Cleaning	35	23
	Brandchange	31	35
	Shiftly Cleaning	35	27
	Brandchange	30	35
	Shiftly Cleaning	31	27
	Minor stops	0	0
07/08/16	Shiftly Cleaning	34	23
	Brandchange	30	32
	Shiftly Cleaning	33	28
	Brandchange	33	37
	Shiftly Cleaning	37	27
	Minor stops	21	18

Total Brandchange time	450	458
Total Shiftly Cleaning time	717	553
Total Minor Stop time	87	63

Week 32			
Date	**Machine off**	**Time (min)**	
		Packer	**Wrapper**
	Minor stops	0	0
12/08/16	Shiftly Cleaning	31	29
	Brandchange	35	29
	Shiftly Cleaning	36	23
	Brandchange	36	37
	Shiftly Cleaning	31	23
	Minor stops	0	0
13/08/16	Shiftly Cleaning	33	23
	Brandchange	29	29
	Shiftly Cleaning	34	28
	Brandchange	31	35
	Shiftly Cleaning	37	23
	Minor stops	20	18
14/08/16	Shiftly Cleaning	34	27
	Brandchange	30	34
	Shiftly Cleaning	31	24
	Brandchange	37	29
	Shiftly Cleaning	35	25
	Minor stops	16	10

Total Brandchange time	470	455
Total Shiftly Cleaning time	720	543
Total Minor Stop time	84	64

APPENDIX 2 Observation Time of Shiftly Cleaning in Packer Machine

No	Activities	Area	Tools	Observation Time (Sec)				
				Obs 1	Obs 2	Obs3	Obs 4	Average
1	Switch the packer from running mode into clearing mode. Machine stops automatically when it's cleared	Control Panel		28	29	30	30	29.25
2	Turn off the vacuum button	Control Panel		15	12	13	15	13.75
3	Turn off the compressed air button	Control Panel		5	7	15	7	8.50
4	Take out cigarette rejection box	Foil unit		28	16	18	7	17.25
5	Open the upper guard	Control Panel		21	16	18	22	19.25
6	Take out lower right guard and lower center guard	Wheel 5		15	17	18	15	16.25
7	Release Alufoil from valve	Foil unit		33	37	31	33	33.50
8	Search roller brush	Operator table		101	88	95	77	90.25
9	Open the Alufoil cutting valve and clean it using roller brush	Foil unit	Roller brush	101	103	95	103	100.50
10	Assembly alufoil cutting valve	Foil unit		26	30	32	29	29.25
11	Open innerframe cutting and notching and clean it using roller brush	Innerframe area	Roller brush	33	45	44	33	38.75
12	Open extractor guard	extractor		20	19	19	15	18.25
13	Take out the vacuum tube and clean it using compressed air	Extractor	Air gun compressor	52	58	56	60	56.50
14	Extend air gun compressor	Coding unit side		48	22	16	37	30.75
15	Shut down the laser marker vacuum	Coding unit		23	29	30	30	28.00
16	Search vacuum cleaner	Behind innerframe		103	102	98	101	101.00

APPENDIX 2 Observation Time of Shiftly Cleaning in Packer Machine (continued)

No	Activities	Area	Tools	Observation Time (Sec)				
				Obs 1	Obs 2	Obs3	Obs 4	Average
17	Clean dust in filter manually	Extractor	Air gun compressor	55	55	58	51	54.75
18	Clean the carousal pocket using compressed air	Extractor	Air gun compressor	49	47	39	49	46.00
19	Compressed air - foil valve	Foil unit	Air gun compressor	51	45	43	35	43.50
	Compressed air - 3rd wheel	Wheel 3	Air gun compressor	56	48	68	49	55.25
	Compressed air - 4th wheel	Wheel 4	Air gun compressor	44	63	44	39	47.50
	Compressed air - 5th wheel	Wheel 5	Air gun compressor	48	41	42	28	39.75
	Compressed air - 3rd drum	Foil unit	Air gun compressor	53	42	50	46	47.75
	Compressed air - 2nd drum	Foil unit	Air gun compressor	42	45	42	42	42.75
	Compressed air - dry beam and extractor	Extractor	Air gun compressor	48	38	41	38	41.25
20	Take out 1st-5th wheel guide	Wheel 5		66	73	73	69	70.25
21	Search scraper and dust clothes	Operator table		100	75	67	74	79.00
22	Clean folding hopper 5th wheel using scraper and dust cloth	Wheel 5	Scraper& dust cloth	47	45	51	45	47.00
23	Clean fixed guide 5th wheel using dust cloth	Wheel 5	dust cloth	40	43	37	43	40.75
24	Clean the guide with dust cloth	Wheel 5	dust cloth	37	38	36	43	38.50

