

MANUFACTURING COST REDUCTION IN TEXTILE FACTORY

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วิทยานิพนธ์ฉบับนี้มีวัตถุประสงค์เพื่อทำการศึกษาสภาพและวิเคราะห์ปัญหาที่เกิดขึ้นภายในโรงงานสิ่งทอ เพื่อหาแนวทางในการลดต้นทุนการผลิตในโรงงานตัวอย่าง โดยการประยุกต์ใช้วิชาการทางวิศวกรรมอุตสาหการ ด้านการศึกษาวិธีการทำงาน ด้านการจัดการระบบเอกสาร การวิเคราะห์โครงสร้างของต้นทุนอุตสาหกรรมและการคาดคะเนต้นทุน นอกจากนี้ยังมีการประยุกต์ใช้ซอฟต์แวร์คอมพิวเตอร์เพื่อนำมาใช้ในการคำนวณต้นทุนของผลิตภัณฑ์ให้มีประสิทธิภาพมากยิ่งขึ้น

จากการศึกษาพบว่า ปัญหาที่สำคัญของโรงงานตัวอย่าง ได้แก่ ปัญหาด้านการจัดการระบบเอกสารต่างๆ มีระบบการคิดต้นทุนที่ไม่เหมาะสม และการสูญเสียวัตถุดิบในกระบวนการผลิต โดยผู้วิจัยได้เสนอแนวทางในการแก้ไขและปรับปรุงดังนี้

1. ปรับปรุงระบบการจับเก็บข้อมูลและเอกสารต่างๆภายในโรงงานให้มีประสิทธิภาพมากยิ่งขึ้น
2. การประยุกต์ใช้แผนผังแสดงเหตุและผล (Cause and Effect Diagram) เพื่อทำการวิเคราะห์หาสาเหตุที่แท้จริงของปัญหานั้นๆ เพื่อที่จะได้หาทางแก้ไขปัญหาได้อย่างมีประสิทธิภาพ
3. การประยุกต์ใช้เทคนิคการศึกษากการทำงาน (Work Study) เพื่อช่วยในการกำหนดมาตรฐานการทำงานและเวลามาตรฐานในการทำงาน และลดความสูญเสียของวัตถุดิบในกระบวนการผลิต
4. การประยุกต์ใช้ซอฟต์แวร์คอมพิวเตอร์ คือ Microsoft Office Access เพื่อเข้ามาช่วยในการจัดทำระบบฐานข้อมูลที่จำเป็นต่อการคำนวณต้นทุนการผลิตของผลิตภัณฑ์

ผลจากการศึกษาและวิจัยพบว่า ภายหลังจากการปรับปรุงตามแนวทางต่างๆที่ได้เสนอแนะ ทำให้อัตราการสูญเสียในกระบวนการผลิตลดลงจากเดิม 30.69% ค่าจ้างแรงงานทางตรงต่อชั่วโมงลดลงจากเดิม 7.42% และประสิทธิภาพการทำงานของแรงงานเพิ่มขึ้นจากเดิม 6.31% นอกจากนี้ยังเป็นการปรับปรุงระบบฐานข้อมูลให้มีความถูกต้องมากยิ่งขึ้น ซึ่งจะช่วยให้ผู้บริหารสามารถตัดสินใจในการทำงานได้อย่างมีประสิทธิภาพและรวดเร็วขึ้น

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The objective of this thesis is to study and analyze the current problems happened in the textile factory in order to find the methods to reduce the production costs by applying the principle of engineering industry such as work study, document management system, analysis of industry costs' structure and cost estimation including apply the computer software to help for calculating the production cost.

As the results of study, the main problems of the sample factory are the inefficiency of document management system, the inappropriate costing system, and the loss in the production process. Thus, the researcher propose the methods in order to solve the problems as follows:

1. Improve the document management system within the sample factory
2. Apply "Cause and Effect diagram" to analyze the root causes of problems in order to find the efficient solutions.
3. Apply the work study method to set the standard work method, the standard time, and reduce losses in the production process.
4. Apply the computer program (Microsoft Office Access) to calculate the production costs.

As the results of improvement, it found that the percentage of defect and waste decreased around 30.69%, the rate of direct labor cost per direct labor hour decreased around 7.42%, and the performance of workers increased around 6.31%. Furthermore, the accuracy of database has been improved that will help the top manager to decide to work more efficient and faster.

The Regional Centre for Manufacturing Systems Engineering Student's Signature:.....

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CHAPTER I

Introduction

1.1 Thesis Background

In the complex world of globalization and technology, nowadays almost businesses are facing with increasingly competitive pressure. Therefore, in order to be survive in the intense competition, to provide the quality products together with the consideration in minimize the cost is necessary. By the improvement cost of the manufacturing process performance or the enhancing in quality control system and delivery system are some strategies to produce products which meet customers' requirements.

In forty years ago, there are a few big manufacturers and a few kinds of products in the textile business. However, new manufacturers have set up recently due to the increasing of customers demand. Therefore, the textile business becomes one of the most competitive businesses. In the high competitive situation both old and new manufacturers of textile business have to change their strategies in term of productivity, marketing and customer service. Especially, waste cost control and reduction for selling products at lower price than the other competitors is as important as improvement of product quality that will increase competitive potentiality for survival in today's business situation.

The sample factory is the manufacturer of collars and sleeves, which are the parts of textile business. The company directly trades for domestic market and has proceeded more than thirty years ago. Currently, the sample factory has about 100 employees. Moreover, the company is the family business that has commanded and controlled by the owner. So, the organization structure of company tends to low in complexity, low in formalization but high in centralization. Furthermore, the systematic work is lack of efficiency because of improper costing system and lack of data collection (data mining). Therefore, the owner can not know the actual manufacturing costs in each process in the factory including the real causes of

problems or the weak points within the production processes because of no data collection.

According to the increasing price of raw materials, oil and labor costs, the company has to pay more attention to use the appropriate costing system, which will help the company to know the actual manufacturing costs and can find the methods to control or reduce wastes.

Thus, constructing the appropriate costing system including reducing the manufacturing costs are necessary to the factory to calculate the actual costs of each product, to reduce losses, to increase the production efficiency and to gain more profits for surviving in the intense competition.

1.2 Production Process in Sample Factory

It can be divided the manufacturing process of collars and sleeves into 5 processes, which are consisted of Spinning, Weaving, Cutting & Finishing, Ironing, and Packaging. Figure below shows the production process of collars and sleeves.

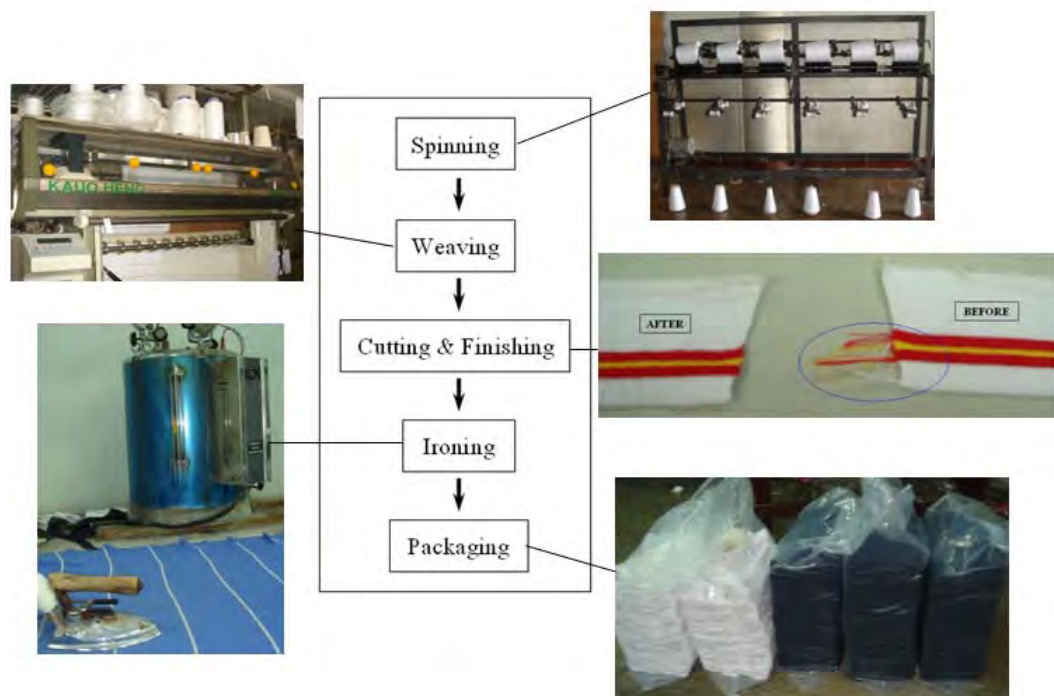


Figure 1.1: Production Process in Sample Factory



Figure 1.2: Sample Products of Sample Factory

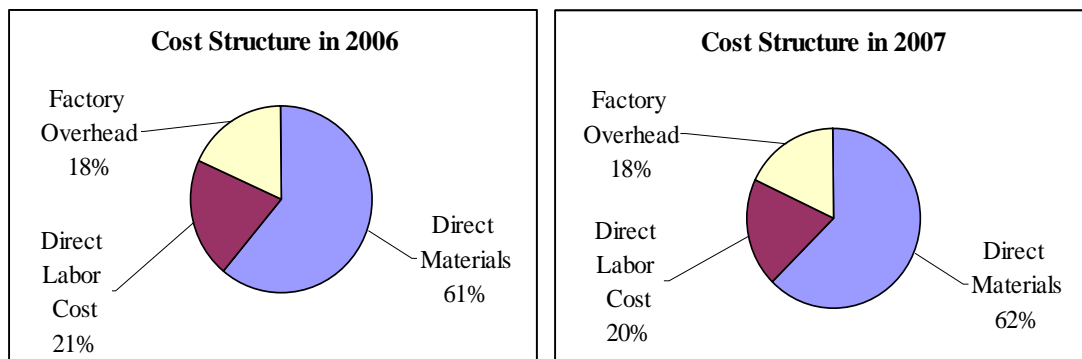
1.3 Statement of Problems

According to the current costing system of the company, it can not provide the accurate financial information and the actual manufacturing costs. Furthermore, the company does not have the data collection and documentation system in the production process so the company can not know the performance of manufacturing processes including the root causes of problems in the production process. Therefore, it is very difficult for the company to improve the production efficiency and compete with the other competitors. Furthermore, the mistakes of the current costing system will lead to wrong decision-making in bargaining price with customers and competing price with competitors.

