FINAL PROJECT – TI 141501

# BENEFIT-COST ANALYSIS TO EVALUATE ALTERNATIVE TECHNOLOGIES FOR VALUE-ADDED SERVICES IN WAREHOUSE

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## APPROVAL SHEET

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## FINAL PROJECT

Proposed as a Requisite to Graduate in Industrial Engineering Major and to
Achieve a Bachelor Degree in Department of Industrial Engineering
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## ABSTRACT


Improved technology along with emerged international policies lead to a phenomenon called globalization. This phenomenon increases competitiveness in all industrial sectors, as well as in logistics. One of Indonesian private companies who provide logistics service is Kamadjaja Logistics. One of warehouses owned by Kamadjaja Logistics is located in Surabaya. Besides warehousing service, the warehouse provides value-added services; such as taping and labeling. The sequences of taping process are bundling, taping, and finishing which are done manually by 89 direct labors.

Due to the slow operation and high labor cost of manual taping process, then several automation technologies are proposed. This research is focused to improve performance of taping service provided by Kamadjaja Logistics in such a way that it can achieve faster processing time and reduced cost by increasing resources efficiency through implementation of automation technology. Stopwatch time study approach is conducted to measure standard time of manual taping process. Then, automated technologies are assessed by using benefit-cost analysis. Sensitivity analysis is also conducted to accommodate uncertainty factors. The result is EntrePack Automatic SW-1713 L-Bar Shrink Wrap Machine (Alternative 1) is the best solution by delivering additional benefit of IDR 129.71 per bundle and reduces cost of IDR 20.92 per bundle.



**Keyword**: Benefit-cost analysis, sensitivity analysis, stopwatch time study, value-added service, warehouse

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The author recognizes that this research is far from perfection. Constructive suggestions and critics will be highly appreciated. May this research deliver usefulness for both academic and practical world.

Surabaya, January 2017

Author

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# CHAPTER I
# INTRODUCTION

This chapter is essential in introducing the initial stages of research. Introduction consists of research background, problem formulation, objectives, benefits, scope of research, and report outline.

## 1.1 Research Background

Improved technology along with emerged international policies lead to a phenomenon called globalization (Pettinger, 2013). Improved technology covers both intangible and tangible technologies. For examples, intangible technology is information technology such as internet; while tangible technology is in the form of mechanical such as machine, vehicle, etc. Furthermore, most of countries made policies and agreements that ease the process of goods and services flows among countries. This leads into interdependency among countries and the speed up of globalization process. Due to the reduced barriers and supportive technologies in the industry, the competitiveness is undoubtedly increasing (Mohaghegh, 2016). Slack et al in Gunasekaran et al (2001) suggest several factors that can attract customers and become competitive advantage; those are cost, quality, speed of delivery (response time), and flexibility. Moreover, innovation and sustainability are also potential to become competitive advantage.

Competitiveness occurs in all industrial sectors, as well as in logistics. According to Eurocham Annual Position Paper (2013), logistics costs in Indonesia are calculated to almost 26% of national GDP. Breakdown of Indonesian logistics cost is shown in Figure 1.1. Along the years, inventory cost steadily contributes at least one-third of total logistics cost. This condition challenges Indonesia's companies who provide warehousing service (inventory) to be both efficient and keep competitive.

One of Indonesian private companies who provide logistics service is Kamadjaja Logistics. As one of the biggest players in this sector, Kamadjaja Logistics operates at least 25 distribution centers across Indonesia and 3 K-Log

Park as integrated logistics facility in certain cities; those are Cibitung, Medan, and Surabaya (Halim, 2016). One of distribution centers owned by Kamadjaja Logistics is located in Surabaya. The warehouse covers area of 7,000 $m^2$. It is a dedicated warehouse only for fast moving consumer goods (FMCG); such as soap, toothpaste, etc. All products are stored there for a while before being distributed for abroad markets.

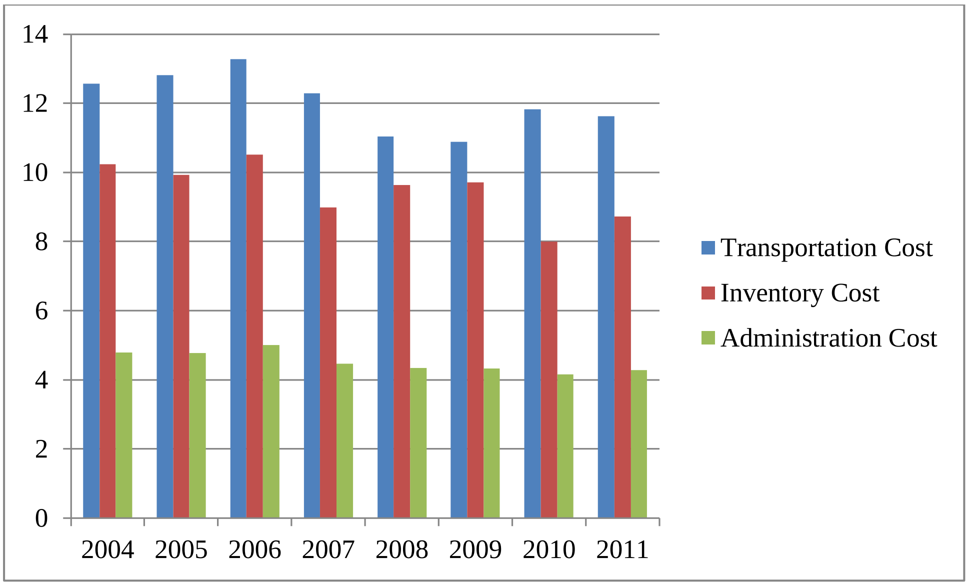


Figure 1. 1 Breakdown of Indonesian Logistics Cost (Bahagia, Sandee, & Meeuws, 2013)

As daily needs, FMCG contribute a large portion of consumers' budget in every country, where high quality and low cost become the main preference (Çelen, Erdogan, & Taymaz, 2005). According to those conditions, fast moving consumer goods are classified into functional product. Some characteristics of functional product are predictable demand and low profit margin (Susman, 2004). Along with population growth, demands of fast moving consumer goods are increasing progressively. However, warehouse's capacity is already fixed and improvement is needed to handle this situation. Application of mass production will help to achieve higher profit margin. Also in response to both issues, the FMCG manufacturer should implement efficient supply chain strategy where Kamadjaja Logistics takes part there.

Purpose of efficient supply chain strategy is to manage material flow to minimize inventories and especially maximize efficiency in the chain (Li, 2007). Moreover, efficient supply chain strategy is suitable in achieving low-cost operation and on-time delivery. This strategy is appropriate to be implemented in the warehouse which has several inventory issues; such as overload capacity, dealing with massive scale of products, inaccurate inventory data, and many material flow processes (inbound and outbound) on a daily basis.

Running efficient supply chain strategy alone is not enough. The aid of sophisticated technologies in warehouse can significantly solve inventory issues experienced by Kamadjaja Logistics. However, the available technologies also vary enormously based on warehouse's needs and targeted objectives. This leads to the need of customization and large investment. In this case, automation technology is proposed as the possible alternative to solve these issues. Implementation of the right automation technology will reduce human operators needed and make processes' time faster as well (Lamb, 2013).

This research is focused to improve performance of value-added services provided by Kamadjaja Logistics in such a way that it can achieve faster process time and reduced cost by increasing resources efficiency through implementation of automation technology. Possible automation technologies are proposed in order to solve difficulties in value-added services. Then, every alternative of possible automation technologies is evaluated by using benefit-cost analysis approach. Effects of automation technology implementation to warehouse performance are also measured in attempt to determine the best investment decision.

## 1.2 Problem Formulation

In accordance with research background in previous subchapter, this research attempts to evaluate the proposed automation technologies for value-added services in warehouse owned by Kamadjaja Logistics based on assessment of benefit-cost analysis and its impacts on warehouse performance; mainly response time and efficiency.

## 1.3 Research Objectives

Several objectives are arranged prior to this research. Those objectives are as follow.

- To identify existing condition and develop alternatives of automation technology for value-added service which suitable to the needs of Kamadjaja Logistics.
- To determine the best alternative of automation technology by using benefit-cost analysis approach and its impact on warehouse performance.

## 1.4 Research Benefits

The following benefits are expected to be obtained from this research; those are as follow.

- Company will understand automation technologies for value-added services which are suitable to improve current warehouse performance.
- Company will has sufficient information before investing on automation technology.
- Company will be able to reduce human operators needed and has faster response time by implementing automation technology.

## 1.5 Research Scope

In keeping the research reliable and valid, some limitations and assumptions are specified prior to the research.

### *1.5.1 Limitation*

This research is considered to be reliable under a limitation. The limitations are as follow.

- Warehouse of Kamadjaja Logistics that is observed is one of warehouses located in Surabaya.
- Opportunity cost is not included in the calculation.

### *1.5.2 Assumption*

Some aspects are assumed in the beginning to assist research validity. Assumptions which are defined for this research are as follow.

- Currency of USD 1 is equal to IDR 13,500.
- Currency of GBP 1 is equal to IDR 16,875
- Currency of EUR 1 is equal to IDR 13,970
- Inflation rate in Indonesia is 5%.

## 1.6 Report Outline

In order to show the big picture of this research, brief explanation of report outline is described as follows.

- CHAPTER I: INTRODUCTION

  The initial chapter covers research background, problem formulation, objectives, benefits, scope of research, and report outline. A thorough outline of this report is provided in the end of this chapter.
- CHAPTER II: LITERATURE REVIEW

  Related theories are elaborated in the second chapter in order to support research comprehension. These theories are collected from reliable literatures. Subjects in literature review are warehouse management, fast moving consumer good, time study, review of automation technologies, benefit-cost analysis, and sensitivity analysis.
- CHAPTER III: RESEARCH METHODOLOGY

  Research methodology are specified in this chapter. Research methodology will guide the research processes systematically. It is shown in a flowchart and followed by description of each process.
- CHAPTER IV: DATA COLLECTION AND PROCESSING

  The fourth chapter shows data gathered from observation, literatures, and historical data. Then, these data are processed based on methodology which is stated in previous chapter.
- CHAPTER V: ANALYSIS AND INTERPRETATION

  Results of data processing in previous chapter are analyzed and interpreted in the fifth chapter. The analysis and interpretation will lead to conclusions that necessary for the company.
- CHAPTER VI: CONCLUSION AND RECOMMENDATION

The last chapter gives conclusions which answer the research objectives. Recommendations are also provided for the research topic and further research.

# CHAPTER II
# LITERATURE REVIEW

Related theories are elaborated in this chapter in order to support research comprehension. These theories are collected from reliable literatures. Subjects in literature review are warehouse management, fast moving consumer goods, warehouse performance, time study, review of automation technologies, gap analysis, benefit-cost analysis, and sensitivity analysis.

## 2.1 Warehouse Management

Warehouse is a temporary place to store products (Richards, 2014). Basic operations in warehouse are not significantly change over time. Those operations are receiving products into warehouse, processing orders, replenishing, and dispatching the products. Some warehouses also provide bundling or re-packaging services. All of these operations are simplified into terms of inbound process, outbound process, and value-added service. Warehouse management tries to operate each process efficiently (Hompel & Schmidt, 2007).

In general, inbound process starts when truck from supplier arrives in warehouse. Truck will head into receiving dock and start the unloading process. Operator will check whether all physical products are match with list on delivery note. Inspection is also conducted during this process. If all are good, then operators will receive the products, update inventory data, and put-away to the specified location in warehouse.

Outbound process occurs when there is order from customer. Operator will pick specified products and gather it all in packing and shipping area. Then, inventory data will be updated and products will be loaded for shipment. Value-added service is certain kind of services provided by warehouse in order to give added value for stored products. Most common value-added services are bundling, re-packaging, and taping.

## 2.2 Fast Moving Consumer Goods

Fisher (1997) classified products into two main categories; those are functional product and innovative product. Fast moving consumer goods (FMCG) is an example of functional product. Some characteristics of functional product are long product life cycle (more than 2 years), less variation, easily forecasted with high accuracy (stable demand), stock out rate less than 2%, there is no markdown, and low profit margin per unit. These characteristics fit with FMCG products; such as soap, toothpaste, shampoo, and detergent.

As functional product, then implementation of efficient supply chain strategy is highly recommended than responsive strategy (Pujawan & Mahendrawathi, Supply Chain Management, 2010). Since functional products only generate low profit margin per unit, then efficient strategy focus on minimizing physical and operational cost. Then as the results of cost reduction, company can decide between reducing price to attract more customers (market expansion) or set the same price with higher profit margin (Sumanth, 1984).

## 2.3 Time Study

Time study defines the principles of work measurement in order to determine standard time to finish a particular work (Wignjosoebroto, 2006). Time study is divided into two parts; those are direct time study and indirect time study. Direct time study measures the work directly by using certain methods. These methods are stopwatch time study and work sampling. While as its name, indirect time study measures the work indirectly through some approaches. The approaches are data standard, regression analysis, and predetermined motion time system. Explanation of stopwatch time study and work sampling is shown as follows.

### *2.3.1 Stopwatch Time Study*

Stopwatch time study is appropriate to be implemented in short and repetitive work. Systematic sequences of stopwatch time study application are as follow.

- Define type of work being observed and gather information related to work completion

- Classify work operation into detailed elements
- Observe, measure, and take note the time needed by operator in finishing the work
- Determine number of work cycle to be measured
- Conduct uniformity and adequacy tests
- Set performance rating of operator’s activities, then adjust time with the performance rating
- Determine allowance time and calculate standard time

### *2.3.2 Work Sampling*

Besides determining standard time, work sampling can be used in measuring delay ratio (idle-work) of machines, operators, and facilities. Work sampling also determines performance level of operator during his working hours. Systematic sequences of work sampling application are as follow.