APPENDIX 2 Observation Time of Shiftly Cleaning in Packer Machine (continued)

No	Activities	Area	Tools	Observation Time (Sec)				
				Obs 1	Obs 2	Obs3	Obs 4	Average
25	Clean distributor unit using scraper and dust cloth	Distributor Area	Scraper& dust cloth	51	53	55	52	52.75
26	Clean packet exit plate using scraper and dust cloth	Distributor Area	Scraper& dust cloth	53	50	58	52	53.25
27	Clean 5th wheel pocket using dust cloth	Wheel 5	dust cloth	34	34	32	32	33.00
28	Clean blank pusher using dust cloth	Drum blank	dust cloth	22	18	20	21	20.25
29	Clean mobile elements using dust cloth	Drum blank	dust cloth	23	22	22	23	22.50
30	Clean 3rd blank drum using dust cloth	Drum blank	dust cloth	19	19	24	18	20.00
31	Search brass brush	Operator table		124	113	132	156	131.25
32	Clean 2nd blank drum using dust cloth and brass brush	Drum blank	dust cloth & Brass Brush	21	23	21	23	22.00
33	Clean blank platform and guide using dust cloth	Wheel 5	dust cloth	18	20	20	20	19.50
34	Take out the glue pot	Glue area		12	13	12	14	12.75
35	Open pot cover	Glue area		10	15	12	15	13.00
36	Search tweezers	Operator table		48	14	16	32	27.50

APPENDIX 2 Observation Time of Shiftly Cleaning in Packer Machine (continued)

No	Activities	Area	Tools	Observation Time (Sec)				
				Obs 1	Obs 2	Obs3	Obs 4	Average
37	Clean glue pot cover using tweezers, scraper and dust cloth	Glue area	Tweezers, Scraper and dust cloth	35	29	32	30	31.50
	Clean roller using brass brush and dust cloth	Glue area	dust cloth & Brass Brush	24	20	24	25	23.25
	Clean glue pot using tweezers, scraper and dust cloth	Glue area	Tweezers, Scraper and dust cloth	21	25	21	24	22.75
38	Putting back glue pot and 5th wheel	Glue area		23	24	21	22	22.50
39	Put glue pot and set it to "ready" mode	Glue area		8	6	6	7	6.75
40	Check glue level	Glue area		31	32	34	34	32.75
41	Turn On Vacuum	Control Panel		11	12	11	10	11.00
42	Re-Treading Alufoil	Foil unit		20	23	21	20	21.00
43	Put back guard (upper, central, right lower and extractor)	Control Panel		35	30	30	30	31.25
44	Switch machine to running mode	Control Panel		13	14	13	13	13.25
Total (in sec)				**2044**	**1937**	**1956**	**1938**	**1968.75**
Total (in min)				**34.067**	**32.283**	**32.600**	**32.300**	**32.813**