According to the current costing system, it can be classified the production costs into 3 major parts that are consisted of direct raw materials cost, direct labor cost, and factory overhead cost. Table and Figure below is shown the details of production costs in year 2006-2007.

Table 1.1: Detail of Production Costs in year 2006-2007

Lists	Baht (year 2006)	Baht (year2007)
Direct Materials	7,180,394.04	6,827,065.10
Direct Labor Cost	2,450,721.00	2,149,759.00
Factory Overhead	2,154,875.28	1,973,819.14
Total Production Cost	11,785,990.32	10,950,643.24

**Figure 1.3:** Proportion of Production Costs in year 2006-2007

According to Figure 1.3, it is shown that the main production cost in manufacturing process is the direct raw materials cost. Therefore, if the company would like to reduce wastes and costs, the direct raw material cost has been taken into account prior.

Currently, the methods of setting the cost of each product are estimated by the owner's experience without the systematic calculation because of the unsuitable costing system. However, it can be roughly concluded the cost calculation of each product that is shown in Figure below.

$$\begin{aligned} &\text{Cost of each product (baht per dozen) =} \\ &[\text{Amount of direct material (kg. per dozen) * Price of raw material (baht per kg.) }] \\ &\quad + (30\% - 50\% \text{ of B}) \end{aligned}$$

B

Figure 1.4: Cost Calculation of Each Product

(**Note:** (30% - 50% of B) is consisted of labour costs and Factory Overhead costs (FOH). Adding (30% - 50% of B) is depended on the patterns and types of each product.)

In summary, the problems can be listed below:

1. The company can not know the actual manufacturing costs of each product because of the unsuitable costing system.
2. There is no effective documentation system to collect data in the production processes. Thus, the company has no guidelines used for reducing manufacturing costs and defects.

There are a plenty of improvement methods for solving the problems. However, the company has to should the suitable methods that fit in with the company's conditions because if the wrong methods are chosen, the result will not be as expected.

1.4 Objectives

To develop the documentation system and the appropriate costing system for cost reduction in the sample factory.

1.5 Scope of the Research

The scopes of this research will be focused on manufacturing cost reduction at the sample factory, which is the manufacturer of collars and sleeves, by developing

the documentation system and constructing the appropriate costing system (new costing system).

1.6 Expected Benefits

The expected benefits of this research are shown as follows:

1. To develop the documentation system and the appropriate costing system.
2. To analyze the cost of each product.
3. To reduce the manufacturing costs and defects in the sample factory.
4. Increasing the competitive opportunity with the competitors.

1.7 Research Procedure

The procedures of this research are shown as follows:

1. Study and review the literatures and the related studies.
2. Study and collect the primary information within the sample factory.
3. Study and analyze the manufacturing processes and the current costing system of the factory.
4. Define the current problems.
5. To develop the documentation system and construct the appropriate costing system (new costing system).
6. To examine and analyze the production losses and find the causes of problems.
7. Determine the methods to solve those problems in order to reduce wastes and defects in manufacturing processes.
8. Analyze and summarize the results of research after implemented the new costing system.
9. Prepare the thesis report.
10. Thesis examination.

1.8 Research Schedule

Table 1.2: Research schedule

Procedure	2008			2009			
	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1. Study and review the literatures and the related studies.							
2. Study and collect the primary information within the sample factory.							
3. Study and analyze the manufacturing processes and the current costing system of the factory.							
4. Define the current problems.							
5. To develop the documentation system and construct the appropriate costing system.							
6. To examine and analyze the production losses and find the causes of problems.							
7. Determine the methods to solve those problems.							
8. Analyze and summarize the results of research.							
9. Prepare the thesis report.							
10. Thesis examination.							

CHAPTER II

Theoretical Considerations and Literature Review

The cost is an important criterion of the production beside the quality and the delivery. Cost accounting is the financial report, which is categorized by the cost structure. Moreover, the cost structure can be divided into three main parts that are consisted of the direct raw material cost, direct labor cost and factory overhead. Cost estimation is an approximation of the expense and has a relationship with the production and the operation. Cost estimation method is calculated according to the type of production. For example, the standard cost estimation estimates the cost of performing the production under the normal condition, where as project process cost estimation is used under the intermittent operation. And, the approximation cost of the project is for the project management.

2.1 The Production Cost

The production cost or the manufacturing cost is the total cost incurred in producing goods. “Most manufacturing companies divide manufacturing costs into three broad categories: direct materials, direct labor, and manufacturing overhead.” (Garrison, et al., 2006)

2.1.1 Type of production costs (Manufacturing Costs)

It can be divided the production cost into three parts as follows:

2.1.1.1 Direct raw material cost (DM) - all raw material that becomes an integral parts of finished products. The amount of direct raw materials will vary depending on the production volume. The more production, the more material. The less production, the less material. However, indirect materials which vary inversely as the production quantity are categorized in the factory overhead.

$$DM = \text{Total Units} \times \text{Cost per Unit}$$

Note:

- Total Units data should be provided by the production sector because they can estimate both the production unit and the normal spoilage.
- Cost/ Unit can be calculated by many methods such as Weight Average (WA), First In First Out (FIFO) and Last In First Out (LIFO).

2.1.1.2 *Direct labor cost (DL)* – the cost of labor used directly in the manufacture of products. It varies directly with the production quantity.

$$DL = \text{Labor Hours} \times \text{Wage Rate}$$

Note:

- Labor hours should be prepared by engineering department and production department because they know the number of workers and the number of hours per activity.
- Wage rate should be responsible by HR department.

2.1.1.3 *Factory overhead (FOH)* – other manufacturing expenses that cannot be charged directly to products such as indirect material cost, indirect labor cost, rent, depreciation, maintenance, social security, utility cost, insurance on manufacturing facilities miscellaneous expenses, etc.

However, there are the other costs that are not included in the production costs (manufacturing costs). “Generally, nonmanufacturing costs are sub classified into two categories: (Garrison, et al., 2006)

1. Marketing or selling costs.
2. Administrative costs.”

Figure below shows the summary of cost terms that are described above.

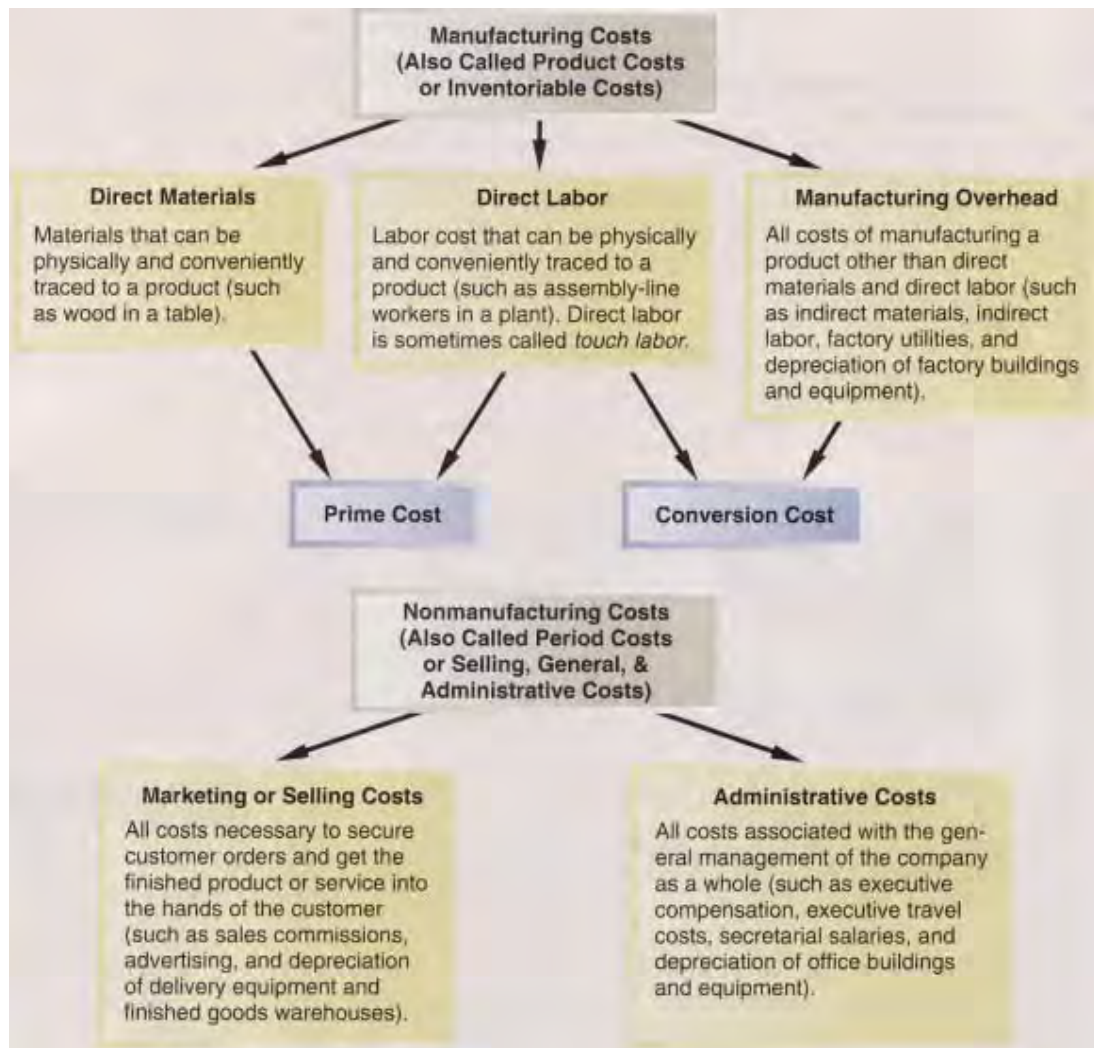


Figure 2.1: Summary of Cost Terms
(Garrison, et al., 2006)

2.2 Costing System

It is used to keep track and control the production and distribution processes. The types of costing system will be discussed below.