- Plan the schedule for observation based on randomization principle
- Do pre-work sampling randomly
- Calculate the pre-work sampling result for certain observation
- Conduct uniformity and adequacy tests
- Calculate degree of accuracy
- Analyze the result and make conclusion

## 2.4 Review of Automation Technology

Groover (2001) suggests that automation can be defined as an integrated technology which applies mechanical, electronic, and computer principles in order to operate and control particular production system. An automation technology should has at least power source, instruction program, and control system. Automation technologies are varying and developed along with time. Due to high investment and flexible customization of automation technology, then the decision should consider several aspects. Through literature study, some automation technologies are proposed to be implemented in assisting warehouse operations. Those technologies are as follow.

### *2.4.1 EntrePack Automatic SW-1713 L-Bar Shrink Wrap Machine*

It is an automated machine which is design for both sealing and shrinking products (EntrePack, 2013). Some of the feature are touch screen control, adjustable height that fits variety of products, and safety guards. Its maximum speed reaches 25 pieces per minute.

Figure 2. 1 EntrePack Automatic SW-1713 L-Bar Shrink Wrap Machine

### *2.4.2 Gramegna Model ECO 2000 Shrink Bundler*

The Gramegna’s machine is compatible to handle wrapping and shrinking operations (Gramegna, n.d.). Its features are flexible for almost all variants of product with good quality outputs.

Figure 2. 2 Gramegna Model ECO 2000 Shrink Bundler

### *2.4.3 Prometica Sleeve Wrapping Heat Sealing Machine*

It can be used for wrapping, sealing, and shrinking wide range of products (Prometica, 2015). The advantage of Prometica machine is its low energy consumption.

Figure 2. 3 Prometica Sleeve Wrapping Heat Sealing Machine

### *2.4.4 Comparison of Automation Technologies*

In order to compare the proposed automation technologies, information of all technologies are elaborated. The information are classified into several categories; those are cost elements and technical data. These information are obtained from literature review and preliminary quotation.

Table 2. 1 Comparison of Proposed Automation Technologies

| **Category** | **Product** | | |
|---|---|---|---|
| | **EntrePack** | **Gramegna** | **Prometica** |
| Country | USA | Italy | England |
| Price | $ 16,875 | £ 9,713 | £ 9,746 |
| | IDR 224,808,750 | IDR 157,468,763 | IDR 158,015,951 |
| Shipping Cost | $ 975 | € 1,500 | £ 2,363 |
| | IDR 12,988,950 | IDR 21,162,000 | IDR 38,303,213 |
| Annual Maintenance Cost | | | £ 1,575 |
| | | | IDR 25,535,475 |
| Lifetime (years) | | | 12 |
| Machine Length (mm) | 3,124 | - | 2,120 |
| Machine Width (mm) | 838 | - | 1,360 |
| Machine Height (mm) | 1,549 | - | 1,900 |
| Weight (kg) | 435 | - | 465 |

| Category | Product | | |
|---|---|---|---|
| | **EntrePack** | **Gramegna** | **Prometica** |
| Speed (pcs / minute) | 25 | 10 – 20 | 6 – 14 |
| Power (kw) | 8.8 | 20 | 2 |
| Package Material | PVC, POF, PP | PP, PE | PVC, PE |

## 2.5 Benefit-Cost Analysis

Benefit-cost analysis is a policy assessment method that quantifies in monetary terms the value of all policy consequences to all members of society (Boardman, Greenberg, Vining, & Weimer, 2001). In benefit-cost analysis, all the costs and benefits are considered to society as a whole. The basic formula is as follows.

$$NSB = B - C \qquad \text{[Equation 2.1]}$$

where:

$NSB$ = net social benefits

$B$ = social benefits

$C$ = social costs

Purposes of benefit-cost analysis are to help social decision-making and to facilitate more efficient allocation of society's resources. The basic steps of benefit-cost analysis are as follow.

a. Specify the set of alternative projects.
b. Decide whose benefits and costs count (standing).
c. Catalogue the impacts and select measurement indicators (units).
d. Predict the impacts quantitatively over the life of the project.
e. Monetize (attach dollar values to) all impacts.
f. Discount benefits and costs to obtain present values.
g. Compute the net present value (NPV) of each alternative.
h. Perform sensitivity analysis.
i. Make a recommendation based on the NPV and sensitivity analysis.

However, in order to compare several alternatives, it is recommended to use incremental benefit-cost analysis (Pujawan, 2012). First, calculate the ratio between benefit and cost of each alternative individually. Eliminate alternative whose benefit-cost ratio is less than one. Then, conduct incremental benefit-cost analysis starts from alternative with the lowest investment. The formula of incremental benefit-cost analysis is as follows.

$$B/C_{M-N} = \frac{\Delta b}{\Delta c} \qquad \text{[Equation 2.2]}$$

where:

$B/C_{M-N}$ = incremental benefit-cost analysis between alternative M (higher investment) and alternative N (lower investment)

$\Delta b$ = differences of benefit between alternative M and alternative N (unit/hour)

$\Delta c$ = differences of cost between alternative M and alternative N (IDR)

If the result is more than one, then choose alternative with higher investment. However if the result is less than one, then choose alternative with lower investment.

### *2.5.1 Benefit Assessment*

Due to the fact that some of benefits are explained in a non-cost measurement, then benefit assessment should be conducted. The purpose is to obtained standard conversion from benefit into cost unit. For example, benefits are usually shown in increasing of output, saving time, reducing labor, etc. These non-cost measurements will be converted into cost measurement by certain standardizations.

- Increasing output

  Increasing output can be converted by using cost per unit. Cost per unit is multiplied by difference of increasing unit of output.

- Saving time

  Saving time is assumed as benefit since labor can do other works and generate more outputs in the same time. It also can increase customer satisfaction due to faster response time.

- Reducing labor

  Calculation for labor reduction involves labor's wage per month and number of labor reduced.

## 2.6 Sensitivity Analysis

Sensitivity analysis is used in decision-making process. It assists decision makers against uncertainty aspects. Different value of certain parameters may leads to different decision to be chosen (Clemen, 1996). Therefore, sensitivity analysis tries to determine the point of indifference. Point of indifference shows each decision alternative will deliver the same consequences. Sensitivity analysis also shows the effect of increasing certain value will give significant impact or not. Types of sensitivity analysis are one-way, two-way, and two-way sensitivity analysis for three alternatives.

## 2.7 Previous Research

There are several previous researches which are using benefit-cost analysis approach to solve the problem. Those researches are as follow.

Table 2. 2 Comparison of Previous Researches and Current Research

| | **Previous Research** | | | **This Research** |
|---|---|---|---|---|
| **Year** | 2016 | 2016 | 2016 | 2016 |
| **Type** | Undergraduate research | Undergraduate research | Undergraduate research | Undergraduate research |
| **Author** | Nurulita Aisyah | Mushonnifun Faiz Sugihartanto | Joshua Triputro Nugroho | Vincentius Kaisar Vishnu |
| **Title** | Analysis of Municipal Waste Transportation Mode Alternatives in Surabaya | Analisis Cost and Benefit antara Sistem Palletizing Delivery dan Non-Palletizing Delivery pada Sistem Pergudangan PT Unilever Rungkut Surabaya | Reduksi Waste pada Proses Produksi Pasta Gigi PT. X dengan Konsep Lean Production dan Benefit Cost Ratio | Benefit-Cost Analysis to Evaluate Alternative Technologies for Value-Added Services in Warehouse |
| **Object** | Municipal waste management by using arm roll truck | Unloading process in warehouse for raw material storage of FMCG | Waste management in production floor | Taping services provided by warehouse |
| **Methods** | Technical, financial (benefit-cost ratio, IRR, NPW), operations | Work sampling, workload analysis, benefit-cost analysis, sensitivity analysis | Value Stream Mapping, Borda Count Method, Root Cause Analysis, | Stopwatch ime study, WACC, benefit-cost analysis, sensitivity analysis |

| | Previous Research | | | This Research |
|---|---|---|---|---|
| | analysis | | FMEA, benefit-cost ratio | |
| **Output** | Best alternative of compactor selection | Best alternative for unloading method and number of operator | Causes of waste (critical waste) and proposed improvements | Best alternative of automation technology |
| **Parameter** | Cost, emission | Workload of operators, cost | Cost, productivity | Cost, efficiency, time |

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# CHAPTER III
# RESEARCH METHODOLOGY

Research methodology are specified in this chapter. Research methodology will guide the research processes systematically. It is shown in a flowchart and followed by description of each phase.

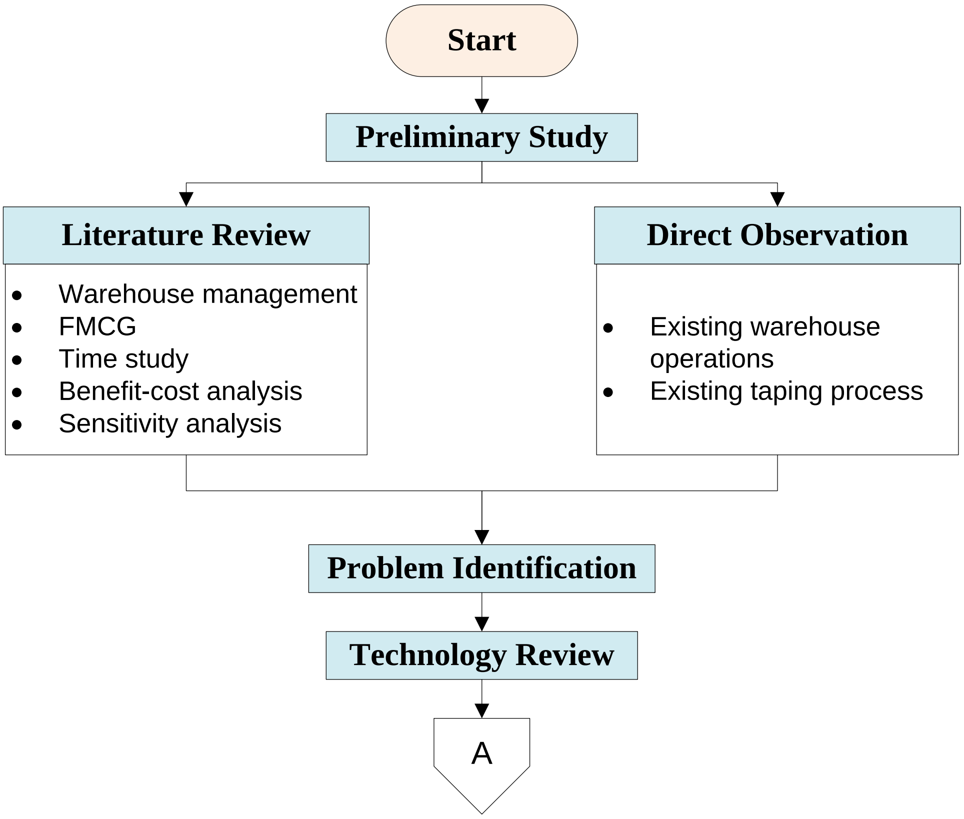


Figure 3. 1 Flowchart of Research Methodology

## 3.1 Preliminary Study

This research begins with preliminary study. It involves direct observation conducted by the author. Observation is done in a warehouse owned by Kamadjaja Logistics. A thorough observation is necessary in order to identify problems existed in value-added services of the warehouse. As problems are identified, author will conduct literature search related to the topic. Appropriate literatures are reviewed in order to support the research. These literatures are gathered from reliable sources; such as books, journals, and online sources. There is also review of automation technologies related to problem identified. The automation technology information is obtained from developer's website and benchmarking.