APPENDIX 3 Observation Time of Shiftly Cleaning in Wrapper Machine

No	Activities	Area	Tools	Observation Time (Sec)				
				Obs 1	Obs 2	Obs 3	Obs 4	Average
1	Stop machine	Control Panel		10	8	8	9	8.75
2	Search air gun compressor and dust cloth	Packer Area		33	35	31	59	39.50
3	Emptying Rejection Box	Front Machine area		89	82	101	121	98.25
4	Open the left and right guard	Front Machine area		12	12	18	18	15.00
5	Search Combination wrench 32 mm	Operator table		56	74	63	84	69.25
6	Open rotating head using Combination wrench 32 mm	Rotating Head	Combination wrench 32 mm	40	38	35	32	36.25
7	Clean rotating head using compressed air and dust cloth, then put it back to C800	Rotating Head	Air gun compressor & dust cloth	49	49	57	55	52.50
8	Use compressed air - Belt Infeed Spider	Rotating Head	Air gun compressor	31	34	31	31	31.75
	Use compressed air - CN Stamper	Rotating Head	Air gun compressor	36	23	48	27	33.50
	Use compressed air - Rotating Head	Rotating Head	Air gun compressor	22	22	29	20	23.25
	Use compressed air - Sensor Stamp	Rotating Head	Air gun compressor	38	18	30	22	27.00
	Use compressed air - Infeed Screw	Rotating Head	Air gun compressor	25	25	27	41	29.50
9	Search drill 2 mm and dust cloth	Operator table		108	111	116	144	119.75
10	Clean the hole of applicator CN unit using dust cloth and drill 2 mm	CN area	dust cloth and drill 2 mm	50	38	45	38	42.75

APPENDIX 3 Observation Time of Shiftly Cleaning in Wrapper Machine (continued)

No	Activities	Area	Tools	Observation Time (Sec)				
				Obs 1	Obs 2	Obs 3	Obs 4	Average
11	Clean the holes from glue storage using tweezers, scraper and dust cloth	CN area	Special tool	36	35	36	37	36.00
12	Clean notch and slitting drum using dust cloth	CN area	dust cloth	30	36	28	34	32.00
13	Clean the nozzle tip using dust cloth	CN area	dust cloth	50	43	43	46	45.50
14	Search scraper	glue area of packer		111	107	108	156	120.50
15	Clean sponge and rubber scraper using dust cloth	CN area	dust cloth	38	41	43	44	41.50
16	Clean glue pot from deposit using dust cloth and scraper	CN area	dust cloth And scraper	43	43	40	43	42.25
17	Disassemble stamp basket	Rotating Head		48	50	42	50	47.50
18	Clean rotating folder using dust cloth	Rotating Head	dust cloth	39	40	37	42	39.50
19	Clean parallel pusher	Rotating Head	dust cloth	44	52	49	44	47.25
20	Clean lug belt using dust cloth	Rotating Head	dust cloth	33	37	32	31	33.25
21	Clean packet guides using dust cloth and scraper	Rotating Head	dust cloth and scraper	35	39	39	40	38.25
22	Clean unwinding roller and contrast using dust cloth	unwinding film area	dust cloth	41	36	42	42	40.25
23	Clean half ring using dust cloth	unwinding film area	dust cloth	50	57	56	58	55.25
24	Clean folding block using dust cloth	unwinding film area	dust cloth	45	49	38	48	45.00

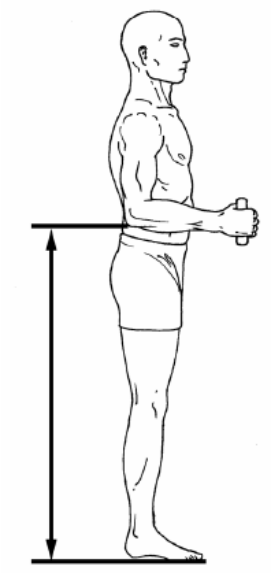
APPENDIX 3 Observation Time of Shiftly Cleaning in Wrapper Machine (continued)