2.2.1 Job Order Cost System: It is a cost system which is used with a variety of products and multiple steps of production process. The production cost analysis is complex. The labor cost and material cost are traced with specific units of production.

2.2.2 Process Cost System: It is used under continuous processing and homogenous mass production methods.

2.2.3 Standard Cost System: It is the system calculating cost per unit and estimating the standard cost based on efficient and attainable performance before completing the products. The standard cost is used to compare with the actual cost in order to control, manage and improve the inefficient performance and operation. Figure 2.2 shows the structure of the standard cost.

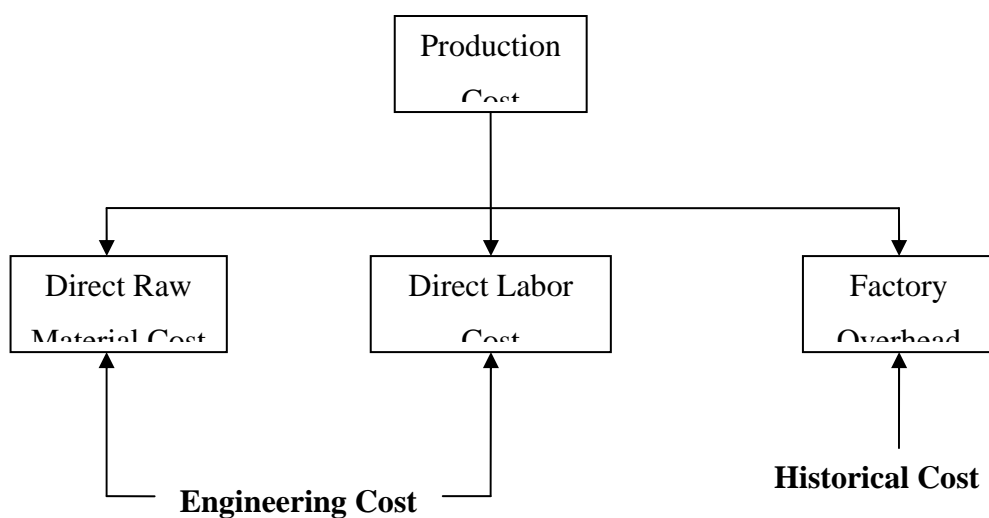


Figure 2.2: The Structure of Standard Cost

2.3 Cost Estimation

The cost estimation is the approximation of the probable total cost for producing the products based on the old data in order to estimate the production cost that will be occurred in the future.

There are 4 types of cost estimation technique.

1. Accounting Analysis
2. Engineering Estimates
3. Scatter graph and High-Low Estimates
4. Statistical Method: Regression Analysis

This thesis focuses only the scatter graph and high-low-estimates method, which will be explained below.

2.3.1 Scatter Graph Method

It is an estimation of the data plotting the cost (Y-axis) and activity (X-axis) relationship (Cost-Activity Relationship) as shown in the following graph.

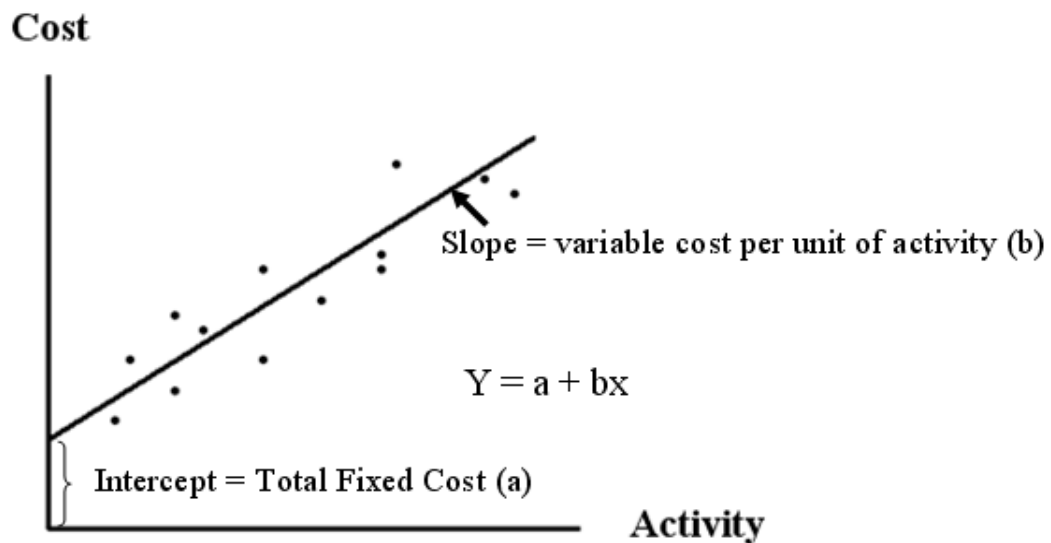


Figure 2.3: Relation Diagram between Cost and Activity
(Cost-Activity Relationship)

After plotted the points, which are represented the relation between cost and activity, the approximate straight line has been created in order to estimate the overall cost that can be divided into the fixed cost (a) and the variable cost (b). The slope (b) is the change in cost due to change in activity and shows the variable cost per unit of activity (labor hour). And, the intercept at Y-axis presents the total fixed cost (a).

Thus, according to the equation: $Y = a + bx$,

Y = Total Cost (fixed + variable cost)

a = Total fixed cost (vertical intercept of line at Y-axis)

b = Variable cost per unit of activity (slope)

X = Unit of activity

Furthermore, the linear equation ($Y = a + bx$) and the coefficient of determination (R-square), which is used to check the accuracy of data, are also created. Moreover, the value of R-square has the range from 0 to 1 and the acceptable value of R-square should more than 0.6. And, the equation of R-square is shown below.

$$R^2 = \frac{\left\{ \sum (X_i - \bar{X})(Y_i - \bar{Y}) \right\}^2}{\sum (X_i - \bar{X})^2 \cdot \sum (Y_i - \bar{Y})^2}$$

This method (scatter graph) is easy to use and simply understand. However, the estimation of fixed cost and variable cost by the scatter graph method cannot be used effectively and efficiently if the observation data are too much different.

2.3.2 High-Low Estimation

If the cost estimation can be found from the two points of the line on the graph, then the cost formula can be created. These two points must be the highest level and lowest level of activity. It means that the cost at the highest activity and the cost at the lowest activity can form a variable cost formula as below.

$$\text{Variable Cost (per hour)} = \frac{\text{The cost at highest activity} - \text{The cost at lowest activity}}{\text{The highest activity (hours)} - \text{The lowest activity (hours)}}$$

$$\text{Total Fixed Cost} = \text{The cost at highest activity} - [\text{Variable Cost/Hour} \times \text{Highest activity (hours)}]$$

$$\text{Or,} \quad = \text{The cost at lowest activity} - [\text{Variable Cost/Hour} \times \text{Lowest activity (hours)}]$$

2.4 Variance Analysis of Standard Costs

The standard cost is set up before the production process. After the production process, the standard cost and the actual cost will be compared. The variance is the difference between the standard cost and the actual cost. The result can be “favorable” which the actual cost is lower than the standard cost, and “unfavorable” which the actual cost is higher than the standard cost. If the actual cost is much higher than the standard cost, it will be a signal to the management department to solve the problem or reduce the production cost by focusing on the following factors:

1. *The different spread between the standard cost and the actual cost*
2. *The department that causes this problem*
3. *Who should be responsible for the difference?*
4. *The causes of the difference*

2.4.1 Material Cost Variance – the difference between the actual cost and the standard cost of material which can be shown into 2 types.

2.4.1.1 Material Price Variance – Material price variance occurs from the changing of the market price, the materials short supply, the negotiation with suppliers, etc. It is a variation between the actual price and the standard price which is

$$\text{Material Price Variance} = \text{Actual Quantity} (\text{Actual Price} - \text{Standard Price})$$

2.4.1.2 Material Usage Variance – a variation between the actual quantity of materials and the standard quantity of materials, valued at the standard cost per unit of materials. It occurs from the raw materials quality, the efficiency of machines, the decay of materials, etc.

$$\text{Material Usage Variance} = \text{Standard Cost} (\text{Actual Quantity} - \text{Standard Quantity})$$

2.4.2 Labor Cost Variance – the difference between the standard labor cost and the actual labor cost incurred, which can be shown into two types.