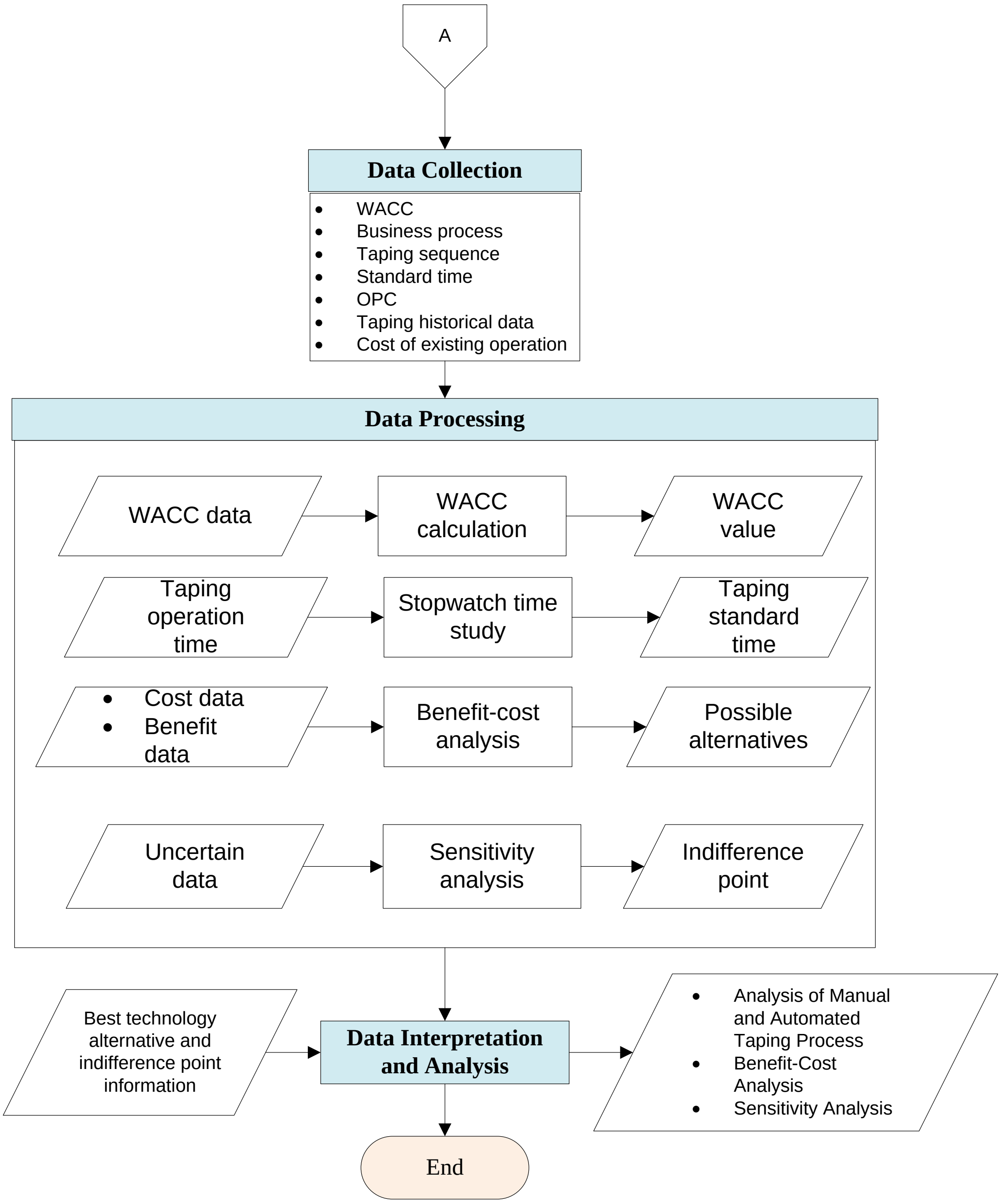


Figure 3. 2 Flowchart of Research Methodology (cont'd)

## 3.2 Data Collection Phase

In data collection phase, author is responsible in gathering necessary data for the research. Those data are related to value-added services in the warehouse; such as WACC, business process, taping sequence, standard time, OPC, etc. These data can be obtained from direct measurement, historical data, and literatures as well.

## 3.3 Data Processing Phase

Data processing consists of WACC calculation, stopwatch time study, benefit-cost analysis, and sensitivity analysis. These processes are done sequentially.

### *3.3.1 WACC Calculation*

Before going further into benefit-cost analysis, weighted average cost of capital (WACC) should be calculated in the beginning. Then, conduct assessment to obtain the components of benefit and cost. Finally, benefit-cost analysis can be calculated. WACC measures company's cost to borrow money based on proportion of debt and equity that the company has taken on. In this research, WACC will be the determination for company whether to invest or not. The formula of WACC is as follows.

$$WACC = \left(\frac{E}{V}\ x\ Re\right) + \left[\frac{D}{V}\ x\ Rd\ x\ (1 - Tc)\right] \qquad \text{[Equation 3.1]}$$

where:

E/V = percentage of financing that is equity

Re = cost of equity

D/V = percentage of financing that is debt

Rd = cost of debt

Tc = corporate tax rate

### *3.3.2 Benefit-Cost Analysis*

Components of benefit involve increasing efficiency (reduction of labor), higher productivity (more outputs), smaller area utilization, and faster operation. While components of cost are investment cost, maintenance cost, and operational cost.

$$B/C = \frac{(Benefit) - (Operational\ \&\ maintenance\ cost)}{Investment\ cost} \quad \text{[Equation 3.2]}$$

Benefit-cost analysis is done by using incremental benefit-cost analysis as explained in previous chapter.

$$B/C_{M-N} = \frac{\Delta b}{\Delta c} \quad \text{[Equation 3.3]}$$

where:

$B/C_{M-N} =$ incremental benefit-cost analysis between alternative M (higher investment) and alternative N (lower investment)

$\Delta b =$ differences of benefit between alternative M and alternative N (unit/hour)

$\Delta c =$ differences of cost between alternative M and alternative N (IDR)

### *3.3.3 Sensitivity Analysis*

Sensitivity analysis will focus on interest rate and technology utilization. There are two approaches used; those are one-way sensitivity analysis for each factor and two-way sensitivity analysis for both factors.

## 3.4 Data Interpretation and Analysis Phase

Results obtained from data processing will be interpreted and analyzed in this phase. Analysis on result of benefit-cost analysis is done by focusing on the calculation result. If it is more than 1, then the alternative will give benefit to the company. If it is less than 1, then the alternative will be rejected. However, if both alternatives have value more than 1, then incremental benefit-cost analysis will assist the decision process. After that, sensitivity analysis on inflation rate will show that the change of certain values may change the final decision.

# CHAPTER IV
# DATA COLLECTION AND PROCESSING

This chapter is classified into two main subchapters; those are data collection and data processing. Data collection will elaborate all related data which were collected from direct observation, literature study, and historical data. Then in data processing, those data will be processed following the aforementioned research methodology.

## 4.1 Data Collection

Data collection covers several subchapters; those are weighted average cost of capital, business process mapping of taping process, stopwatch time study of manual taping process, operation process chart of manual taping process, and demand forecasting of taping process.

### *4.1.1 Weighted Average Cost of Capital*

In determining the value of Weighted Average Cost of Capital (WACC), data about percentage of equity (E/V) and debt (D/V) are needed. Since Kamadjaja Logistics did not provide those data, then the data will follow another company's data from the same sector; that is DHL. The following are data from DHL's balance sheet of 2015 Annual Report (DHL Investor Relations, 2016).

$$Equity\ (in\ €\ million) = 11{,}295$$

$$Debt\ (in\ €\ million) = 26{,}575$$

Then the value of E/V and D/V can be calculated. Other data are also needed for the calculation of WACC; those are cost of equity (Re), cost of debt (Rd), and corporate tax rate (Tc).

$$E/V = \frac{Equity}{Equity+Debt} = \frac{11{,}295}{37{,}870} = 29.83\% \approx 30\%$$

$$D/V = \frac{Debt}{Equity+Debt} = \frac{26{,}575}{37{,}870} = 70.17\% \approx 70\%$$

$$Re = 27\%$$

$$Rd = 4.5\%$$

$$Tc = 25\%$$

$$WACC = \left(\frac{E}{V}\ x\ Re\right) + \left[\frac{D}{V}\ x\ Rd\ x\ (1 - Tc)\right]$$

$$WACC = (30\%\ x\ 27\%) + [70\%\ x\ 4.5\%\ x\ (1 - 25\%)]$$

$$WACC = 10.5\%$$

### *4.1.2 Business Process Mapping of Taping Process*

Taping process is done manually by more than 80 labors. These labors are called as tapper. Besides tapper, in total there are 5 sections who take responsibility during taping process; those are customer, warehouse admin, taping coordinator, tapper, and packer. Business process of taping process is mapped by using cross-functional (swim-lane) approach as follows.

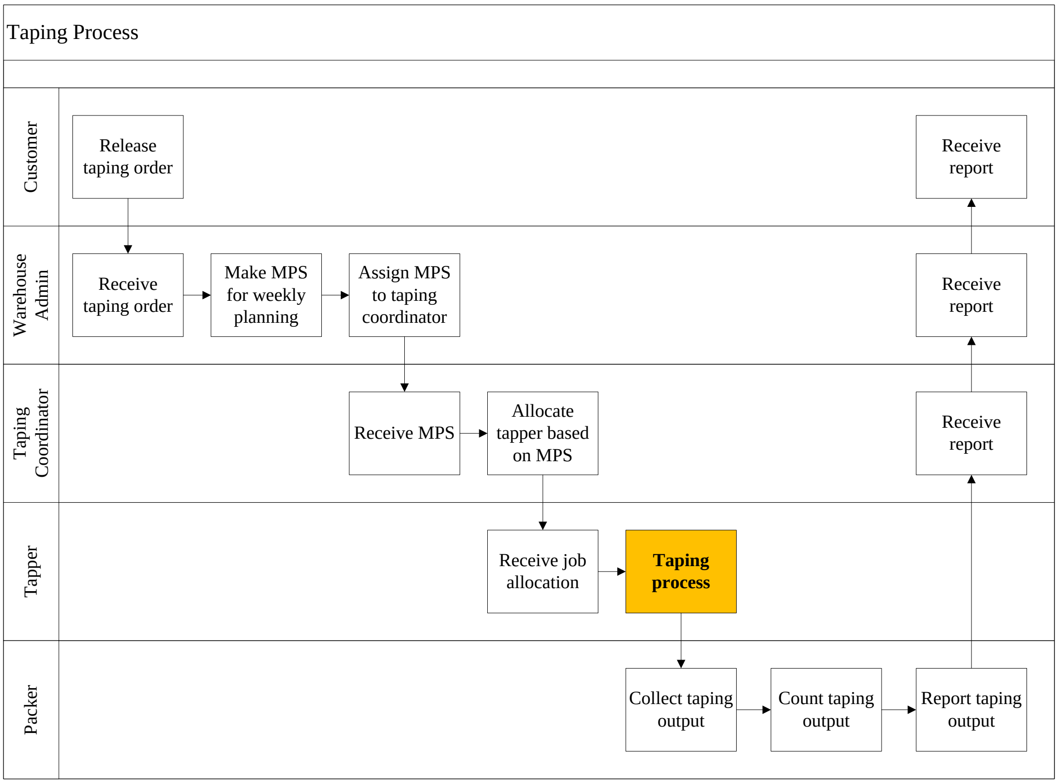


Figure 4. 1 Business Process of Taping Process

The process is triggered by customer order to Kamadjaja Logistics. Warehouse admin who receives the order will directly make MPS for weekly planning based on production capacity. Then, warehouse admin will assign the

MPS to taping coordinator. Taping coordinator will allocate the job to tapper and manage the production during taping process. Outputs of taping process are collected and counted by packer. Finally, recapitulation of production output is reported to taping coordinator, warehouse admin, and customer consecutively. Here taping coordinator, tapper, and packer are classified as direct labors.

#### *4.1.3 Stopwatch Time Study of Manual Taping Process*

Stopwatch time study is focused mainly on manual taping process. The purpose of stopwatch time study is to measure the standard time of manual taping process. First, manual taping process is classified into several operations. Then, each operation is divided into several working elements.

Table 4. 1 Operations and Working Elements of Manual Taping Process

| **Operation 1** | **Bundling** |
|---|---|
| Working element 1 | Taking jig from the middle of table |
| Working element 2 | Taking soaps and putting it on the jig |
| Working element 3 | Moving loaded-jig to the middle of table |
| **Operation 2** | **Taping** |
| Working element 4 | Taking loaded-jig from the middle of table |
| Working element 5 | Taping the upper side of loaded-jig |
| Working element 6 | Reversing and moving the loaded-jig to the middle of table |
| **Operation 3** | **Finishing** |
| Working element 7 | Taking loaded-jig from the middle of table |
| Working element 8 | Taping the upper side of loaded-jig |
| Working element 9 | Separating bundled-soaps and jig, then putting label on it |
| Working element 10 | Placing bundled-soaps to the edge of table |

As shown in the table above, the sequences of manual taping process are bundling, taping, and finishing. Each operation is done in a short time repetitively, with different labors in charge for each operation.

Secondly, direct observation is conducted to measure time needed by operator to finish each working element. However, since each working element can be done in a very short time, then the measurement is done for each operation. The initial observation will measure 30 work cycles (repetitions) of manual taping process. Table below shows recapitulation of the measurement.

Table 4. 2 Recapitulation of Manual Taping Process Measurement

| | Actual Time (second) | | |
|---|---|---|---|
| **Work Cycle** | **Operation 1** | **Operation 2** | **Operation 3** |
| 1st | 4.8 | 6.1 | 7.6 |
| 2nd | 7.1 | 6.4 | 9.8 |
| 3rd | 7 | 6.1 | 18.8 |
| 4th | 5.9 | 6.5 | 13.2 |
| 5th | 7 | 6.7 | 9.7 |
| 6th | 5.3 | 6.3 | 8.5 |
| 7th | 5.1 | 6.1 | 7.4 |
| 8th | 6.2 | 7.6 | 8.2 |
| 9th | 6.5 | 9.9 | 9.3 |
| 10th | 6 | 7.5 | 7 |
| 11th | 5.3 | 10.7 | 6.4 |
| 12th | 7 | 5.7 | 6.8 |
| 13th | 5.3 | 6.4 | 6.9 |
| 14th | 7.2 | 5.9 | 7.1 |
| 15th | 5.7 | 10.2 | 6.9 |
| 16th | 5 | 5.2 | 7.7 |
| 17th | 5.1 | 6 | 7.8 |
| 18th | 5.1 | 5.8 | 6.4 |
| 19th | 4.9 | 5.6 | 9.1 |
| 20th | 6.1 | 6.3 | 9.8 |
| 21st | 5.9 | 6.2 | 8.2 |
| 22nd | 5.1 | 6.6 | 8 |
| 23rd | 4.8 | 6.7 | 8.4 |
| 24th | 6.9 | 6.3 | 9.9 |
| 25th | 5.2 | 6.2 | 7.5 |
| 26th | 7 | 8.2 | 9 |
| 27th | 5.6 | 9.5 | 7.5 |
| 28th | 5.1 | 6.6 | 7.9 |
| 29th | 5.5 | 6.6 | 8.6 |
| 30th | 5.7 | 6.2 | 8.3 |

Next, uniformity and adequacy tests are conducted. The purpose of uniformity test is to check whether all data are already uniform or not by identifying and eliminating the outlier data. If there is outlier datum in the first iteration, then the second iteration is needed; while if all data are already uniform in the first iteration, then the second iteration is not necessary. Uniformity test is done by using the aid of Minitab software.