No	Activities	Area	Tools	Observation Time (Sec)				
				Obs 1	Obs 2	Obs 3	Obs 4	Average
25	Clean bottom side of folder using dust cloth	unwinding film area	dust cloth	59	50	60	52	55.25
26	Clean TTR packet roller using dust cloth	TTR packet area	dust cloth	46	44	43	40	43.25
27	Clean heating drum using dust cloth	Sealing wheel area	dust cloth	53	54	49	55	52.75
28	Clean TTR slof roller using dust cloth	TTR slof area	dust cloth	38	43	39	38	39.50
29	Clean vacuum tube in CN/stamper using compressed air	CN area	Air gun compressor	40	38	39	42	39.75
30	Reactive all vacuum and air pressure in the machine	Control Panel		10	10	12	11	10.75
31	Re-threading film unwinding	unwinding film area		28	26	30	25	27.25
32	Put back guard (left & right guard)	Front Machine area		11	16	12	15	13.50
33	Switch on the machine	Control Panel		6	9	5	7	6.75
Total (in sec)				**1523**	**1516**	**1553**	**1692**	**1579.75**
Total (in min)				**25.383**	**25.267**	**25.883**	**28.200**	**26.329**

APPENDIX 4 Anthropometry Measurement from Anthropometric Survey of U.S. Personnel: Summary Statistics Interim Report

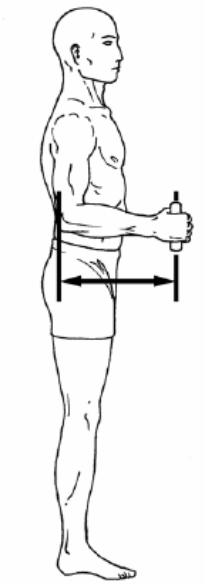
Elbow Rest Height, Standing

FEMALE N = 2208			MALE N = 1774		
Centimeters		Inches	Centimeters		Inches
99.79	Mean	39.29	107.25	Mean	42.22
4.48	Std Dev	1.76	4.81	Std Dev	1.89
118.50	Maximum	46.65	126.10	Maximum	49.65
85.60	Minimum	33.70	88.80	Minimum	34.96
	Percentiles			Percentiles	
89.51	1st	35.24	96.18	1st	37.87
90.80	2nd	35.75	97.56	2nd	38.41
91.58	3rd	36.06	98.40	3rd	38.74
92.63	5th	36.47	99.52	5th	39.18
94.20	10th	37.09	101.21	10th	39.85
95.24	15th	37.50	102.34	15th	40.29
96.06	20th	37.82	103.23	20th	40.64
96.77	25th	38.10	104.00	25th	40.95
97.41	30th	38.35	104.70	30th	41.22
98.00	35th	38.58	105.35	35th	41.48
98.57	40th	38.87	105.97	40th	41.72
99.12	45th	39.02	106.57	45th	41.96
99.67	50th	39.24	107.18	50th	42.20
100.23	55th	39.46	107.78	55th	42.43
100.79	60th	39.68	108.40	60th	42.68
101.38	65th	39.92	109.05	65th	42.93
102.02	70th	40.16	109.73	70th	43.20
102.71	75th	40.44	110.47	75th	43.49
103.49	80th	40.74	111.31	80th	43.82
104.41	85th	41.11	112.28	85th	44.20
105.60	90th	41.57	113.50	90th	44.68
107.40	95th	42.28	115.28	95th	45.39
108.59	97th	42.75	116.41	97th	45.83
109.47	98th	43.10	117.21	98th	46.15
110.87	99th	43.65	118.41	99th	46.62