2.4.2.1 Labor Rate Variance – a variation between the standard labor rate and the actual labor rate, multiplied by the actual labor hours incurred.

2.4.2.2 Labor Efficiency Variance - a variation between the standard labor hours and the actual labor hours, multiplied by the standard labor rate.

2.4.3 Factory Overhead Variance – the difference between the standard factory overhead and the actual factory overhead, which is divided into

2.4.3.1) Two variance Method

2.4.3.1.1) Budget Variance

2.4.3.1.2) Volume/ Capacity Variance

2.4.3.2) Three Variance Method

2.4.3.2.1) Budget Variance

2.4.3.2.2) Volume/ Capacity Variance

2.4.3.2.3) Efficiency Variance

2.4.3.3) Four Variance Method

2.4.3.3.1) Budget Variance

2.4.3.3.2) Volume/ Capacity Variance

2.4.3.3.3) Efficiency Variance

2.4.3.3.4) Fixed Efficiency Variance

Therefore, the variance analysis of the reasonable and efficient standard cost is a useful tool to check and improve the inefficiency (falsify) of operational procedures.

2.5 Analysis Causes of Problem

The factors, which cause the loss in the production process, are consisted of man, machines, materials, methods, and environment. It has the steps for analyzing the causes of problems as follow:

2.5.1 Collecting Data

To create the documentation system and the reporting system for recording data in order to measure the production process's dissemination or to find the cause of things which need to improve to measure the level of dissemination to know the origin of problems. There are various kinds of technique to collect its data such as

Histogram - is a graphical display of the tabulated frequencies, shown as bar graph.

Pareto Chart - is a chart to demonstrate the most important cause of problem. How to create the chart? - classify data to each category then arrange the most frequency category to the far left of the chart and then other categories respectively. It is not only indicates the most important cause and others by priority but also shows the cumulative graph.

2.5.2 Analysis Cause and Effect

The systematic analysis will help to seek the root causes of problem in order to reduce the loss. Thus, one of the useful techniques for seeking and solving the problems is 5W 1H question that is explained below.

- Who: Who made an effect?
- What: What an effect is?
- Where: Where did an effect occur?
- When: When did an effect occur?
- Why: Why did an effect occur?
- How: How did an effect occur?

As for analyzing the causes, creating a valuable question is very important because it would be helpful to find the real cause to solve the problems.

Moreover, one of the most popular methods to analyze the causes of problem is Cause and Effect diagram which continues from Pareto Chart. After choosing one of problems, which would like to solve, from Pareto Chart, it needs to brainstorm to explain causes of problem. And, the causes will be classified like a fishbone and shown the effect by writing down at the bottom of the chart.

“The fishbone diagram is used primarily in the Define, Analyze, and Improve steps of the DMAIC process. It helps identify which input variables should be studied further and gives focus to the analysis. The purpose of a fishbone diagram is to identify all input variables that could be causing the problem of interest.” (Brussee, 2004)

The principles of creating fishbone are described below.

i) Choosing the specific problem from Pareto Chart, it will be the effect that is shown at the end of Cause and Effect Diagram. (Draw a horizontal line and the effect (specific problem) is normally the head of a fishbone diagram.)

ii) Write down causes of problem separate from horizontal straight line which directly point to effect. Start with the majority causes which are generally consisted of man, machines, materials, working methods, and environment as shown in figure below.

Moreover, Brussee (2004) explained that “The six categories are Measurements, Materials, Men, Methods, Machines, and Environment. (Some people remember these as the five M’s and one E.) The six categories are what make the fishbone diagram more effective than just simply listing the input variables.” Figure below shows the fishbone diagram.

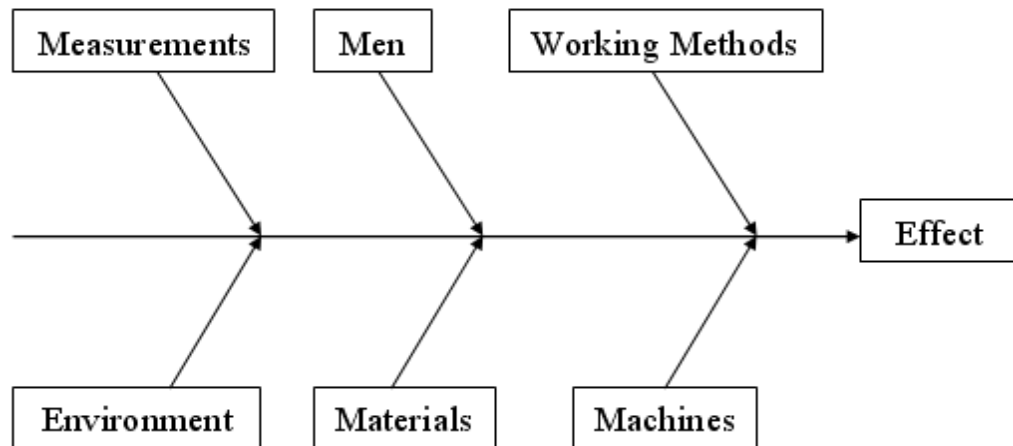


Figure 2.4: Cause and Effect Diagram (Ishikawa or Fishbone Diagram)

2.6 Database System

Database system is a collection of files which enables to access, organize and select data in a database.

2.6.1 The Elements of Database System

The important elements of database system consist of 3 parts.

2.6.1.1 Input: It is basic information of internal and external organizations sent to the processing unit to produce the report required by the production department.

2.6.1.2 Processing: It is an accumulated data used to process and summarize mass data like the calculator and typewriter.

2.6.1.3 Output: Information is produced after processing the data. The analyzed output is used for planning and controlling the activity.

2.6.2 The Database Design

Database design is the process of creating the data into the system or implementing some parts of the old system depending on the required output and the analyzed data. Database design consists of three significant steps as follows:

2.6.2.1 *The report design* – the important and useful part for manager to achieve the target objective.

2.6.2.2 *The design information to import processing system* – screening the data into the system to produce the required report.

2.6.2.3 *Designing a data processing system* – collecting, recording, procession, analyzing and revocable information to produce the required output.

2.7 Method Study

Method study can improve, facilitate, eliminates and innovate some areas of process such as production, method, working environment etc. to reach the optimum outcome effectively and efficiently under resource and environmental constraints. These can be described in the following steps.

2.7.1 Define - Select the project to be studied and consider the following criteria e.g. priority, necessary, possibility, breakeven, and other difficulties.

2.7.2 Record - Collect the data and problems in each procedure to be solved later. The steps for recording data are shown as follows:

2.7.2.1 Define the starting step and finishing step

2.7.2.2 Study and distinguish the manufacturing process until completely understand

2.7.2.3 Draw the symbol in each step

2.7.2.4 Describe the symbol in detail

2.7.2.5 Examine and compare the description of symbol with the actual task

2.7.2.6 Correct and record all details again

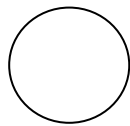
2.7.2.7 Proved by third party

2.7.3 Examine - Consider the process to improve the method by using 6W-1H method: What, Who, When, Where, Why, Which and How.

2.7.4 Improve and Develop – Eliminate the weak points and increase the efficiency of process.

The Process Chart Analysis - The process chart is the chart of work flows used to present and examine the sequence of steps or tasks to be simple understood. It shows all steps from raw materials to the finished products. It also records and identifies areas of possible improvement, elimination and delay to achieve the lowest cost and the optimum performance.

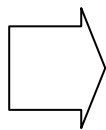
The process chart is represented by the symbols promulgated by the American Society of Mechanical Engineers (ASME) which can be categorized into 5 groups. (Source: Adapt from: Institute of Management Services [online])



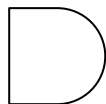
Operation - It is the main step where material is modified, changed, separated, conjugated and prepared by physical or chemical.



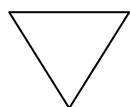
Inspection - This step inspects the quality and quantity of each type of products.



Transportation - It moves the products from one place to another place, except the movement during the operation and inspection processes.



Delays - The product is laid aside or waited until the next step begins.



Storages - The product is retained until required.

2.7.5 Measure – Comparing the results before and after improvement.

“The terms *time study* and *work measurement* are often used interchangeably. Both are concerned with how much time it should take to complete a unit of work. **Work measurement** refers to a set of four techniques that are concerned with the evaluation of a task in terms of the time that should be allowed for an average human worker to perform the task: (1) direct time study, (2) predetermined motion time systems, (3) standard data system, and (4) work sampling, an alternative work measurement technique in which statistical measures are determined about how workers allocate their time among multiple activities. The task that is measured is usually a repetitive work cycle. The objective of these work measurement techniques is to determine a **standard time** for the task.” (Groover, 2007)

Figure below shows the classification of methods to determine the time standards.