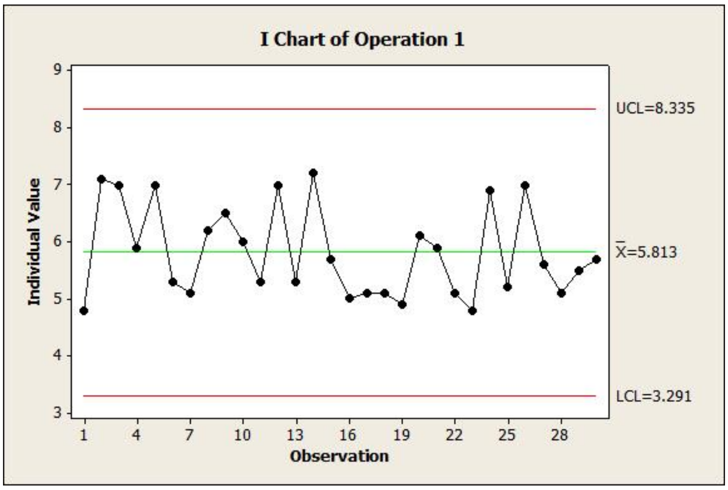


Figure 4. 2 Uniformity Test of Operation 1 (First Iteration)

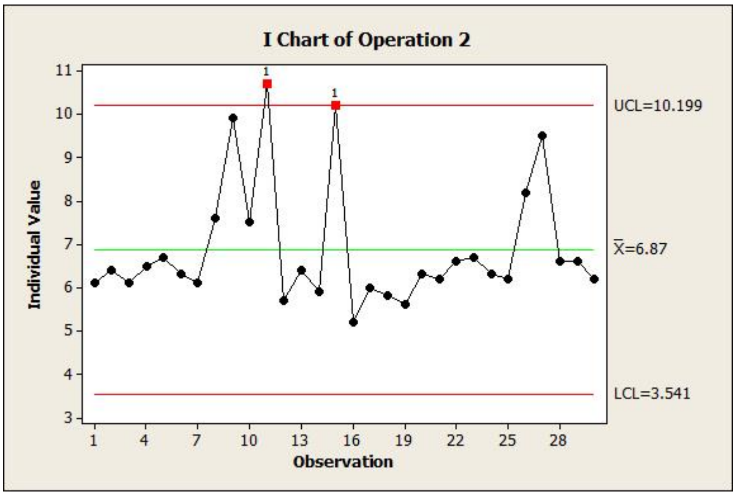


Figure 4. 3 Uniformity Test of Operation 2 (First Iteration)

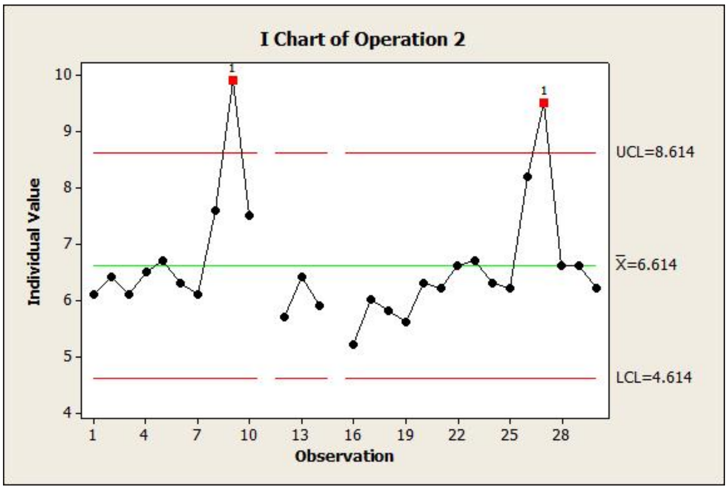


Figure 4. 4 Uniformity Test of Operation 2 (Second Iteration)

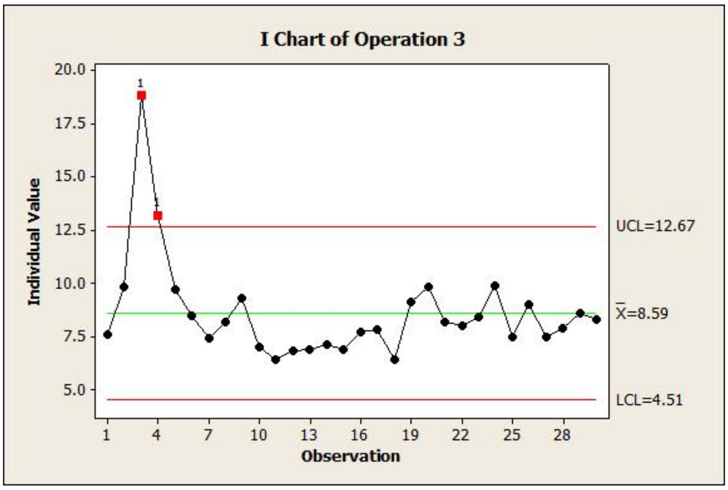


Figure 4. 5 Uniformity Test of Operation 3 (First Iteration)

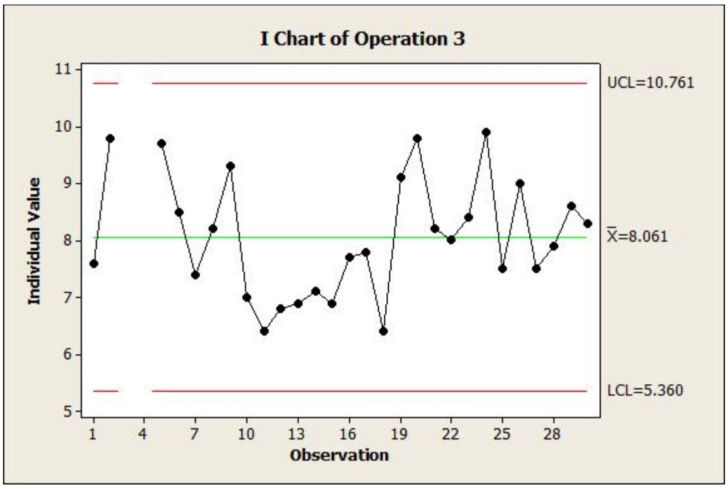


Figure 4. 6 Uniformity Test of Operation 3 (Second Iteration)

Results of uniformity test show that there is no outlier data in Operation 1; while there are several outlier data in Operation 2 and Operation 3. In Operation 2, two outlier data are identified in the first iteration. Then in the second iteration, there are two more outlier data. In Operation 3, two outlier data are only identified in the first iteration; while the second iteration shows that all data are already uniform. Table below shows summary of uniformity test. Cell with yellow color means the outlier data in the first iteration; while blue-colored cell means outlier data in the second iteration.

Table 4. 3 Summary of Uniformity Test

| | **Actual Time (second)** | | |
|---|---|---|---|
| **Work Cycle** | **Operation 1** | **Operation 2** | **Operation 3** |
| 1st | 4.8 | 6.1 | 7.6 |
| 2nd | 7.1 | 6.4 | 9.8 |
| 3rd | 7 | 6.1 | 18.8 |
| 4th | 5.9 | 6.5 | 13.2 |
| 5th | 7 | 6.7 | 9.7 |
| 6th | 5.3 | 6.3 | 8.5 |
| 7th | 5.1 | 6.1 | 7.4 |
| 8th | 6.2 | 7.6 | 8.2 |
| 9th | 6.5 | 9.9 | 9.3 |
| 10th | 6 | 7.5 | 7 |
| 11th | 5.3 | 10.7 | 6.4 |
| 12th | 7 | 5.7 | 6.8 |
| 13th | 5.3 | 6.4 | 6.9 |
| 14th | 7.2 | 5.9 | 7.1 |
| 15th | 5.7 | 10.2 | 6.9 |
| 16th | 5 | 5.2 | 7.7 |
| 17th | 5.1 | 6 | 7.8 |
| 18th | 5.1 | 5.8 | 6.4 |
| 19th | 4.9 | 5.6 | 9.1 |
| 20th | 6.1 | 6.3 | 9.8 |
| 21st | 5.9 | 6.2 | 8.2 |
| 22nd | 5.1 | 6.6 | 8 |
| 23rd | 4.8 | 6.7 | 8.4 |
| 24th | 6.9 | 6.3 | 9.9 |
| 25th | 5.2 | 6.2 | 7.5 |

| | Actual Time (second) | | |
|---|---|---|---|
| **Work Cycle** | **Operation 1** | **Operation 2** | **Operation 3** |
| 26th | 7 | 8.2 | 9 |
| 27th | 5.6 | 9.5 | 7.5 |
| 28th | 5.1 | 6.6 | 7.9 |
| 29th | 5.5 | 6.6 | 8.6 |
| 30th | 5.7 | 6.2 | 8.3 |

Then, adequacy test can be conducted. The purpose of adequacy test is to check whether the number of observation already represents the population or not. If not yet, then more observations must be done. The formula of adequacy test is as follows.

$$N' = \left(\frac{Z\ x\ S}{\bar{x}\ x\ k}\right)^2$$

where:

$N' = amount\ of\ observation\ that\ should\ be\ done$

$Z = level\ of\ confidence$

$S = standard\ deviation\ of\ data$

$\bar{x} = average\ of\ data$

$k = error\ level$

Prior to adequacy test calculation, the value of Z and k are determined. Level of confidence value is set into 2 which means 95% of confidence level; while value of error level is 5%. Example of adequacy test calculation for Operation 1 and the recapitulation for all operations are shown as follow.

$$N' = \left(\frac{2\ x\ 0.787}{5.813\ x\ 0.05}\right)^2 = 29.31$$

The calculation shows that N > N', then data in Operation 1 is sufficient and pass adequacy test.

Table 4. 4 Recapitulation of Adequacy Test Calculation

| Operation | N | N' | x | S | Conclusion |
|---|---|---|---|---|---|
| Operation 1 | 30 | 29.31 | 5.813 | 0.787 | Sufficient |
| Operation 2 | 26 | 15.05 | 6.377 | 0.619 | Sufficient |
| Operation 3 | 28 | 26.09 | 8.061 | 1.029 | Sufficient |

The next step is determining the performance rating by using Westinghouse Rating System approach. This approach evaluates operator performance based on four evaluation factors. Those factors are skill, effort, condition, and consistency. Table below shows the Westinghouse Rating System's leveling and scoring.

Table 4. 5 Westinghouse Rating System

| Description | Level | Score | |
|---|---|---|---|
| | | Skill | Effort |
| Super skill | A1 | 0.15 | 0.16 |
| | A2 | 0.13 | 0.12 |
| Excellent | B1 | 0.11 | 0.10 |
| | B2 | 0.08 | 0.08 |
| Good | C1 | 0.06 | 0.05 |
| | C2 | 0.03 | 0.02 |
| Average | D | 0.00 | 0.00 |
| Fair | E1 | -0.05 | -0.04 |
| | E2 | -0.10 | -0.08 |
| Poor | F1 | -0.16 | -0.12 |

| Description | Level | Score | |
|---|---|---|---|
| | | Condition | Consistency |
| Ideal | A | 0.06 | 0.04 |
| Excellent | B | 0.04 | 0.03 |
| Good | C | 0.02 | 0.01 |
| Average | D | 0.00 | 0.00 |
| Fair | E | -0.03 | -0.02 |
| Poor | F | -0.07 | -0.04 |

Determination of performance rating is done subjectively for each operation. Recapitulation of performance rating are as follow.

Table 4. 6 Recapitulation of Performance Rating

| Operation | Factor | Level | Score | Total | Performance Factor | Performance Rating |
|---|---|---|---|---|---|---|
| **Operation 1** | Skill | B1 | 0.11 | 0.19 | 1.19 | 119% |
| | Effort | C1 | 0.05 | | | |
| | Condition | C | 0.02 | | | |

| Operation | Factor | Level | Score | Total | Performance Factor | Performance Rating |
|---|---|---|---|---|---|---|
| | Consistency | C | 0.01 | | | |
| **Operation 2** | Skill | B2 | 0.08 | 0.13 | 1.13 | 113% |
| | Effort | C2 | 0.02 | | | |
| | Condition | C | 0.02 | | | |
| | Consistency | C | 0.01 | | | |
| **Operation 3** | Skill | B2 | 0.08 | 0.13 | 1.13 | 113% |
| | Effort | C2 | 0.02 | | | |
| | Condition | C | 0.02 | | | |
| | Consistency | C | 0.01 | | | |

In order to overcome some interruptions during work, then allowance time is set up. It is also called as personal time. Barnes (1980) argued that average allowance time of light-repetitive work is between 2% – 5%. Then, 5% of allowance time is determined for manual taping process. After all data are gathered, finally normal time and standard time can be calculated. The formula and calculation (example for Operation 1) are as follow.

$$Normal\ time = Cycle\ time\ x\ Performance\ rating$$

$$Normal\ time = 5.813\ x\ 119\% = 6.918\ seconds$$

$$Standard\ time = Normal\ time\ x\ \frac{100\%}{100\% - \%Allowance}$$

$$Standard\ time = 6.918\ x\ \frac{100\%}{100\% - 5\%} = 7.282\ seconds$$

Table 4. 7 Recapitulation of Normal and Standard Time (second)

| Operation | Normal Time | Standard Time |
|---|---|---|
| **Operation 1** | 6.918 | 7.282 |
| **Operation 2** | 7.206 | 7.585 |
| **Operation 3** | 9.109 | 9.588 |

### *4.1.4 Operation Process Chart of Manual Taping Process*

Refer to Figure 4.1 about business process mapping, taping process is shown as an activity done by tapper. Here the taping process itself will be elaborated in more detail and depicted in operation process chart (OPC).