Elbow-Center of Grip Length

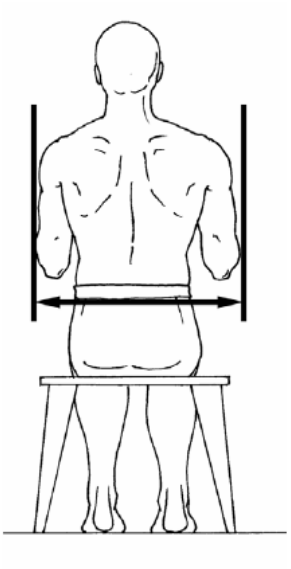
FEMALE N = 2208			MALE N = 1774		
Centimeters		Inches	Centimeters		Inches
32.88	Mean	12.94	36.00	Mean	14.17
1.77	Std Dev	.70	1.79	Std Dev	.70
41.30	Maximum	16.26	43.60	Maximum	17.17
23.70	Minimum	9.33	29.30	Minimum	11.54
	Percentiles			Percentiles	
29.93	1st	11.39	32.26	1st	12.70
29.35	2nd	11.56	32.64	2nd	12.85
29.63	3rd	11.67	32.89	3rd	12.95
30.02	5th	11.82	33.23	5th	13.08
30.63	10th	12.06	33.78	10th	13.30
31.04	15th	12.22	34.16	15th	13.45
31.37	20th	12.35	34.47	20th	13.57
31.66	25th	12.47	34.75	25th	13.68
31.92	30th	12.57	35.00	30th	13.78
32.17	35th	12.66	35.24	35th	13.87
32.40	40th	12.75	35.47	40th	13.97
32.62	45th	12.84	35.70	45th	14.05
32.84	50th	12.93	35.92	50th	14.14
33.06	55th	13.02	36.15	55th	14.23
33.29	60th	13.10	36.39	60th	14.33
33.52	65th	13.20	36.63	65th	14.42
33.77	70th	13.29	36.89	70th	14.52
34.04	75th	13.40	37.18	75th	14.64
34.34	80th	13.52	37.50	80th	14.76
34.69	85th	13.66	37.87	85th	14.91
35.15	90th	13.84	38.35	90th	15.10
35.84	95th	14.11	39.06	95th	15.38
36.29	97th	14.29	39.51	97th	15.55
36.64	98th	14.42	39.83	98th	15.68
37.20	99th	14.64	40.33	99th	15.88



APPENDIX 4 Anthropometry Measurement from Anthropometric Survey of U.S. Personnel: Summary Statistics Interim Report (cont.)

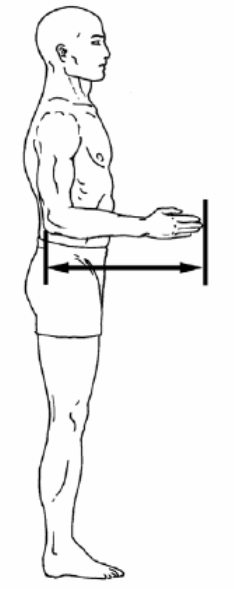
Forearm-Forearm Breadth

FEMALE N = 2208			MALE N = 1774		
Centimeters		Inches	Centimeters		Inches
46.85	Mean	18.44	54.61	Mean	21.50
3.47	Std Dev	1.36	4.36	Std Dev	1.72
60.90	Maximum	23.98	72.52	Maximum	28.54
37.30	Minimum	14.69	39.90	Minimum	15.71
	Percentiles			Percentiles	
39.42	1st	15.52	45.12	1st	17.76
40.24	2nd	15.84	46.17	2nd	18.18
40.76	3rd	16.05	46.84	3rd	18.44
41.47	5th	16.33	47.74	5th	18.80
42.58	10th	16.76	49.16	10th	19.35
43.33	15th	17.06	50.13	15th	19.74
43.94	20th	17.30	50.91	20th	20.04
44.47	25th	17.51	51.59	25th	20.31
44.94	30th	17.69	52.21	30th	20.56
45.39	35th	17.87	52.79	35th	20.79
45.82	40th	18.04	53.35	40th	21.00
46.24	45th	18.20	53.90	45th	21.22
46.66	50th	18.37	54.45	50th	21.44
47.08	55th	18.54	55.00	55th	21.65
47.52	60th	18.71	55.56	60th	21.88
47.98	65th	18.89	56.16	65th	22.11
48.47	70th	19.08	56.79	70th	22.36
49.01	75th	19.30	57.47	75th	22.63
49.63	80th	19.54	58.25	80th	22.93
50.37	85th	19.83	59.16	85th	23.29
51.33	90th	20.21	60.32	90th	23.75
52.84	95th	20.80	62.06	95th	24.43
53.87	97th	21.21	63.18	97th	24.87
54.66	98th	21.52	64.00	98th	25.20
55.95	99th	22.03	65.27	99th	25.70