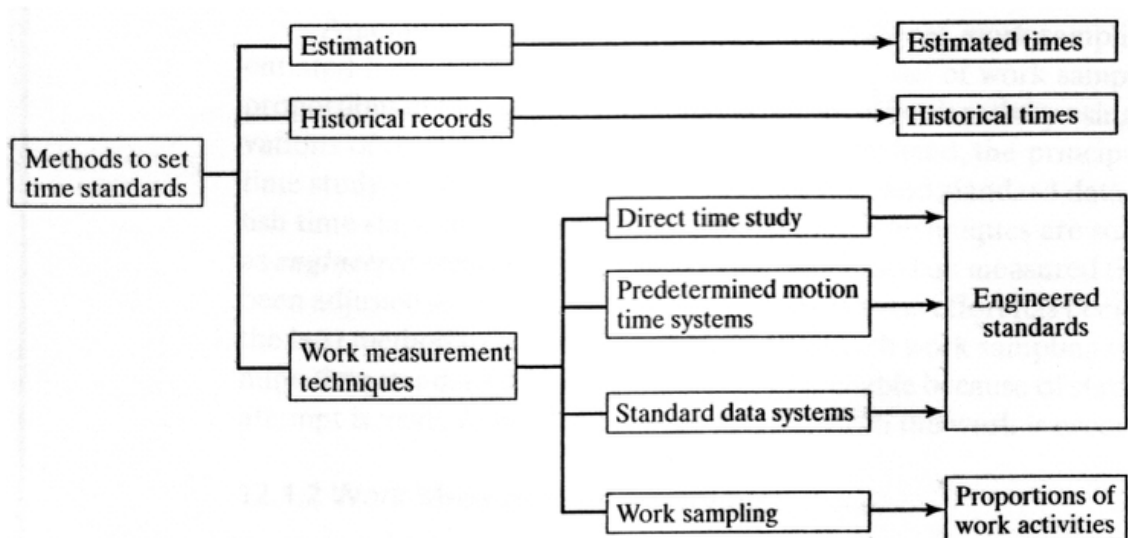


Figure 2.5: Classification of Methods to Determine Time Standards

(Groover, 2007)

2.7.5.1 Direct Time Study (Stop Watch Method) - It records the time taken to complete the task in each step by using timekeeping devices. It is useful for batch and mass processing. The steps of this method are described below.

1. Select the operation/ project, and well-trained and similar speed level workers.
2. Divide the operation/ project into work elements in order to calculate the time and the velocity of each element. Table 2.1 shows the guidelines for defining the work elements in direct time study.
3. Observe, record, and time the work elements to obtain the observed (actual) time required to complete the task.
4. Take the primary data to compute the number of cycles.

Table 2.1: Guidelines for Defining the Work Elements in Direct Time Study

Guideline	Explanation and Examples
Each work element should consist of a logical group of motion elements.	The work element should have a unified purpose, such as reaching for an object and moving it to a new location (e.g., reach, grasp, move, and place). There would be no purpose in separating the reach from the move motions since they both involve the same object.
Beginning point of one element should be end point of preceding element.	There should be no gap between one element and the next in the task sequence. Otherwise, the time of the gap is omitted from the recorded total time.
Each element should have a readily identifiable end point.	A readily identifiable end point can be easily detected during the study. It can often be anticipated to allow reading of the watch more conveniently. An audible sound, such as the actuation of a pneumatic device, provides a readily identifiable end point.
Work elements should not be too long.	If a work element is very long (i.e., several minutes), it should probably be divided into multiple elements that are timed separately. Machine semiautomatic cycle time is an exception. Some machine cycles can take several minutes and should be identified as one element.
Work elements should not be too short.	A practical lower limit in direct time study is around 3 sec. Below this, reading accuracy may suffer. If a video camera is used for timing purposes, shorter elements may be possible.
Irregular work elements should be identified and distinguished from regular elements.	Irregular elements are work elements that do not occur every cycle. The frequency with which they should be performed must be noted. The time(s) for the irregular element(s) are prorated across the regular work cycle when the standard time is computed.
Manual elements should be separated from machine elements.	Manual elements depend on the operator's performance (pace) and therefore vary over time. Machine elements are generally constant values that depend on machine settings. Once the settings are established, the actuation time shows no perceptible variation.
Internal elements should be separated from external elements.	Internal elements are performed by the operator during the machine cycle. In most cases, they do not affect the overall work cycle time. External elements are performed outside of the machine cycle. They contribute to the overall work cycle time.

(Source: Groover, 2007)

5. Evaluate worker's pace relative standard performance depending on skills, effort, working environment (conditions), the difficulty of the task (consistency), etc. called performance rating factor.

“Rating is the process of adjusting the time taken by an individual operator to what could be expected from a normal operator. The industrial technologist must understand the industry standards of *normal*.

Rating an operator includes four factors:

1. Skill
2. Consistency
3. Working conditions
4. Effort (most important).” (Meyers, 1992)

6. Calculate “the normal time”

$$\text{Normal Time} = \text{Observed (actual) Time} \times \text{Rating Factor}$$

7. Calculate the allowable time (PFD allowance).

“Allowances are extra time added to the normal time to make the time standard practical and attainable.” (Meyers, 1992) There are three types of allowances that are personal, fatigue, and delays allowances.

“**Personal time** includes restroom breaks, phone calls, water fountain visits, and similar interruptions of a personal nature.

The **fatigue** or **rest** allowance is intended to compensate the worker for time that must be taken to overcome fatigue due to work-related stresses and conditions.

Delays are unavoidable interruptions from work that occur at random times during the day.” (Groover, 2007)

Table 2.2 shows typical allowances in percentage for various conditions of work. (See more details of the recommended allowances of International Labour Organization in Appendix A: Table A-10)

8. Calculate the standard time to recover personal, fatigue and delay allowances.

$$\text{Standard Time} = \text{Normal Time} + (\% \text{ Time Allowances} \times \text{Normal Time})$$

Table 2.2: Typical Allowance Percentages for Working Conditions

Percent		Percent	
A. Constant allowances:			
1. Personal allowance	5	4. Bad light:	
2. Basic fatigue allowances	4	a. Slightly below recommended	0
B. Variable allowances:			
1. Standing allowance	2	b. Well below	2
2. Abnormal position allowance:		c. Very inadequate	5
a. Slightly awkward	0	5. Atmospheric conditions (heat and humidity)—variable	0-10
b. Awkward (bending)	2	6. Close attention:	
c. Very awkward (lying, stretching)	7	a. Fairly fine work	0
3. Use of force or muscular energy (lifting, pulling, or pushing):		b. Fine or exacting	2
Weight lifted (in pounds):		c. Very fine or very exacting	5
5	0	7. Noise level:	
10	1	a. Continuous	0
15	2	b. Intermittent—loud	2
20	3	c. Intermittent—very loud	5
25	4	d. High-pitched—loud	5
30	5	8. Mental strain:	
35	7	a. Fairly complex process	1
40	9	b. Complex or wide span of attention	4
45	11	c. Very complex	8
50	13	9. Monotony:	
55	15	a. Low	0
60	17	b. Medium	1
65	19	c. High	4
70	22	10. Tediousness:	
		a. Rather tedious	0
		b. Tedious	2
		c. Very tedious	5

(Source: Stevenson, 2007)

2.7.5.2 *Work Sampling* - It is a statistical selection technique to record and evaluate performance of the certain activity by using random observations, and estimate the proportion of time which workers or machines spending on tasks. The data collection for further computing can be one of two states: working or idle. The concept is the larger the sample size, the results will be more accurate. The result of this assessment tool is quite rough, so it is useful for the task that has many steps.

Principles of data collection of work sampling:

- i. Random Time
- ii. Sufficient Data

Table 2.3 shows the recommended steps for conducting a work sampling study.

Table 2.3: Recommended Steps in Conducting a Work Sampling Study

1. **Define the objective(s) of study.** What is the problem to be studied? Why is work sampling the appropriate technique to study the problem? What is the desired information that will be realized from the study? Formal answers to these kinds of questions help to structure the study, reduce ambiguities, and define expectations.
2. **Define the subjects to be studied.** If the study involves the activities of workers, which specific workers are to be studied? If the study involves machines, which specific machines will be included?
3. **Define the output measure(s).** This applies to situations in which an average task time or time standard will be established by means of the work sampling study. In a factory, what are the parts or products that relate to the activities performed by the subjects in the study? In an office work situation, what are the bills, or claims, or other documents that are being processed by the subjects? If the objective of the work sampling study is to determine a time per unit of output, the output units will have to be counted. If the work sampling study has other objectives, then defining an output measure may not be necessary.
4. **Define the activity categories.** These are the defined states of the subjects that will be identified during the study. If the study includes output measures, the activity categories must correlate with these outputs. But additional categories will likely be included also, such as "idle," "waiting for work," and "downtime." Some of the issues in defining the activity categories are discussed in Section 16.3.1.
5. **Design the study.** Design of the work sampling study includes the following steps and decisions: (a) Design the forms that will be used to record the observations (Section 16.3.2). (b) Determine how many observations will be required. This is likely to involve the types of decisions and calculations discussed in Section 16.2.2. (c) Decide on the number of days or shifts to be included in the study. It is important that the period covered by the study is representative of the usual activities engaged in by the subjects. (d) Schedule the observations. What are the randomized times when the observations will be made (Section 16.3.3), and what are the routes the observers will follow to make the observations? (e) Determine the number of observers needed.
6. **Identify the observers who will do the sampling.** The likely candidates include the industrial engineer in charge of the work sampling study, technicians who are assigned to this industrial engineer, and first-line supervisors in charge of the subject workers. An alternative approach is to use *self-observation* where the subjects themselves record the data, using a buzzer in the work area or beepers for workers located remotely. The problem with this technique is the risk that bias will be introduced into the results. Training will be required for whoever is assigned to be an observer. Typical training would include making sure the observers understand the objective(s), introduction to the principles of sampling and statistics, practice in identifying the activity categories, and understanding the importance of making the observations at the appointed times. If the study requires performance ratings to be made by the observer, then special training in this function must be provided.
7. **Announce the study.** All those who will be affected by the study should be informed about it. This includes obtaining the approval of the supervisor of the subject population. In particular, the subjects who will be observed are owed an explanation about the study and its objectives. This announcement step is of critical importance. Work sampling studies have failed because workers were not properly informed and their support was not obtained. Only novices and fools would be tempted to perform a secret work sampling study and expect the results to be taken seriously.
8. **Make the observations.** Make all observations according to the schedule. Record the data, and summarize the data each day. At the beginning, before collecting the data, it may be appropriate to conduct a trial study over a one- to three-day period. This will help to work out any "bugs" in the study, such as difficulties in classifying activity categories or recognizing and dealing with biases, or it may lead to a revision in the length of the full study or the number of observations required. Some or all of the data in this initial trial period may need to be discarded if problems exist.
9. **After completing the study, analyze and present the results.** Prepare a report that summarizes and analyzes all data. Make recommendations if appropriate.