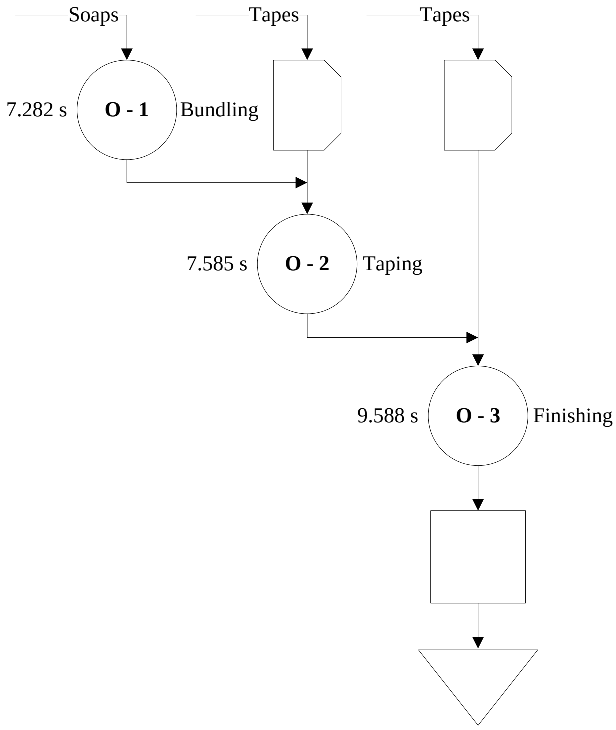


Figure 4. 7 Operation Process Chart of Manual Taping Process

Manual taping process is started by unpacking cartons of soap then inspecting all of the soap. Defect soaps will be rejected, while the good one will be the input for taping process. The sequences of manual taping process are as follow.

a. The first operation is bundling. Here the operator puts several soaps into a jig. Standard time for this operation is 7.282 seconds. Then soaps in the loaded-jig will be taped in the second operation.

Figure 4. 8 Operation 1: Bundling

b. The second operation is taping. Only one side of the bundled-soaps is taped. Then the bundled-jig will be reversed before it go to the last operation. Standard time for the second operation is 7.585 seconds.

Figure 4. 9 Operation 3: Finishing

c. The last operation is finishing. Operator will put the tape on another side of the bundled-soaps, separate bundled-soaps and the jig, put label (barcode) on bundled-soaps, and then place bundled-soaps in the edge of table. Standard time of this operation is 9.588 seconds.

Since the longest time of all operations is 9.588 seconds, so it can be concluded that three tappers can produce one bundle of soaps in every 9.588 seconds or in every minute there are 6.26 bundles of soap come out from manual taping process.

### *4.1.5 Demand Forecasting of Taping Process*

Taping process in warehouse of Kamadjaja Logistics is triggered by customer’s taping order. Periodically, customer will release taping order for certain product in certain bundle and certain quantity. Demand forecasting is necessary in order to calculate number of technologies to be invested. Demand is forecasted for the next 12 years. The reason is the average lifetime of the technologies is 12 years. Table below shows annual data of actual taping output.

Table 4. 8 Annual Data of Actual Taping Output

| Year | Taping Output (bundle) | 3 Soaps / Bundle | 4 Soaps / Bundle | 6 Soaps / Bundle | 8 Soaps / Bundle |
|---|---|---|---|---|---|
| 2013 | 21,888,374 | 13,076,304 | 5,081,124 | 2,335,268 | 1,395,678 |
| 2014 | 27,150,436 | 15,113,568 | 8,519,208 | 2,020,264 | 1,497,396 |
| 2015 | 14,617,898 | 6,030,608 | 6,675,468 | 1,046,904 | 864,918 |
| 2016 | 23,155,518 | 7,063,056 | 13,871,568 | 773,640 | 1,447,254 |

There are 4 types of bundle based on number of soap in it; those are 3, 4, 6, and 8. Most of the taping output (at least 83% each year and increasing) is composed from bundles of 3 and 4 soaps. Taping output also fluctuates along the years. In order to forecast the taping demand, moving average approach (with n = 3 years) is used.

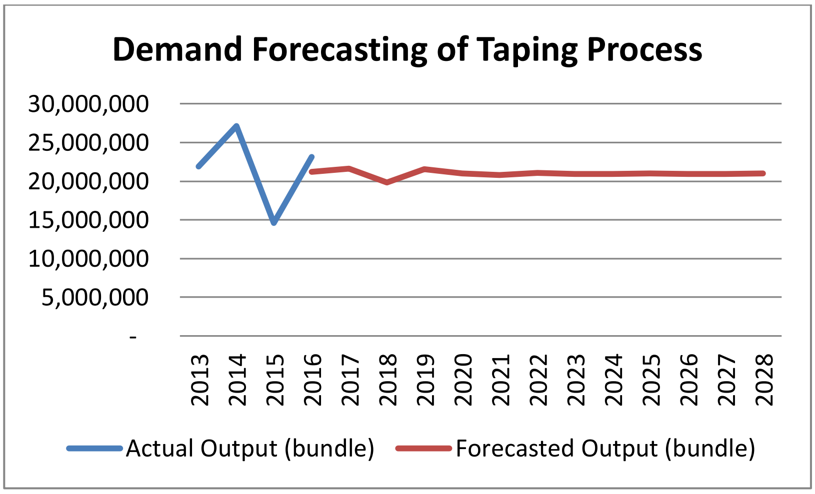


Figure 4. 10 Demand Forecasting of Taping Process

Table 4. 9 Demand Forecasting of Taping Process

| Year | Actual Output (bundle) | Forecasted Output (bundle) |
|---|---|---|
| 2013 | 21,888,374 | |
| 2014 | 27,150,436 | |
| 2015 | 14,617,898 | |
| 2016 | 23,155,518 | 21,218,903 |
| 2017 | | 21,641,284 |
| 2018 | | 19,804,900 |
| 2019 | | 21,533,901 |
| 2020 | | 20,993,362 |

| Year | Actual Output (bundle) | Forecasted Output (bundle) |
|---|---|---|
| 2021 | | 20,777,387 |
| 2022 | | 21,101,550 |
| 2023 | | 20,957,433 |
| 2024 | | 20,945,457 |
| 2025 | | 21,001,480 |
| 2026 | | 20,968,123 |
| 2027 | | 20,971,687 |
| 2028 | | 20,980,430 |
| 2029 | | 20,973,413 |

The highest forecasted output during the years occurs in 2017 with the value of 21,641,284 bundles. This information will be used as reference for calculation of number of machine needed.

## 4.2 Data Processing

Data processing is composed by cost calculation of manual taping process, cost and benefit calculation of automated taping process, incremental benefit-cost analysis, and sensitivity analysis.

### *4.2.1 Cost Calculation of Manual Taping Process*

Cost components of existing process can be divided into two main costs; those are investment cost and operational cost. Investment cost covers taping tables, long chairs, small tables, and equipment (jig and cutter). Each element in investment cost is elaborated as follows.

- Taping table

  Price of taping table = IDR 375,000 per unit

  Number of taping table = 20 units

  Cost of taping table = 375,000 x 20 = IDR 7,500,000

- Long chair

  Price of long chair = IDR 150,000 per unit

  Number of long chair = 40 units

  Cost of long chair = 150,000 x 40 = IDR 6,000,000

- Small table

Price of small table = IDR 187,500 per unit

Number of small table = 18 units

Cost of small table = 187,500 x 18 = IDR 3,375,000

- Equipment - jig

  Price of jig = IDR 11,250 per unit

  Number of jig = 1,531 units

  Cost of jig = 11,250 x 1,531 = IDR 27,223,750

- Equipment - cutter

  Price of cutter = IDR 3,000 per pack (1 pack = 12 units)

  Number of cutter = 7 packs

  Cost of cutter = 3,000 x 7 = IDR 21,000


Figure 4. 11 Table and Chair for Manual Taping Process

Operational cost is composed by direct labor and material costs. Direct labor involves taping coordinator, tapper and packer; while material cost is come from tape usage. It is important to be noted that the status of all direct labors is sub-contract. This means the company does not need to give compensation if there is labor reduction (layoff). Elements of operational cost are elaborated as follow.

- Direct labor

  Number of taping coordinator = 2 labors

Number of tapper = 83 labors

Number of packer = 4 labors

Total salary = IDR 231,750,000 per month

= IDR 2,781,000,000 per year

- Material

Price (wholesale) = IDR 435,000 per pack (1 pack = 72 units)

Number of tape = 54,616 units per year = 759 packs per year

Cost of tape = 435,000 x 759 = IDR 330,165,000 per year

All cost elements in manual taping process are already calculated. Those data will be projected following time horizon of 12 years and using 5% of inflation rate as assumed in the beginning. For example, the calculation of direct labor cost in 2018 is as follows.

$$Direct\ labor\ cost\ of\ year\ n = (1 + inflation\ rate)^{n-2017}\ x\ direct\ labor\ cost$$

$$Direct\ labor\ cost\ of\ year\ 2018 = (1 + 5\%)^{2018-2017}\ x\ 2{,}781{,}000{,}000$$

$$Direct\ labor\ cost\ of\ year\ 2018 = IDR\ 2{,}920{,}050{,}000$$

Table 4. 10 Projected Cash Flow of Manual Taping Process (in IDR)

| Time Horizon | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| | | | | | | | |
| **Investment Cost** | | | | | | | |
| Taping table | 7,500,000 | | | | | | |
| Long chair | 6,000,000 | | | | | | |
| Small table | 3,375,000 | | | | | | |
| Equipment | 17,244,750 | | | | | | |
| Total Investment Cost | 34,119,750 | | | | | | |
| | | | | | | | |
| **Operational Cost** | | | | | | | |
| Direct labor | | 2,920,050,000 | 3,066,052,500 | 3,219,355,125 | 3,380,322,881 | 3,549,339,025 | 3,726,805,977 |
| Material | | 346,673,250 | 364,006,913 | 382,207,258 | 401,317,621 | 421,383,502 | 442,452,677 |
| Total Operational Cost | | 3,266,723,250 | 3,430,059,413 | 3,601,562,383 | 3,781,640,502 | 3,970,722,527 | 4,169,258,654 |
| | | | | | | | |
| **TOTAL COST** | 34,119,750 | 3,266,723,250 | 3,430,059,413 | 3,601,562,383 | 3,781,640,502 | 3,970,722,527 | 4,169,258,654 |

| Time Horizon | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
| | | | | | | |
| **Investment Cost** | | | | | | |
| Taping table | | | | | | |
| Long chair | | | | | | |
| Small table | | | | | | |
| Equipment | | | | | | |
| Total Investment Cost | | | | | | |
| | | | | | | |
| **Operational Cost** | | | | | | |
| Direct labor | 3,913,146,275 | 4,108,803,589 | 4,314,243,769 | 4,529,955,957 | 4,756,453,755 | 4,994,276,443 |
| Material | 464,575,311 | 487,804,077 | 512,194,280 | 537,803,994 | 564,694,194 | 592,928,904 |
| Total Operational Cost | 4,377,721,586 | 4,596,607,666 | 4,826,438,049 | 5,067,759,952 | 5,321,147,949 | 5,587,205,347 |
| | | | | | | |
| **TOTAL COST** | 4,377,721,586 | 4,596,607,666 | 4,826,438,049 | 5,067,759,952 | 5,321,147,949 | 5,587,205,347 |

Using 10.5% of WACC, annual total cost data are calculated into present value (2017 is the base line). Then, the net present value (NPV) can be obtained by adding up all present value data. For example, present value calculation of annual total cost year 2018 is as follows.

$$Present\ value\ in\ 2017 = \frac{1}{(1+WACC)^{n-2017}}\ x\ annual\ total\ cost\ year\ n$$

$$Present\ value\ in\ 2017 = \frac{1}{(1+10.5\%)^{2018-2017}}\ x\ annual\ total\ cost\ year\ 2018$$

$$Present\ value\ in\ 2017 = \frac{1}{(1+10.5\%)^{2018-2017}}\ x\ 3{,}266{,}723{,}250$$

$$Present\ value\ in\ 2017 = IDR\ 2{,}956{,}310{,}633$$

Table 4. 11 NPV Calculation of Manual Taping Process (in IDR)

| Time Horizon | Year | Annual Total Cost | Present Value |
|---|---|---|---|
| | 2017 | 34,119,750 | 34,119,750 |
| 1 | 2018 | 3,266,723,250 | 2,956,310,633 |
| 2 | 2019 | 3,430,059,413 | 2,809,163,950 |
| 3 | 2020 | 3,601,562,383 | 2,669,341,310 |
| 4 | 2021 | 3,781,640,502 | 2,536,478,168 |
| 5 | 2022 | 3,970,722,527 | 2,410,228,124 |
| 6 | 2023 | 4,169,258,654 | 2,290,262,018 |
| 7 | 2024 | 4,377,721,586 | 2,176,267,076 |
| 8 | 2025 | 4,596,607,666 | 2,067,946,090 |
| 9 | 2026 | 4,826,438,049 | 1,965,016,647 |
| 10 | 2027 | 5,067,759,952 | 1,867,210,388 |
| 11 | 2028 | 5,321,147,949 | 1,774,272,315 |
| 12 | 2029 | 5,587,205,347 | 1,685,960,118 |
| | | **Cost NPV** | 27,242,576,588 |

The cost NPV of manual taping process for 12 years is IDR 27,242,576,588. Since Kamadjaja Logistics do not provide benefit in the form of income from taping process, then the benefit NPV is assumed to be zero.

### *4.2.2 Cost and Benefit Calculation of Automated Taping Process*

Referring to Subchapter 2.4, there are three alternatives of automated taping process. Each alternative is delivered by different automation technologies. Each technology has its own specification based on price information and technical data.