Forearm-Hand Length

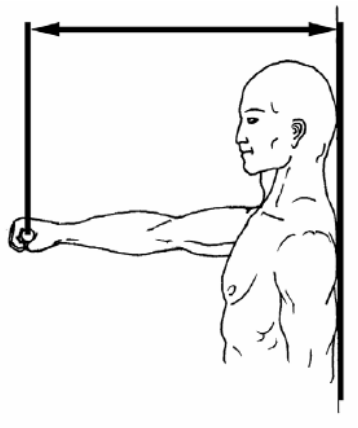
FEMALE N = 2208			MALE N = 1774		
Centimeters		Inches	Centimeters		Inches
44.29	Mean	17.44	48.40	Mean	19.06
2.34	Std Dev	.92	2.33	Std Dev	.92
54.60	Maximum	21.50	57.80	Maximum	22.76
32.40	Minimum	12.76	38.60	Minimum	15.20
	Percentiles			Percentiles	
39.14	1st	15.41	43.43	1st	17.10
39.74	2nd	15.65	43.98	2nd	17.31
40.12	3rd	15.79	44.32	3rd	17.45
40.62	5th	15.99	44.79	5th	17.63
41.38	10th	16.29	45.52	10th	17.92
41.91	15th	16.50	46.02	15th	18.12
42.32	20th	16.66	46.42	20th	18.28
42.69	25th	16.81	46.78	25th	18.42
43.02	30th	16.94	47.10	30th	18.54
43.33	35th	17.06	47.41	35th	18.66
43.63	40th	17.18	47.70	40th	18.78
43.92	45th	17.29	47.99	45th	18.89
44.21	50th	17.41	48.28	50th	19.01
44.51	55th	17.52	48.58	55th	19.12
44.81	60th	17.64	48.88	60th	19.24
45.13	65th	17.77	49.20	65th	19.37
45.47	70th	17.90	49.53	70th	19.50
45.84	75th	18.05	49.91	75th	19.65
46.26	80th	18.21	50.33	80th	19.82
46.74	85th	18.40	50.83	85th	20.01
47.35	90th	18.64	51.46	90th	20.26
48.25	95th	18.99	52.42	95th	20.64
48.81	97th	19.22	53.04	97th	20.88
49.21	98th	19.38	53.49	98th	21.06
49.81	99th	19.61	54.20	99th	21.34



APPENDIX 4 Anthropometry Measurement from Anthropometric Survey of U.S. Personnel: Summary Statistics Interim Report (cont.)