(Source: Groover, 2007)

2.7.5.3 Predetermined Time Standard - It is a work measurement technique defining the time needed for the operational performance by deviation from the standard time for human motions. It uses time measurement unit (TMU: 1 TMU = 1/100,000 hours)

2.7.6 Define Standard Method - Define the method in writing as standard rules of the company to be acted by workers. "The *standard method* is the procedure

that has been determined to be the optimum method for processing a work unit. It is the procedure that is the safest, quickest, most productive, and least stressful to the worker. It is constrained only by the practical conditions and economic limitations of the particular work environment.” (Groover, 2007)

2.7.7 Apply – Apply the standard method in the actual work.

2.7.8 Sustain – Improve working methods and develop processes in order to work on sustainable and efficient.

2.8 Literature Review

Chutipong Punyaprasiddhi (2002) studied about manufacturing process cost reduction in a lady shoe factory by creating the standard costing method. As the result of this research, it was shown that constructing the appropriate costing system, which fits in with the factory’s condition, and developing the effective documentation system will help the company to reduce the production costs and wastes.

Freimer, Michael, Thomas, Douglas, and Tyworth, John (2006) studied about the investment in setup cost reduction and quality improvement will result in the number of defects reduction.

Kaemkarn Phinyo (2001) studied about production cost reduction in garment factory. By applying the work study to help the company to set the standard time and work in each process. Moreover, this research was applied Microsoft Access program to manage the documentation system and support the production planning and control.

Lere, John C. (2001) studied about the problems of using inappropriate product costing system and defined the methods to solve the problems. According to the inappropriate product costing system, the company can not know the actual manufacturing costs and also can lead to the wrong decision-making. Moreover, “this article describes three types of adjustments in the handling of manufacturing overhead: (1) change the denominator used in computing the overhead rate to one that

better reflects differences in product demands on manufacturing facilities, (2) divide manufacturing overhead into multiple cost pools yielding multiple rates to reflect differences in intensity of use of different segments of manufacturing facilities, and (3) use dominators that represent batch-and product-level in addition to unit-level cost drives together with multiple cost pools, as in activity-based costing.”

özbayrak, M., Akgün, M., and Türker, A.K. (2004) studied about the effects of production planning and control systems on the estimation of the manufacturing cost with Activity-Based Cost calculation in an advanced manufacturing system. Activity-Based Cost (ABC) will help to know how cost is incurred in products in each activity. According to this research, it is shown that the ineffective and inefficient production planning and control system will be occurred the wasted actions in manufacturing process and all wastes will be translated into cost. In order to minimize the losses, it is importance to manage a balanced work load and streamlined production processes together with using the powerful costing system (ABC).

Ukrit Saisit (2000) studied about a variance analysis between standard cost and actual cost in automotive parts manufacturing. According to the existing costing system, it did not show the actual manufacturing cost because it calculated cost by using “cost average by product weight” or “cost average by product quantity” method. Therefore, this research was analyzed the cost structure and created the suitable costing system including developed software to support the cost calculation more accurately.

Walairat Jangcharoenjittkul (1998) studied about construct of a cost system and cost reduction in a biscuit and candy manufacturing plant. The objectives of this research were construct the new costing system, which accurately calculated the real manufacturing costs, and manufacturing costs reduction focused on reducing direct materials and direct labour costs. By applying the fish bone diagram to analyze the causes of problems in the sample factory. Furthermore, the researcher was developing the documentation system, improving the manufacturing process, applying the work study, and adapting FOXPRO 2.6 program in order to achieve the objectives. After implemented the new costing system and developed the documentation system, the

sample factory had reduced losses in production about 3.54% and manufacturing costs about 548,618.22 baht within 6 months.

Moreover, there are related thesis researches and literatures involving with the improvement of quality system and cost reduction such as Peangchan Chringchit (1993) studied in Cost Reduction and Control for Productivity Improvement: A Case Study of Umbrella Industry; and Peerasak Phooapisit (2000) concerned about Loss Reduction and Control of Cutting in The Sheet Metal Forming Industry.

Furthermore, techniques and strategies for improving management can be found in Hines, Peter and Rich, Nick (1997) mentioned about The Seven Value Stream Mapping Tools, International Journal of Operations & Production Management; Rother, Mike and Shook, John (1999) discussed about Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA; and Vipavee Limpiwan, Juthamard Nakngaunghahn, and Chinnapat Helem (2004) used Activities Based Costing to reduce manufacturing cost in a case study of food industry.

CHAPTER III

General Information and Analysis Current Problems

3.1 Background of Company

The sample factory is the manufacturer of collars and sleeves, which are the parts of textile business. The company is the small factory and was established in 1978. Now, the company has about 100 employees and directly trades for domestic market. Moreover, the company is the family business that has been controlled and commanded by the owner.

3.2 Organization Chart

The organization structure of the sample company tends to low in complexity, low in formalisation but high in centralisation. Therefore, the sample company has the informal organization structure and is completely controlled by the owner. However, the owner assigns some employees to be the head of each department in order to control the other employees and receive the owner's commands. After noticed and studied the overall company, it can be summarized the organization chart as shown in figure below.

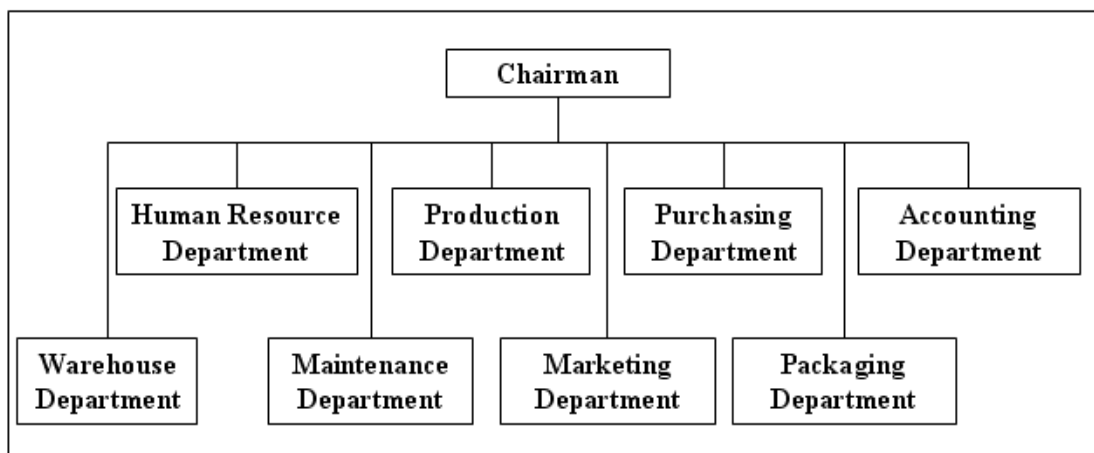


Figure 3.1: Organization Chart of Sample Company

3.3 Category of Products

It can be divided the category of sample company's products into two main groups that are collar and sleeve. Both of two main products are made of cotton yarn, polyester yarn, nylon, TC yarn, which is consisted of polyester, rayon and cotton, or unbleached yarn that is depended on the customers' orders. According to the company's product is made to order, there are many patterns, styles and varieties of products. For example, the sizes of collar vary from 3 inches x 12 inches to 4 inches x 19 inches and the sizes of sleeve vary from 1.5 inches x 12 inches to 1.75 inches x 33 inches. However, the sizes of products can be changed in order to meet the customers' requirements.

3.4 Business Flow

The business flow of the sample company will be briefly summarized and shown in figure below.

1. After received the customers' orders, the owner will estimate the amount of raw material, which will be used to produce for each order, and evaluate the cost of each order in order to quote the price to the customer.

2. After completely negotiated the price with the customer, the stocker will check the stock of raw materials, which will be used for production process, and send the samples of raw materials to the customer for approving. If the customer does not approve the samples of raw materials or the amount of raw material does not enough, the purchaser will order the new raw materials that meet the customer's requirements. In case of dyed yarn, the unbleached yarn must be brought to lab dip process before passing to the pigmentation process in order to test the yarn's color for satisfying the customer's needs. (Both lab dip and pigmentation processes are decided to outsource.)

3. The next step is making the sample products and sending the samples to customer for approving. If the customers approve the sample products, it will start the

production process. If the customers do not approved the sample products, it will remake the other samples until the customers accept that samples.

4. After finished the production process, the products will be delivered to customer. (Detail of production process will be described in the next section.)