In general, components of cost are investment, operational, and maintenance costs. Due to all machines are bought from abroad (import), then Kamadjaja Logistics must follow Incoterms 2010 regulation and Indonesia National Trade Repository (INTR) which means investment cost is in the form of CIF (cost, insurance, freight) and importing taxes. These costs are only paid once in the beginning. Operational costs consist of direct labor, material, and energy costs. Both operational and maintenance costs are paid annually.

On the other hand, benefit describes savings that occurs due to investment in automation technology. Savings are generated due to faster operation time. Faster operation time means number of direct labor can be reduced and there is no need for overtime work. Reduction of direct labor will directly reduce the company's expense for their salary; while no overtime work means overtime cost can be eliminated. Besides those quantitative benefits, there are also several qualitative benefits that will be elaborated in the next chapter. Each alternative is elaborated as follows.

- Alternative 1: EntrePack Automatic SW-1713 L-Bar Shrink Wrap Machine

Calculation of investment costs:

Machine cost = IDR 224,808,750

Freight (shipping cost) = IDR 12,988,950

Insurance = 0.5% x (machine cost + freight) = IDR 1,188,989

CIF = machine cost + insurance + freight = IDR 238,986,689

Following HS code of 8422.40.00.00 for heat-shrink wrapping machinery:

Import duty = 5% x CIF = IDR 11,949,334

PPN = 10% x CIF = IDR 23,898,669

PPh = 2.5% x CIF = IDR 5,974,667

Investment cost = IDR 280,809,359 per machine

Machine speed = 25 bundles per minute

1 year = 300 days ; 1 day = 8 hours ; 1 hour = 60 minutes

Capacity = 25 x 60 x 8 x 300 = 3,600,000 bundles per year

$$Machine\ needed = \frac{Highest\ forecast}{Capacity} = \frac{21{,}641{,}284}{3{,}600{,}000} = 6.01 \approx 6\ machines$$

Total investment cost = investment cost x machine needed

Total investment cost = IDR 1,684,856,154

Calculation of direct labor cost:

There are 2 loaders and 1 pickers needed for each machine. Also 4 packers and 2 taping coordinators are required for the whole process.

Number of loader = 2 x 6 machines = 12 labors

Number of picker = 1 x 6 machines = 6 labors

Number of packer = 4 labors

Number of taping coordinator = 2 labors

Direct labor = 12 + 6 + 4 + 2 = 24 labors

Salary = IDR 2,472,159 per labor per month (scaled-UMR of Surabaya)

Labor cost = 24 x 2,472,159 x 12 months = IDR 711,981,900 per year

Calculation of material cost:

Price of PVC shrink film (wholesale) = IDR 97,425 per roll

Number of PVC shrink film = 16,119 rolls per year

Cost of PVC = 97,425 x 16,119 = IDR 1,570,393,575 per year

Calculation of energy cost:

Power = 8.8 kW per machine

Energy = 8.8 kW x 8 hours x 300 days x 6 machines = 126,720 kWh/year

Price of electricity = IDR 1,125 per kWh

Energy cost = 1,125 x 126,720 = IDR 142,560,000 per year

Calculation of maintenance cost:

Maintenance cost = IDR 25,535,475 per machine per year

= 25,535,475 x 6 machines = IDR 153,212,850 per year

Calculation of saving from direct labor reduction:

Labor cost of manual taping process = IDR 2,781,000,000 per year

Labor cost of Alternative 1 = IDR 711,981,900 per year

Saving from labor reduction = 2,781,000,000 – 711,981,900

= IDR 2,069,018,100 per year

Calculation of overtime cost elimination:

Overtime cost = IDR 5,457,204 per month

= 5,457,204 x 12 months = IDR 65,486,448 per year

After all related costs and benefits are already calculated, then those data will become the input for projected cash flow of Alternative 1 as follows.

Table 4. 12 Projected Cash Flow of Alternative 1 (in IDR)

| Time Horizon | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| **Investment Cost** | | | | | | | |
| Investment | 1,684,856,154 | | | | | | |
| **Operational Cost** | | | | | | | |
| Direct labor | | 747,580,995 | 784,960,045 | 824,208,047 | 865,418,449 | 908,689,372 | 954,123,840 |
| Material | | 1,648,913,254 | 1,731,358,916.44 | 1,817,926,862.26 | 1,908,823,205.37 | 2,004,264,365.64 | 2,104,477,583.92 |
| Energy | | 149,688,000 | 157,172,400.00 | 165,031,020.00 | 173,282,571.00 | 181,946,699.55 | 191,044,034.53 |
| Total Operational Cost | | 2,546,182,249 | 2,673,491,361 | 2,807,165,929 | 2,947,524,226 | 3,094,900,437 | 3,249,645,459 |
| **Maintenance Cost** | | 160,873,493 | 168,917,167.13 | 177,363,025.48 | 186,231,176.76 | 195,542,735.59 | 205,319,872.37 |
| **TOTAL COST** | 1,684,856,154 | 2,707,055,741 | 2,842,408,528 | 2,984,528,955 | 3,133,755,402 | 3,290,443,173 | 3,454,965,331 |
| **Labor Reduction** | | 2,172,469,005 | 2,281,092,455 | 2,395,147,078 | 2,514,904,432 | 2,640,649,654 | 2,772,682,136 |
| **Overtime cost elimination** | | 68,760,770 | 72,198,808.92 | 75,808,749.37 | 79,599,186.83 | 83,579,146.18 | 87,758,103.48 |
| **TOTAL BENEFIT** | | 2,241,229,775 | 2,353,291,264 | 2,470,955,827 | 2,594,503,619 | 2,724,228,800 | 2,860,440,240 |

| Time Horizon | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
| | | | | | | |
| **Investment Cost** | | | | | | |
| Investment | | | | | | |
| | | | | | | |
| **Operational Cost** | | | | | | |
| Direct labor | 1,001,830,032 | 1,051,921,534 | 1,104,517,611 | 1,159,743,491 | 1,217,730,666 | 1,278,617,199 |
| Material | 2,209,701,463.12 | 2,320,186,536.28 | 2,436,195,863.09 | 2,558,005,656.24 | 2,685,905,939.06 | 2,820,201,236.01 |
| Energy | 200,596,236.25 | 210,626,048.07 | 221,157,350.47 | 232,215,217.99 | 243,825,978.89 | 256,017,277.84 |
| Total Operational Cost | 3,412,127,732 | 3,582,734,118 | 3,761,870,824 | 3,949,964,366 | 4,147,462,584 | 4,354,835,713 |
| | | | | | | |
| **Maintenance Cost** | 215,585,865.99 | 226,365,159.29 | 237,683,417.26 | 249,567,588.12 | 262,045,967.52 | 275,148,265.90 |
| | | | | | | |
| **TOTAL COST** | 3,627,713,598 | 3,809,099,278 | 3,999,554,242 | 4,199,531,954 | 4,409,508,551 | 4,629,983,979 |
| | | | | | | |
| **Labor Reduction** | 2,911,316,243 | 3,056,882,055 | 3,209,726,158 | 3,370,212,466 | 3,538,723,089 | 3,715,659,244 |
| **Overtime cost elimination** | 92,146,008.66 | 96,753,309.09 | 101,590,974.55 | 106,670,523.27 | 112,004,049.44 | 117,604,251.91 |
| | | | | | | |
| **TOTAL BENEFIT** | 3,003,462,252 | 3,153,635,364 | 3,311,317,132 | 3,476,882,989 | 3,650,727,139 | 3,833,263,495 |

Using 10.5% of WACC, annual total cost and benefit data are calculated into present value. The summary of NPV calculation is as follows.

Table 4. 13 NPV Calculation of Alternative 1 (in IDR)

| Time Horizon | Year | Present Value of Cost | Present Value of Benefit |
|---|---|---|---|
| | 2017 | 1,684,856,154 | |
| 1 | 2018 | 2,449,824,200 | 2,028,262,240 |
| 2 | 2019 | 2,327,887,249 | 1,927,308,011 |
| 3 | 2020 | 2,212,019,558 | 1,831,378,653 |
| 4 | 2021 | 2,101,919,037 | 1,740,224,059 |
| 5 | 2022 | 1,997,298,632 | 1,653,606,572 |
| 6 | 2023 | 1,897,885,578 | 1,571,300,363 |
| 7 | 2024 | 1,803,420,685 | 1,493,090,843 |
| 8 | 2025 | 1,713,657,665 | 1,418,774,104 |
| 9 | 2026 | 1,628,362,487 | 1,348,156,388 |
| 10 | 2027 | 1,547,312,770 | 1,281,053,582 |
| 11 | 2028 | 1,470,297,203 | 1,217,290,734 |
| 12 | 2029 | 1,397,114,989 | 1,156,701,602 |
| | **NPV** | 24,231,856,207 | 18,667,147,150 |

- Alternative 2: Gramegna Model ECO 2000 Shrink Bundler

Calculation of investment costs:

Machine cost = IDR 157,468,763

Freight (shipping cost) = IDR 21,162,000

Insurance = 0.5% x (machine cost + freight) = IDR 893,154

CIF = machine cost + insurance + freight = IDR 179,523,916

Following HS code of 8422.40.00.00 for heat-shrink wrapping machinery:

Import duty = 5% x CIF = IDR 8,976,196

PPN = 10% x CIF = IDR 17,952,392

PPh = 2.5% x CIF = IDR 4,488,098

Investment cost = IDR 210,940,602 per machine

Machine speed = 20 bundles per minute

1 year = 300 days ; 1 day = 8 hours ; 1 hour = 60 minutes

Capacity = 20 x 60 x 8 x 300 = 2,880,000 bundles per year

$$Machine\ needed = \frac{Highest\ forecast}{Capacity} = \frac{21{,}641{,}284}{2{,}880{,}000} = 7.51 \approx 8\ machines$$

Total investment cost = investment cost x machine needed

Total investment cost = IDR 1,687,524,813

Calculation of direct labor cost:

There are 2 loaders and 1 pickers needed for each machine. Also 4 packers and 2 taping coordinators are required for the whole process.

Number of loader = 2 x 8 machines = 16 labors

Number of picker = 1 x 8 machines = 8 labors

Number of packer = 4 labors

Number of taping coordinator = 2 labors

Direct labor = 16 + 8 + 4 + 2 = 30 labors

Salary = IDR 2,472,159 per labor per month (UMR of Surabaya)

Labor cost = 30 x 2,472,159 x 12 months = IDR 889,977,375 per year

Calculation of material cost:

Price of PVC shrink film (wholesale) = IDR 97,425 per roll

Number of PVC shrink film = 16,119 rolls per year

Cost of PVC = 97,425 x 16,119 = IDR 1,570,393,575 per year

Calculation of energy cost:

Power = 20 kW per machine

Energy = 20 kW x 8 hours x 300 days x 8 machines = 384,000 kWh/year

Price of electricity = IDR 1,125 per kWh

Energy cost = 1,125 x 384,000 = IDR 432,000,000 per year

Calculation of maintenance cost:

Maintenance cost = IDR 25,535,475 per machine per year

= 25,535,475 x 8 machines = IDR 204,283,800 per year

Calculation of saving from direct labor reduction:

Labor cost of manual taping process = IDR 2,781,000,000 per year

Labor cost of Alternative 2 = IDR 889,977,375 per year

Saving from labor reduction = 2,781,000,000 – 889,977,375

= IDR 1,891,022,625 per year

Calculation of overtime cost elimination:

Overtime cost = IDR 5,457,204 per month

= 5,457,204 x 12 months = IDR 65,486,448 per year

After all related costs and benefits are already calculated, then those data will become the input for projected cash flow of Alternative 2 as follows.

Table 4. 14 Projected Cash Flow of Alternative 2 (in IDR)

| Time Horizon | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| **Investment Cost** | | | | | | | |
| Investment | 1,687,524,813 | | | | | | |
| **Operational Cost** | | | | | | | |
| Direct labor | | 934,476,244 | 981,200,056 | 1,030,260,059 | 1,081,773,062 | 1,135,861,715 | 1,192,654,800 |
| Material | | 1,648,913,254 | 1,731,358,916.44 | 1,817,926,862.26 | 1,908,823,205.37 | 2,004,264,365.64 | 2,104,477,583.92 |
| Energy | | 453,600,000 | 476,280,000.00 | 500,094,000.00 | 525,098,700.00 | 551,353,635.00 | 578,921,316.75 |
| Total Operational Cost | | 3,036,989,498 | 3,188,838,972 | 3,348,280,921 | 3,515,694,967 | 3,691,479,715 | 3,876,053,701 |
| **Maintenance Cost** | | 214,497,990 | 225,222,889.50 | 236,484,033.98 | 248,308,235.67 | 260,723,647.46 | 273,759,829.83 |
| **TOTAL COST** | 1,687,524,813 | 3,251,487,488 | 3,414,061,862 | 3,584,764,955 | 3,764,003,203 | 3,952,203,363 | 4,149,813,531 |
| **Labor Reduction** | | 1,985,573,756 | 2,084,852,444 | 2,189,095,066 | 2,298,549,820 | 2,413,477,311 | 2,534,151,176 |
| **Overtime cost elimination** | | 68,760,770 | 72,198,808.92 | 75,808,749.37 | 79,599,186.83 | 83,579,146.18 | 87,758,103.48 |
| **TOTAL BENEFIT** | | 2,054,334,527 | 2,157,051,253 | 2,264,903,816 | 2,378,149,006 | 2,497,056,457 | 2,621,909,280 |

| Time Horizon | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
| | | | | | | |
| **Investment Cost** | | | | | | |
| Investment | | | | | | |
| | | | | | | |
| **Operational Cost** | | | | | | |
| Direct labor | 1,252,287,541 | 1,314,901,918 | 1,380,647,013 | 1,449,679,364 | 1,522,163,332 | 1,598,271,499 |
| Material | 2,209,701,463.12 | 2,320,186,536.28 | 2,436,195,863.09 | 2,558,005,656.24 | 2,685,905,939.06 | 2,820,201,236.01 |
| Energy | 607,867,382.59 | 638,260,751.72 | 670,173,789.30 | 703,682,478.77 | 738,866,602.71 | 775,809,932.84 |
| Total Operational Cost | 4,069,856,386 | 4,273,349,206 | 4,487,016,666 | 4,711,367,499 | 4,946,935,874 | 5,194,282,668 |
| | | | | | | |
| **Maintenance Cost** | 287,447,821.32 | 301,820,212.39 | 316,911,223.01 | 332,756,784.16 | 349,394,623.37 | 366,864,354.53 |
| | | | | | | |
| **TOTAL COST** | 4,357,304,208 | 4,575,169,418 | 4,803,927,889 | 5,044,124,283 | 5,296,330,497 | 5,561,147,022 |
| | | | | | | |
| **Labor Reduction** | 2,660,858,735 | 2,793,901,672 | 2,933,596,755 | 3,080,276,593 | 3,234,290,423 | 3,396,004,944 |
| **Overtime cost elimination** | 92,146,008.66 | 96,753,309.09 | 101,590,974.55 | 106,670,523.27 | 112,004,049.44 | 117,604,251.91 |
| | | | | | | |
| **TOTAL BENEFIT** | 2,753,004,744 | 2,890,654,981 | 3,035,187,730 | 3,186,947,116 | 3,346,294,472 | 3,513,609,196 |

Using 10.5% of WACC, annual total cost and benefit data are calculated into present value. The summary of NPV calculation is as follows.