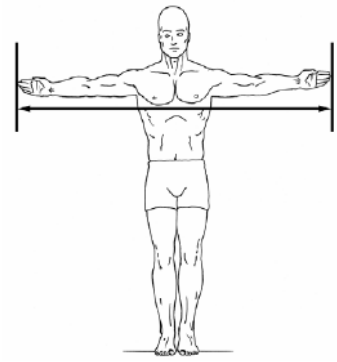
Functional Grip Reach

FEMALE N = 2208			MALE N = 1774		
Centimeters		Inches	Centimeters		Inches
68.61	Mean	27.01	75.07	Mean	29.55
3.39	Std Dev	1.33	3.68	Std Dev	1.45
83.20	Maximum	32.76	92.10	Maximum	36.26
57.50	Minimum	22.64	62.60	Minimum	24.65
	Percentiles			Percentiles	
61.51	1st	24.22	67.26	1st	26.48
62.12	2nd	24.46	68.04	2nd	26.79
62.55	3rd	24.63	68.55	3rd	26.99
63.19	5th	24.88	69.28	5th	27.28
64.26	10th	25.30	70.45	10th	27.74
65.03	15th	25.60	71.27	15th	28.06
65.66	20th	25.85	71.93	20th	28.32
66.22	25th	26.07	72.52	25th	28.55
66.72	30th	26.27	73.05	30th	28.76
67.19	35th	26.45	73.54	35th	28.95
67.64	40th	26.63	74.02	40th	29.14
68.08	45th	26.80	74.49	45th	29.33
68.51	50th	26.97	74.95	50th	29.51
68.95	55th	27.15	75.42	55th	29.69
69.40	60th	27.32	75.90	60th	29.88
69.86	65th	27.50	76.40	65th	30.08
70.34	70th	27.69	76.92	70th	30.29
70.87	75th	27.90	77.50	75th	30.51
71.46	80th	28.14	78.15	80th	30.77
72.15	85th	28.41	78.91	85th	31.07
73.03	90th	28.75	79.87	90th	31.45
74.36	95th	29.27	81.31	95th	32.01
75.24	97th	29.62	82.25	97th	32.38
75.90	98th	29.88	82.94	98th	32.65
76.97	99th	30.30	84.03	99th	33.08



Span

FEMALE N = 2208			MALE N = 1774		
Centimeters		Inches	Centimeters		Inches
167.19	Mean	65.82	182.31	Mean	71.77
8.13	Std Dev	3.20	8.19	Std Dev	3.23
196.80	Maximum	77.48	215.90	Maximum	85.00
135.60	Minimum	53.39	147.40	Minimum	58.03
	Percentiles			Percentiles	
148.81	1st	58.89	164.79	1st	64.88
151.02	2nd	59.46	166.53	2nd	65.56
152.38	3rd	59.99	167.68	3rd	66.02
154.21	5th	60.71	169.31	5th	66.66
157.00	10th	61.81	171.94	10th	67.69
158.88	15th	62.55	173.78	15th	68.42
160.37	20th	63.14	175.28	20th	69.01
161.67	25th	63.65	176.60	25th	69.53
162.85	30th	64.11	177.80	30th	70.00
163.94	35th	64.54	178.92	35th	70.44
164.98	40th	64.95	179.99	40th	70.86
166.00	45th	65.36	181.04	45th	71.28
167.02	50th	65.76	182.09	50th	71.69
168.04	55th	66.16	183.14	55th	72.10
169.09	60th	66.57	184.21	60th	72.52
170.18	65th	67.00	185.32	65th	72.96
171.33	70th	67.45	186.50	70th	73.42
172.60	75th	67.95	187.77	75th	73.93
174.02	80th	68.51	189.21	80th	74.49
175.67	85th	69.16	190.86	85th	75.14
177.76	90th	69.99	192.96	90th	75.97
180.86	95th	71.20	196.03	95th	77.18
182.84	97th	71.98	197.99	97th	77.95
184.27	98th	72.55	199.42	98th	78.51
186.45	99th	73.41	201.62	99th	79.38



APPENDIX 5 SOP of Cleaning Packer Machine

PT XY	PT XY Management System Document Shiftly Cleaning Procedure for Packer Machine		Effective date: 2016
	Doc. N°:	Doc. Type: Standard Operation Procedure (SOP)	Revision: 00	Page 1 of 1

Description:

This SOP has a purpose to :

Make sure Operator follows the Shiftly cleaning process in Packer Machine

Procudure :