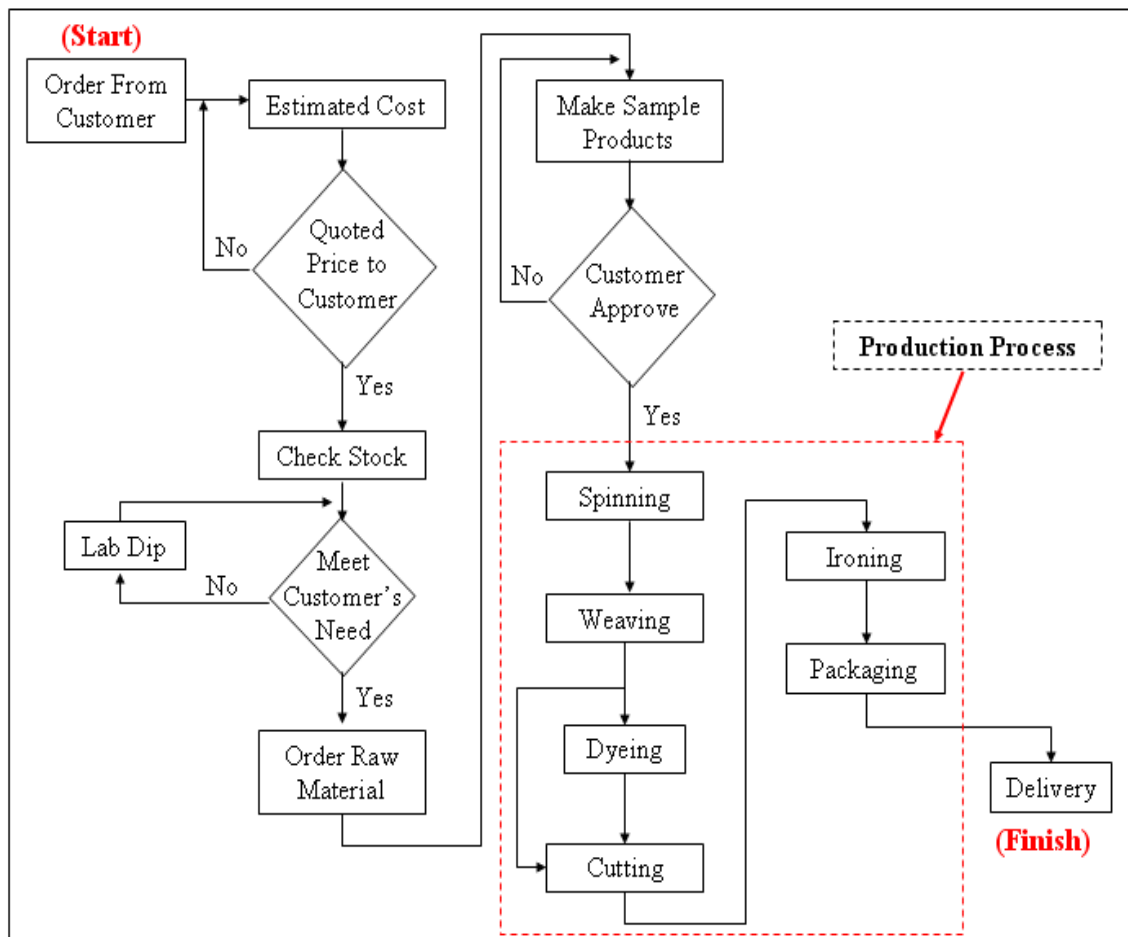


Figure 3.2: Business Flow of Sample Company

3.5 Production Process

It can be divided the production process of the sample company into five main steps: Spinning, Weaving, Cutting, Ironing, and Packaging; as shown in figure below.

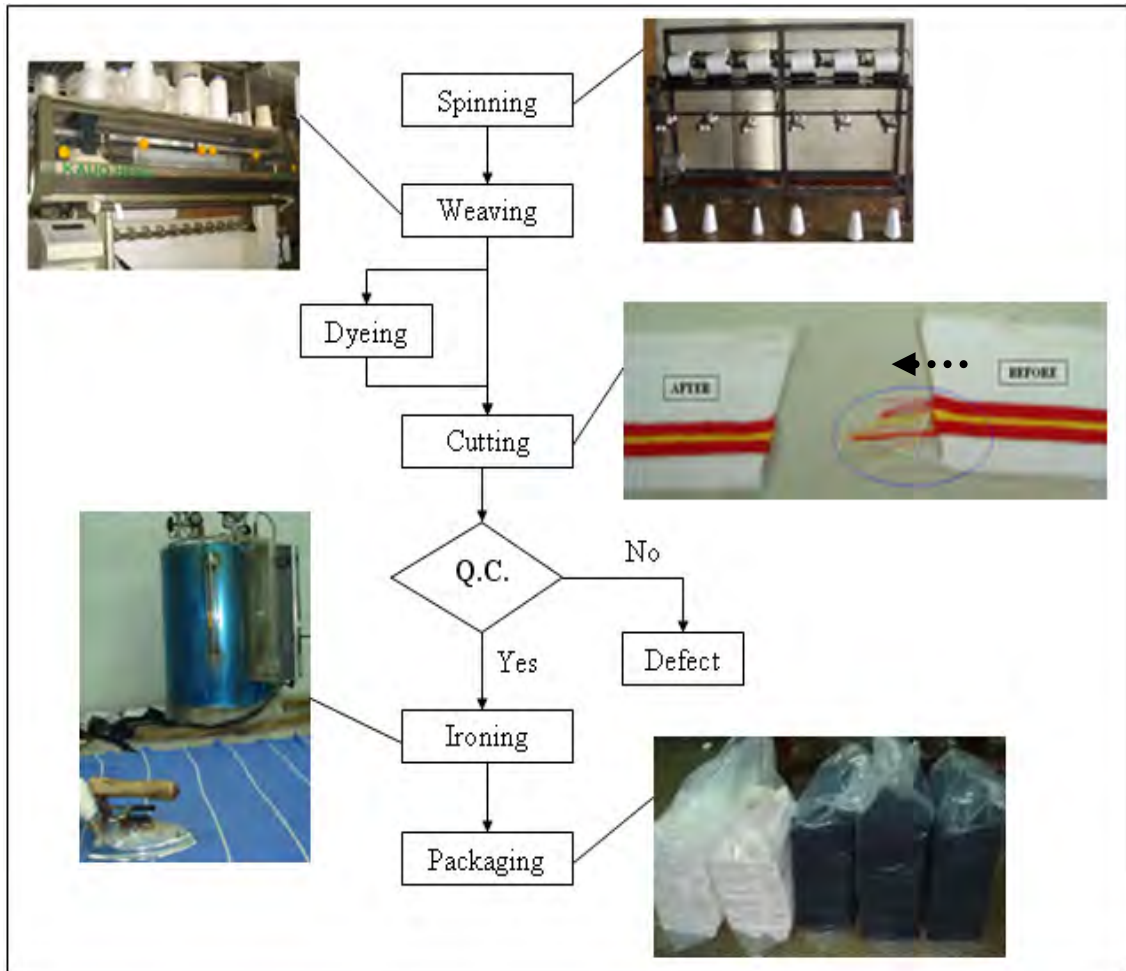


Figure 3.3: Production Process of Sample Company

Furthermore, both collar and sleeve, which are two main products of the sample company, have the same production process as shown in figure above. The detail of each process will be described as follows:

- **Spinning:** Spinning is the first step in production process. After passed the spinning process, yarn will be made smoother. Furthermore, it will protect yarn from tearing when going to the next step (weaving process).
- **Weaving:** Weaving is a process that transforms yarn into fabric, which are collar and sleeve in this case. (Producing collars or sleeves are used the same production process but it has to adjust the machine specifications such as amount of needle and velocity of motor.)

In case of dyed yarn, after finished weaving process, it will be brought to cutting and trim process. However, in case of unbleached yarn, after finished weaving process, it will be brought to the pigmentation process (dyeing) after that return to cutting and trim process. The pigmentation process is outsourced and this process will take time around 7-12 days that depends on amount of unbleached yarn and dyed color.

- **Cutting & Trim:** The rolls of collars or sleeves, which are weaved from the previous process, will be cut into each piece. Then, labors will gradually trim the threads, which are protruded from collars or sleeves, in order to make the neat and clean products.

Furthermore, quality control will be included among cutting and trim processes. During cutting and trim processes, labors will check the products' quality. If the products did not meet the standard or have flaws, they will be rejected.

- **Ironing:** Each piece of collars and sleeves has to iron in order to make the fine and tidy products. Moreover, some extra products will be heated in the steam oven.
- **Packaging:** Packaging is the last step of production process. All products will be packed in the packets in order to deliver at the customers.

3.6 Analysis Current Problems of Sample Company

After surveyed and studied the overall company and the systematic work of the sample company, there are many weak points that have been made the problems and the losses during the production process and the working system. However, this research will be presented some current problems in the sample company that are shown the important points as follows:

- Problems of the communication and the documentation system
- Problems of the current costing system
- Problems of the defects and wastes during the production process

However, there are the other problems in the sample company but the above three problems are the important problems that the manager has to take into account and pay more attention in order to solve the problems. If the severe problems are solved, the company will be gained a lot of benefits and has the better performance.

3.6.1 Problems of the communication and the documentation system

The communication within the sample company is the downward communication. The owner will command the jobs to the heads of each department and employees without the formal orders (written form). Therefore, when the errors have been occurred, it will have no one to take the responsibility. Moreover, the argument between each department will be happened if the mistakes were made because they did not have the documentary evidences during passed the jobs to another person or department.

Furthermore, the current documentation and information system of the sample company are lack of efficiency because of no standard system and no systematic data record. Moreover, the report forms, which are used for keeping records such as purchasing order, stock data, production report, and direct labor hour report, are not completely correct and have many mistakes because of no controllable data system.

The current document flow of the sample company is shown in Figure 3.4 and the examples of document form are shown in Figure 3.5, 3.6, and 3.7 respectively.