Table 4. 15 NPV Calculation of Alternative 2 (in IDR)

| Time Horizon | Year | Present Value of Cost | Present Value of Benefit |
|---|---|---|---|
| | 2017 | 1,687,524,813 | |
| 1 | 2018 | 2,942,522,613 | 1,859,126,268 |
| 2 | 2019 | 2,796,062,212 | 1,766,590,572 |
| 3 | 2020 | 2,656,891,694 | 1,678,660,724 |
| 4 | 2021 | 2,524,648,216 | 1,595,107,476 |
| 5 | 2022 | 2,398,986,993 | 1,515,712,986 |
| 6 | 2023 | 2,279,580,400 | 1,440,270,258 |
| 7 | 2024 | 2,166,117,123 | 1,368,582,598 |
| 8 | 2025 | 2,058,301,338 | 1,300,463,102 |
| 9 | 2026 | 1,955,851,950 | 1,235,734,170 |
| 10 | 2027 | 1,858,501,853 | 1,174,227,039 |
| 11 | 2028 | 1,765,997,236 | 1,115,781,349 |
| 12 | 2029 | 1,678,096,921 | 1,060,244,721 |
| | **NPV** | 28,769,083,363 | 17,110,501,264 |

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- Alternative 3: Prometica Sleeve Wrapping Heat Sealing Machine

Calculation of investment costs:

Machine cost = IDR 158,015,951

Freight (shipping cost) = IDR 38,303,213

Insurance = 0.5% x (machine cost + freight) = IDR 981,596

CIF = machine cost + insurance + freight = IDR 197,300,760

Following HS code of 8422.40.00.00 for heat-shrink wrapping machinery:

Import duty = 5% x CIF = IDR 9,865,038

PPN = 10% x CIF = IDR 19,730,076

PPh = 2.5% x CIF = IDR 4,932,519

Investment cost = IDR 231,828,392 per machine

Machine speed = 14 bundles per minute

1 year = 300 days ; 1 day = 8 hours ; 1 hour = 60 minutes

Capacity = 14 x 60 x 8 x 300 = 2,016,000 bundles per year

$$Machine\ needed = \frac{Highest\ forecast}{Capacity} = \frac{21{,}641{,}284}{2{,}016{,}000} = 10.73 \approx 11\ machines$$

Total investment cost = investment cost x machine needed

Total investment cost = IDR 2,550,112,317

Calculation of direct labor cost:

There are 2 loaders and 1 pickers needed for each machine. Also 4 packers and 2 taping coordinators are required for the whole process.

Number of loader = 2 x 11 machines = 22 labors

Number of picker = 1 x 11 machines = 11 labors

Number of packer = 4 labors

Number of taping coordinator = 2 labors

Direct labor = 22 + 11 + 4 + 2 = 39 labors

Salary = IDR 2,472,159 per labor per month (UMR of Surabaya)

Labor cost = 39 x 2,472,159 x 12 months = IDR 1,156,970,588 per year

Calculation of material cost:

Price of PVC shrink film (wholesale) = IDR 97,425 per roll

Number of PVC shrink film = 16,119 rolls per year

Cost of PVC = 97,425 x 16,119 = IDR 1,570,393,575 per year

Calculation of energy cost:

Power = 2 kW per machine

Energy = 2 kW x 8 hours x 300 days x 11 machines = 52,800 kWh/year

Price of electricity = IDR 1,125 per kWh

Energy cost = 1,125 x 52,800 = IDR 59,400,000 per year

Calculation of maintenance cost:

Maintenance cost = IDR 25,535,475 per machine per year

= 25,535,475 x 11 = IDR 280,890,225 per year

Calculation of saving from direct labor reduction:

Labor cost of manual taping process = IDR 2,781,000,000 per year

Labor cost of Alternative 3 = IDR 1,156,970,588 per year

Saving from labor reduction = 2,781,000,000 – 1,156,970,588

= IDR 1,624,029,413 per year

Calculation of overtime cost elimination:

Overtime cost = IDR 5,457,204 per month

= 5,457,204 x 12 months = IDR 87,315,264 per year

After all related costs and benefits are already calculated, then those data will become the input for projected cash flow of Alternative 3 as follows.

Table 4. 16 Projected Cash Flow of Alternative 3 (in IDR)

| Time Horizon | | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| Year | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 |
| **Investment Cost** | | | | | | | |
| Investment | 2,550,112,317 | | | | | | |
| **Operational Cost** | | | | | | | |
| Direct labor | | 1,214,819,117 | 1,275,560,073 | 1,339,338,076 | 1,406,304,980 | 1,476,620,229 | 1,550,451,241 |
| Material | | 1,648,913,254 | 1,731,358,916.44 | 1,817,926,862.26 | 1,908,823,205.37 | 2,004,264,365.64 | 2,104,477,583.92 |
| Energy | | 62,370,000 | 65,488,500.00 | 68,762,925.00 | 72,201,071.25 | 75,811,124.81 | 79,601,681.05 |
| Total Operational Cost | | 2,926,102,371 | 3,072,407,489 | 3,226,027,864 | 3,387,329,257 | 3,556,695,720 | 3,734,530,506 |
| **Maintenance Cost** | | 294,934,736 | 309,681,473.06 | 325,165,546.72 | 341,423,824.05 | 358,495,015.25 | 376,419,766.02 |
| **TOTAL COST** | 2,550,112,317 | 3,221,037,107 | 3,382,088,962 | 3,551,193,410 | 3,728,753,081 | 3,915,190,735 | 4,110,950,272 |
| **Labor Reduction** | | 1,705,230,883 | 1,790,492,427 | 1,880,017,049 | 1,974,017,901 | 2,072,718,796 | 2,176,354,736 |
| **Overtime cost elimination** | | 68,760,770 | 72,198,808.92 | 75,808,749.37 | 79,599,186.83 | 83,579,146.18 | 87,758,103.48 |
| **TOTAL BENEFIT** | | 1,773,991,654 | 1,862,691,236 | 1,955,825,798 | 2,053,617,088 | 2,156,297,942 | 2,264,112,839 |

| Time Horizon | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|
| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
| **Investment Cost** | | | | | | |
| Investment | | | | | | |
| **Operational Cost** | | | | | | |
| Direct labor | 1,627,973,803 | 1,709,372,493 | 1,794,841,117 | 1,884,583,173 | 1,978,812,332 | 2,077,752,949 |
| Material | 2,209,701,463.12 | 2,320,186,536.28 | 2,436,195,863.09 | 2,558,005,656.24 | 2,685,905,939.06 | 2,820,201,236.01 |
| Energy | 83,581,765.11 | 87,760,853.36 | 92,148,896.03 | 96,756,340.83 | 101,594,157.87 | 106,673,865.77 |
| Total Operational Cost | 3,921,257,031 | 4,117,319,882 | 4,323,185,877 | 4,539,345,170 | 4,766,312,429 | 5,004,628,050 |
| **Maintenance Cost** | 395,240,754.32 | 415,002,792.03 | 435,752,931.64 | 457,540,578.22 | 480,417,607.13 | 504,438,487.48 |
| **TOTAL COST** | 4,316,497,785 | 4,532,322,674 | 4,758,938,808 | 4,996,885,749 | 5,246,730,036 | 5,509,066,538 |
| **Labor Reduction** | 2,285,172,473 | 2,399,431,096 | 2,519,402,651 | 2,645,372,784 | 2,777,641,423 | 2,916,523,494 |
| **Overtime cost elimination** | 92,146,008.66 | 96,753,309.09 | 101,590,974.55 | 106,670,523.27 | 112,004,049.44 | 117,604,251.91 |
| **TOTAL BENEFIT** | 2,377,318,481 | 2,496,184,405 | 2,620,993,626 | 2,752,043,307 | 2,889,645,472 | 3,034,127,746 |

Using 10.5% of WACC, annual total cost and benefit data are calculated into present value. The summary of NPV calculation is as follows.

Table 4. 17 NPV Calculation of Alternative 3 (in IDR)

| Time Horizon | Year | Present Value of Cost | Present Value of Benefit |
|---|---|---|---|
| | 2017 | 2,550,112,317 | |
| 1 | 2018 | 2,914,965,708 | 1,605,422,311 |
| 2 | 2019 | 2,769,876,917 | 1,525,514,413 |
| 3 | 2020 | 2,632,009,740 | 1,449,583,831 |
| 4 | 2021 | 2,501,004,730 | 1,377,432,600 |
| 5 | 2022 | 2,376,520,332 | 1,308,872,606 |
| 6 | 2023 | 2,258,231,990 | 1,243,725,101 |
| 7 | 2024 | 2,145,831,302 | 1,181,820,232 |
| 8 | 2025 | 2,039,025,219 | 1,122,996,600 |
| 9 | 2026 | 1,937,535,276 | 1,067,100,842 |
| 10 | 2027 | 1,841,096,869 | 1,013,987,225 |
| 11 | 2028 | 1,749,458,563 | 963,517,273 |
| 12 | 2029 | 1,662,381,440 | 915,559,400 |
| | **NPV** | 29,378,050,403 | 14,775,532,435 |

### *4.2.3 Incremental Benefit-Cost Analysis*

Incremental benefit-cost analysis is conducted by using equivalent uniform annual cost (EUAC) approach. All NPV data of manual and automated processes are calculated into annual worth, then cost per unit and benefit per unit can be obtained. These data will become the input for incremental benefit-cost analysis. Formula to calculate annual worth is as follows.

$$Annual\ worth = NPV\ x\ (A/P\ , 10.5\%, 12)$$

$$Annual\ worth = NPV\ x\ 0.150377$$

Table below shows results of annual worth calculation for manual and automated alternatives.

Table 4. 18 Annual Worth of Manual and Automated Alternatives (in IDR)

| | Manual | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|---|
| NPV Cost | 27,242,576,588 | 24,231,856,207 | 28,769,083,363 | 29,378,050,403 |
| NPV Benefit | - | 18,667,147,150 | 17,110,501,264 | 14,775,532,435 |
| Annual Cost | 4,096,650,010 | 3,643,907,677 | 4,326,201,131 | 4,417,775,613 |
| Annual Benefit | - | 2,807,104,839 | 2,573,021,496 | 2,221,896,483 |

Then, in order to obtain cost per unit and benefit per unit, annual cost and annual benefit are divided by forecasted demand of 21,641,284 bundles per year. The results are as follow.

Table 4. 19 Data of Cost per Unit and Benefit per Unit (in IDR)

| | **Manual** | **Alternative 1** | **Alternative 2** | **Alternative 3** |
|---|---|---|---|---|
| Cost per unit | 189.30 | 168.38 | 199.91 | 204.14 |
| Benefit per unit | - | 129.71 | 118.89 | 102.67 |

For comparison purpose, all alternatives must be sorted by its investment cost, starting from the smallest into the biggest. The sequence of alternatives from the smallest investment cost is manual, Alternative 1, Alternative 2, and Alternative 3. Then, incremental benefit-cost analysis can be conducted as follows.

- Compare Alternative 1 and Manual

$$\frac{\Delta Benefit}{\Delta Cost} = \frac{129.71 - 0}{168.38 - 189.3} = \frac{+129.71}{-20.92} = -6.2 \approx 6.2$$

The initial calculation compares cost per unit and benefit per unit between Alternative 1 and manual. It is clearly shown that by shifting from manual to Alternative 1, there will be IDR 129.71 additional benefit per unit and IDR 20.92 cost reduction per unit. Since the results is more than 1, then alternative with the higher investment cost (Alternative 1) is chosen.

- Compare Alternative 2 and Alternative 1

$$\frac{\Delta Benefit}{\Delta Cost} = \frac{118.89 - 129.71}{199.91 - 168.38} = \frac{-10.82}{+31.53} = -0.34 \approx 0.34$$

Next, compares cost per unit and benefit per unit between Alternative 2 and Alternative 1. It is clearly shown that by shifting from Alternative 1 to Alternative 2, there will be IDR 10.82 benefit reduction per unit and IDR 31.53 additional cost per unit. Since the results is less than 1, then alternative with the lower investment cost (Alternative 1) is chosen.