No	Activity	Area	Tools
1	Operator prepare the tools need in Tools Cabinet. All the tools should be completed. (Dust cloth, Scrapper, Tweezers, Combination wrench 32mm, Round brush, Brass brush, Vacuum cleaner, Drill 2mm). And make sure the air gun compressor can reach all area or Wrapper machine.	-	Tools Cabinet
2	Operator clean rejected product in Rejection Box	Foil Unit	-
3	Operator stops switch Packer machine into clearing mode, turn off vacuum, compressed air and open the upper guard	Control Panel	-
4	Opertor takes out lower right guard and lower center guard. Then takes out 1st 5th wheel guide. Next the operator clean parts in wheel area (folding hopper 5th wheel, fixed guide 5th wheel, guide, 5th wheel pocket, blank platform and guide.	Wheel	Scrapper and dust cloth
5	Operator cleans blank pusher, mobile elements, 3rd blank drum, 2 drum blank.	Drum Blank	Dust cloth and brass brush
6	Operators firstly take out the glue pot and open cover of pot. Then, clean pot cover, roller, and glue pot. Next operator put glue pot after cleaning and set it to "ready" mode	Glue Area	tweezers, scrapper, dust cloth, and brass brush
7	Operator cleans distributor unit and packet exit plate	Distributor Area	Scrapper and dust cloth
8	Operator releases alufoil material from valve, and open alufoil cutting valve, then clean it. After cleaning, cutting valve is assembled back to machine.	Foil Unit	Roller Brush
9	Operator opens innerframe cutting and notching, then clean it.	Innerframe	Roller Brush
10	Operator shuts down laser marker vacuum	Coding Unit	
11	Operator opens the extractor guard. Then, taking out vacuum tube to clean it. Also clean filter, carousal pocket, dry beam and extractor	Extractor	Compressed Air gun
12	Operator clean 5th, 4th, 3rd wheels	Wheel	Compressed Air gun
13	Operator clean foil valve, and 3rd, 2nd drum	Foil Unit	Compressed Air gun
14	Operator turns the vacuum on	Control Panel	-
15	Re-threading Alufoil Material	Foil Unit	-
16	Operator locks all the guard, and switches on machine.	Control Panel	-
17	After finish cleaning, operator should put tools in its location in tool cabinet	-	-

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APPENDIX 6 SOP of Cleaning Wrapper Machine

PT XY	PT XY Management System Document Shiftly Cleaning Procedure for Wrapper Machine		Effective date: 2016
	Doc. N°:	Doc. Type: Standard Operation Procedure (SOP)	Revision: 00	Page 1 of 1

Description:
This SOP has a purpose to :
Make sure Operator follows the Shiftly cleaning process in Wrapper Machine

Procudure :

No	Activity	Area	Tools
1	Operator prepare the tools need in Tools Cabinet. All the tools should be completed. (Dust cloth, Scrapper, Tweezers, Combination wrench 32mm, Round brush, Brass brush, Vacuum cleaner, Drill 2mm). And make sure the air gun compressor can reach all area or Wrapper machine.	-	Tools Cabinet
2	Operator clean rejected product in Rejection Box	Front Machine	-
3	Operator Stops Wrapper Machine	Control Panel	-
4	Operator opens left and right guards	Front Machine	-
5	Operator opens rotating head, and clean it. After cleaning, rotating head is re-assemble to machine. Then operator cleans belt infeed spider, CN stamper, rotating head, sensor stamps infeed screw. Using compressed air. Operator disassembles stampt basket and clean it. Operator also cleans rotating folder, parallel pusher, lug belt, and packet guide. After cleaning all parts, operator assembles stamp basket	Rotating Head Area	Wrench 32 mm, dust cloth, compressed air and srapper
6	Operator cleans Unwinding roller and contrast, half ring, folding block, and bottom side of folder	Unwinding Film Area	Dust cloth
7	Operator cleans TTR packet roller	TTR Packet Area	Dust cloth
8	Operator cleans heating drum	Sealing Wheel Area	Dust cloth
9	Operator cleans TTR slof roller	TTR Slof Area	Dust cloth
10	Operator cleans hole of applicator CN unit, and hole from glue storage. Operator also cleans notch and slitting drum, nozzle tip, sponge and rubber, glue pot from deposit, and vacuum tube in CN/stamper	CN Area	Dust cloth, drill 2 mm, tweezer, scrapper, and compressed air
11	Operator reactives all vacuum and air pressure	Control Panel	-
12	Operator re-threading the film material into vacuum	Unwinding Film Area	-
13	Operator puts and locks left and right guards	Front Machine	-
14	Operator turns on Wrapper machine	Control Panel	-
15	After finish cleaning, operator should put tools in its location in tool cabinet	-	-

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