- Compare Alternative 3 and Alternative 1

$$\frac{\Delta Benefit}{\Delta Cost} = \frac{102.67 - 129.71}{204.14 - 168.38} = \frac{-27.04}{+35.76} = -0.76 \approx 0.76$$

Last, compares cost per unit and benefit per unit between Alternative 3 and Alternative 1. It is clearly shown that by shifting from Alternative 1 to Alternative 3, there will be IDR 27.04 benefit reduction per unit and IDR 35.76 additional cost per unit. Since the results is less than 1, then alternative with the lower investment cost (Alternative 1) is chosen.

Result from incremental benefit-cost analysis shows that Alternative 1 is the best alternative. Alternative 1 delivers the biggest benefit and also reduces the biggest cost than other alternatives.

### *4.2.4 Sensitivity Analysis*

Some aspects in benefit and cost calculation are assumed to have certain value, but in fact those aspects have uncertain values. The value is ranging from its possible lowest point until the highest point. Sensitivity analysis tries to accommodate this situation by changing the value of uncertain aspects and observe its effect.

Aspects to be tested in sensitivity analysis are direct labor, material costs, and demand uncertainty. In initial assumption, direct labor cost will follow inflation rate of 5%. However, in sensitivity analysis, direct labor cost will increase by certain scenarios. This condition will also be applied to material cost. Besides cost, demand uncertainty will show the effect of decreasing demand to the final decision. These scenarios are only checked to the best alternative (Alternative 1). The results of sensitivity analysis are as follow.

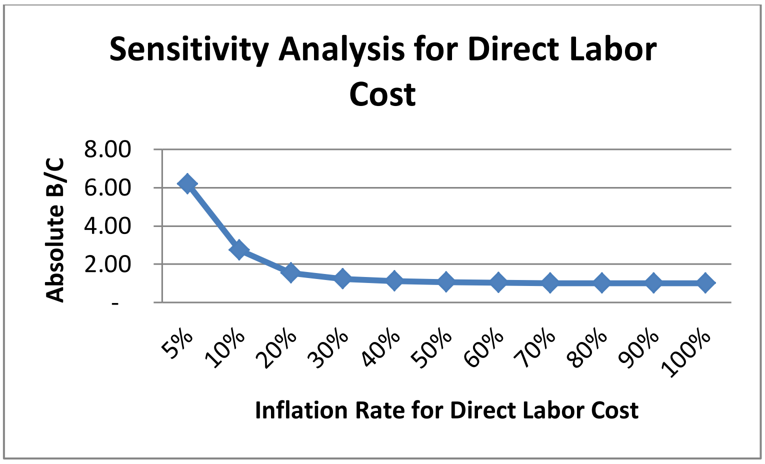


Figure 4. 12 Sensitivity Analysis for Direct Labor Cost

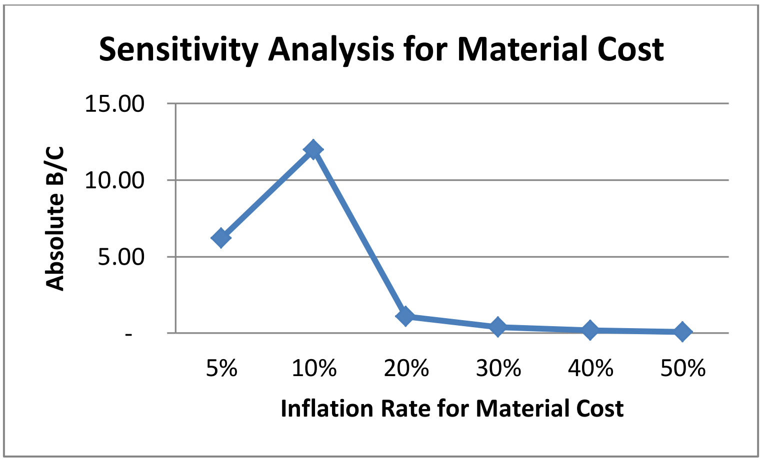


Figure 4. 13 Sensitivity Analysis for Material Cost

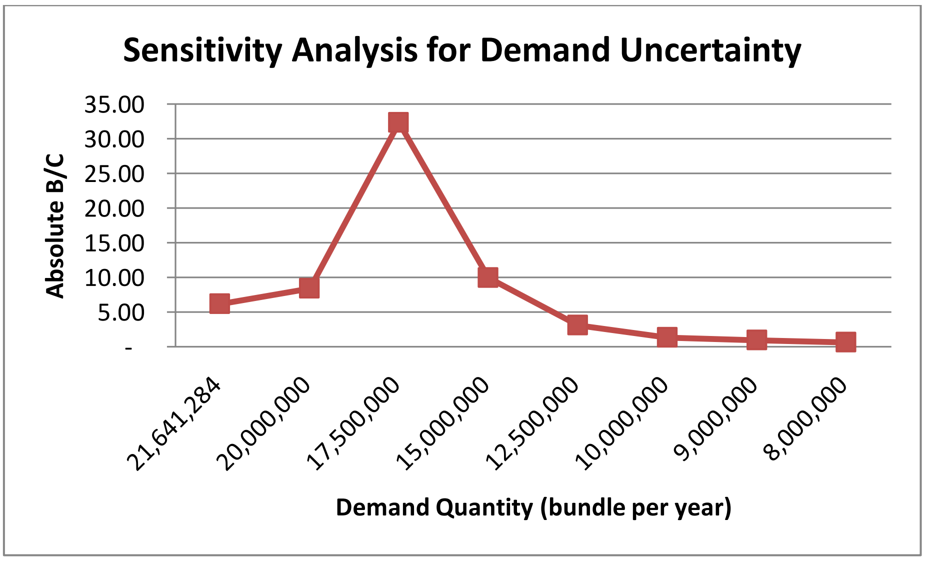


Figure 4. 14 Sensitivity Analysis for Demand Uncertainty

# CHAPTER V
# ANALYSIS AND INTERPRETATION

Results of data processing on previous chapter are analyzed and interpreted in this chapter. There are four main subchapters; those are analysis of manual taping process, analysis of automated taping process, benefit-cost analysis, and sensitivity analysis.

## 5.1 Analysis of Manual Taping Process

Analysis of manual taping process will be started by identifying the elements of cost in the initial year. Total investment cost is IDR 34,119,750; while total operational cost is IDR 3,111,165,000 per year. The proportion of investment cost to operational cost is only around 1%. It shows the common characteristic of manual process which is small investment but very high operational cost. It may happens due to prior management decision to keep in manual process without realizing that demand will be increasing along with time, especially when it is a functional product (ex. soap). In this case, Kamadjaja Logistics conducts manual process due to the business begins from agreement of certain contracts with its customer. On certain point, management should decide to shift the process into automation process.

Inside the operational cost itself, labor cost contributes almost 90% of total operational cost. This huge expense happens due to many labors who are hired for manual taping process. In total, there are 89 direct labors. Stopwatch time study approach already gave the answer of this condition. It happens because of the standard time of labor in manual taping process is only 9.588 seconds per bundle or 6.3 bundle per minute generated by 3 operators. It is too slow especially when the demand more than 21,000,000 bundles per year and increasing.

## 5.2 Analysis of Automated Taping Process

As well as analysis of manual taping process, analysis of automated taping process is initialized by identification of cost proportion in the early year. The summary of cost proportion is shown in the following table.

Table 5. 1 Cost Proportion of Automated Alternatives (in IDR)

| | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| Investment cost | 1,684,856,154 | 1,687,524,813 | 2,550,112,317 |
| Operational cost | 2,424,935,475 | 2,892,370,950 | 2,786,764,163 |
| Maintenance cost | 153,212,850 | 204,283,800 | 280,890,225 |
| Total cost | 4,263,004,479 | 4,784,179,563 | 5,617,766,705 |
| % Investment cost | 40% | 35% | 45% |
| % Operational cost | 57% | 60% | 50% |
| % Maintenance cost | 4% | 4% | 5% |

It is clearly seen that the proportion of investment cost is escalated significantly from only 1% in manual process to around 40% in automated alternatives. The operational cost decreases from almost 90% in manual process to around 56%. This is the typical characteristic of investing in automation, that is high expense for investment but only once in the beginning and followed by lower operational cost along the year. There is also additional cost for maintenance due to technology implementation. Then, cost proportion inside the operational cost is summarized as follows.

Table 5. 2 Operational Cost Proportion of Automated Alternatives (in IDR)

| | Alternative 1 | Alternative 2 | Alternative 3 |
|---|---|---|---|
| Direct labor cost | 711,981,900 | 889,977,375 | 1,156,970,588 |
| Material cost | 1,570,393,575 | 1,570,393,575 | 1,570,393,575 |
| Energy cost | 142,560,000 | 432,000,000 | 59,400,000 |
| % Direct labor cost | 29% | 31% | 42% |
| % Material cost | 65% | 54% | 56% |
| % Energy cost | 6% | 15% | 2% |

In automated alternatives, most of operational cost is contributed from material cost for almost 60% in average. Here, the reduction of direct labor cost has trade off to additional costs for material and energy.

A factor that lowering the operational cost is reduction of direct labor which leads to reduction of company's expense for direct labor cost. As can be seen in proportion of labor cost to total operational cost from manual to automated. In manual taping process, the proportion is almost 90%; while in automated taping process the proportion is significantly reduced to around 34%.

The reduction of direct labor cost cannot be separated from the new composition of working post. Previously, three labors can only produce 6.3 bundles per minute. Now, three labors and a machine can produce up to 25 bundles per minute. Its productivity is increased almost 4 times than before.

However, there is another effect by implementing automated taping process; that is the increasing of material cost. By percentage, proportion of material cost to operational costs in manual process is around 10%; but in automated taping process it escalates significantly to almost 60%. It happens due to the price of PVC shrink film which replace tape is quite expensive. PVC usage for one bundle is also added up to follow mechanism of automated machine. Increasing of material cost become the consequence of implementing automation technology.

### 5.3 Benefit-Cost Analysis

All automated alternatives deliver certain benefit per unit. However, two alternatives (Alternative 2 and Alternative 3) have value of cost per unit exceed the manual cost per unit. Only Alternative 1 whose cost per unit is less than manual cost per unit. Moreover, Alternative 1 delivers the biggest benefit per unit than others. It is also proven by incremental benefit-cost analysis that Alternative 1 is the best solution of automation technology to replace manual taping process in Kamadjaja Logistics.

Besides cost, several factors become the reasons for choosing alternatives. Those factors are machine speed and its energy consumption. Machine speed will determine how many machines to be invested and how many direct labors to be hired. There are already two costs of investment and direct labor which come up from machine speed specification. Alternative 1 has the fastest machine speed among the alternatives. This is what make Alternative 1 become competitive than others.

Energy consumption will directly affect the energy cost calculation. The bigger the power (kW), the bigger amount of money to be paid for energy cost. Alternative 2 has the biggest energy consumption due to the machine has been refurbished before, while Alternative 3 has the smallest energy consumption but has the slowest machine speed. Even though Alternative 1 has power of 8,8 kW (the middle among alternatives), but its machine speed is the fastest.

## 5.4 Sensitivity Analysis

In sensitivity analysis, the effects of changing direct labor and material costs are observed. Along with increasing inflation of direct labor, the absolute incremental benefit-cost ratio is decreasing as well. However, benefit-cost ratio still more than 1. This is happens due to both benefit from labor reduction and cost of direct labor are increasing. It makes even though the cost per unit is increased but the benefit per unit is also increased.

Different result is obtained from increasing inflation rate for material cost. The result is automated process of Alternative 1 is not recommended if the inflation rate for material cost is more than 20%. The 20% of inflation rate will make the cost per unit of manual process is a lot cheaper than automated alternatives and the automated alternatives only deliver a slightly more benefit.

Sensitivity analysis for demand uncertainty shows that along with decreasing demand, the benefit-cost ratio is decreasing as well. Since automation technology is design to do mass production or overcome abundant demand, then if the demand is decreasing, so the automation technology is not recommended anymore. Here the indifferent point is at 9,228,284 bundles per year of demand.

# CHAPTER VI
# CONCLUSION AND SUGGESTION

This chapter will elaborate conclusions of this research and suggestions to improve the next research.

## 6.1 Conclusion

Conclusions of this research are as follow.

- The existing condition of value-added service, taping process, in Kamadjaja Logistics is still done manually by 89 direct labors. The standard time of manual taping process is 9.588 seconds per bundle or only 6.3 bundles per minute generated by 3 labors, with the production output for 2016 is up to 23,155,518 bundles. Here automated technologies are proposed to replace the manual process. Those automated machines are EntrePack Automatic SW-1713 L-Bar Shrink Wrap Machine, Gramegna Model ECO 2000 Shrink Bundler, and Prometica Sleeve Wrapping Heat Sealing Machine. All of those machine using the principle of sealing, wrapping, and heat-shrinking mechanisms.
- The best alternative of automation technology is using EntrePack Automatic SW-1713 L-Bar Shrink Wrap Machine (Alternative 1). The technology delivers additional benefit of IDR 129.71 per bundle and reduces cost of IDR 20.92 per bundle. It also speeds up the taping process into 25 bundles per minute generated by 3 labors or almost 4 times faster than manual process.

## 6.2 Suggestion

Suggestions for this and the next research are as follow.

- Opportunity cost calculation should be conducted.
- Observation is done more detailed for different bundle size.
- Conduct time study for different roles of direct labors.
- Develop more alternatives of technology.

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