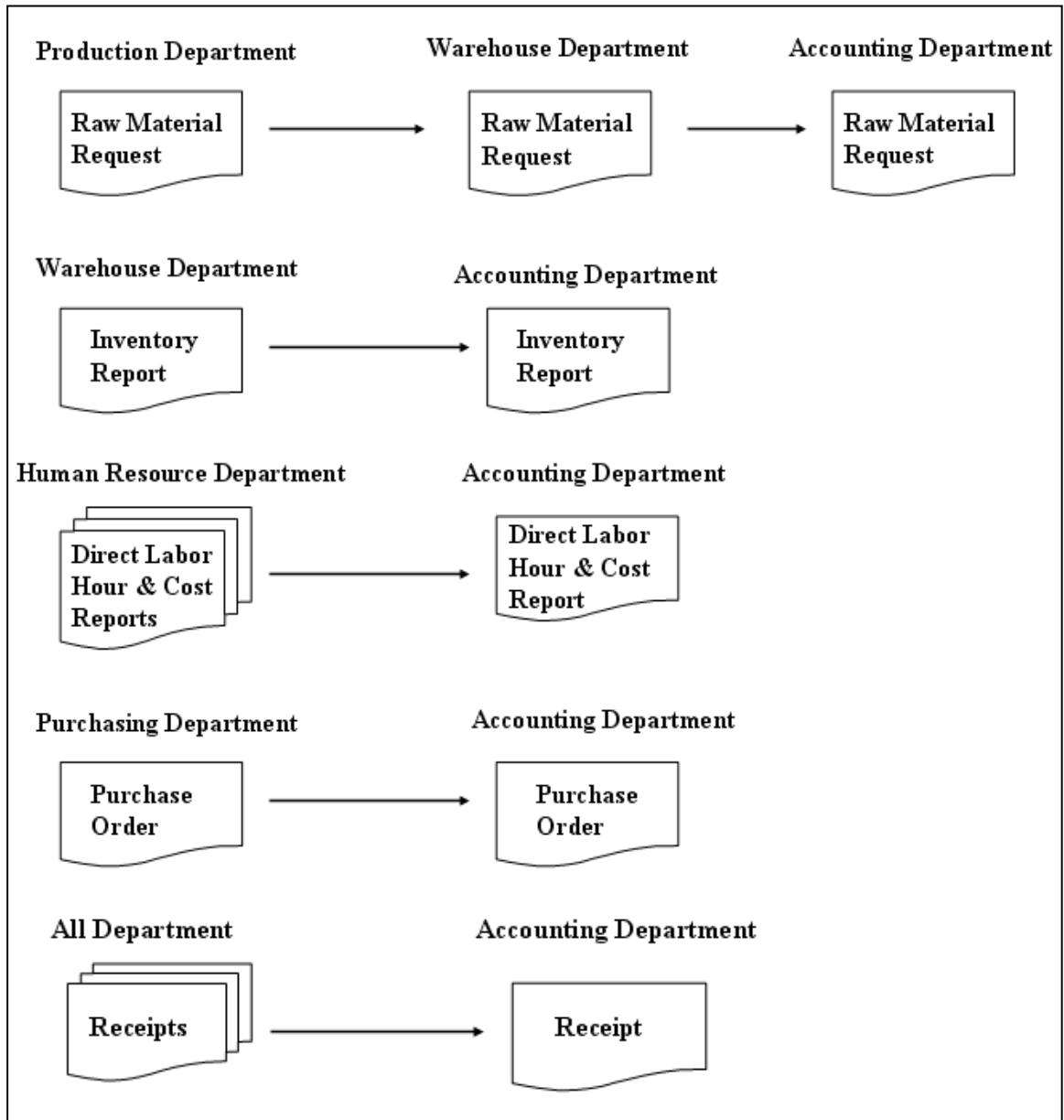


Figure 3.4: Current Document Flow of Sample Company










List	Type of Yarn	Color : Code	Batch	Amount (Kg)
1	TC 34/1 	Pink : TJ 617	30/5406	22.0, 22.5
2	TC 34/1 	Pink : R 052	38/7680	21.5, 21.4
3	TC34/1 	Pink : TJ 094	30/4112	17.1, 26.0, 17.4, 17.6
4	TC 34/1 	Pink: TJ 631	31/3237	21.8, 22.4
5	TC 34/1 	Pink : TJR 048	50/3811	21.5
6	TC 34/1 	Pink : TJ 090	35/5337	15.2
7	TC 34/1 	Pink : TJR 194	33/7973	11.1, 10.3
8	TC 34/1 	Pink : TJR 095	50/3452	20.5, 12.8
9	TC 34/1 	Pink : TJR 041	50/3224	9.5, 22.4

Figure 3.5: Stock of Raw Materials

Date: 1-15/10/2008

Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date	11/10	12/10	13/10	14/10	15/10	16/10	17/10	18/10	19/10	20/10	21/10	22/10	23/10	24/10
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	1	1	0	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	1	1	1	0	0	1	1	1	1
6	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	1	1	1	0	1	1	1	1	0	1	1	1	1	1
8	1	1	1	1	1/2	1	1	1	0	1	1	1	1	1
9	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	1	1	1	1	1	1	1	-	1	1	1	1	1	1
11	1	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1	1	1	1	1	1	1	1	1	1	1
13	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	1	1	1	1	1	1	-	1	1	1
15														

Figure 3.6: Half Month Attendance Report

Date: 12/10/2008

List	Name - Surname	In	Out	Signature
1	ကျွ	7:30	21:30	ကျွ
2	မျိုး	7:30	21:30	မျိုး
3	အောင်	7:30	21:30	အောင်
4	အိမ်	21:30	7:30	အိမ်
5	အောင်	7:30	21:30	အောင်
6				
7				
8				
9	အောင်	24:00	7:30	အောင်
10				
11	အောင်	21:30	7:30	အောင်
12	အိမ်	21:30	7:30	အိမ်
13	အိမ်	7:30	21:30	အိမ်
14	အိမ်	7:30	21:30	အိမ်
15	အိမ်	7:30	21:30	အိမ်
16	အိမ်	7:30	21:30	အိမ်
17	အိမ်	7:30	21:30	အိမ်

Figure 3.7: Daily Time Attendance Report

According to the example of document forms of the sample company, the stock of raw materials did not record the received date of each raw material and it only record the time attendance of labor. As the result of inefficiency of the document management system, the owner did not have the adequate and right information for planning the production plan, assessing the company's performance and efficiency, assessing the labors' performance, checking the stock, estimating the actual production cost, improving the production process, and making the right decisions. Thus, it is very hard to improve and modify the company's performances. Moreover, it has made the administrative expenditures higher than it should be.

3.6.2 Problems of the current costing system

The current costing system of the sample company did not show the real production cost of each product because the lack of efficiency of the documentation management system. Furthermore, as the result of the inefficient documentation management system, the sample company did not know the accurate financial information within the company including the actual manufacturing cost of each product. Thus, the improper costing system will lead to wrong decision making in bargaining the product's price with the customers and competing the product's price with the other competitors.

Therefore, creating the appropriate costing system together with developing the documentation system will help the company to know the actual production cost of each product, control the administrative cost including labor cost, factory overhead cost and the expenditures for manufacturing, and improve the company's performance and efficiency.

However, the current method for calculating the manufacturing cost of each product of the sample company is come from the estimation of the direct material cost and the overall expenses that will be used to produce the products. Moreover, both collar and sleeve, which are the main products, have the same principles for calculating the production cost. The principles for calculating the current production cost of the sample company will be described as follows:

1. After received the customers' orders, it will be classified the orders according to size, type of yarn, and color.
2. Estimated the amount of raw material, which will be used to produce the product per dozen. After that plus the percentages of defect and waste from the production process. Then, the result is the amount of raw material add the percentages of loss for producing the product per dozen. (Assessment of the amount and weight of raw materials, which are used to produce each type of products, and the percentages of loss depend on the owner's experience.)
3. To multiply by the total dozens that the customers' orders. Then, the result is the total weight of raw material to produce the product.
4. Take the total amount of raw material multiply by the raw material's price, which is referenced to the market price. Then, the result is the direct material cost.

In case of unbleached yarn, it has to add the pigmentation cost. The pigmentation cost is varied and depended on each type of yarn, dyed color, and weight of unbleached yarn.

5. Adding the labor cost, factory overhead cost, administrative cost, and the other expenses around 30 – 50 % of the direct material cost that depends on the type and pattern of product and the owner's experience. Then, the result is the production cost of each product.

$$\begin{array}{c}
 \text{Cost of each product (baht per dozen) =} \\
 \boxed{[\text{Amount of direct material (kg. per dozen) * Price of raw material (baht per kg.)]} \\
 + (30\% - 50\% \text{ of B})}
 \end{array}$$

B

Figure 3.8: Cost Calculation of Each Product per Dozen

Figure above shows the cost calculation of each product per dozen. (**Note:** B is the direct material cost. It has to add the pigmentation cost in case of unbleached yarn.) The example for calculating the production cost of the sample company will be shown as follows:

This example will be presented the cost calculation of collar and sleeve per dozen. (The size of collar and sleeve are 3.5" x 17" and 1.5" x 25" respectively. The type of unbleached yarn is TC 34.)

Collars size 3.5" x 17" use raw material (TC 34) around 0.420 kg per dozen and sleeves size 1.5" x 25" use raw material (TC 34) around 0.264 kg per dozen. (Both weight of collar and sleeve are already included the percentage of loss.)

Thus, one dozen of collar and sleeve size 3.5" x 17" and 1.5" x 25" respectively use the total raw material around 0.684 kg or 1.508 pounds. (1 Kg. = 2.2046 Pounds)

Assumed that the raw material (TC 34) price is 42 baht per pound and the pigmentation cost is 30 baht per pound. (In this case, the pigmentation cost uses the average rate.)

The total raw material cost is $(1.508 \times 42) = 63.34$ baht

The pigmentation cost is $(1.508 \times 30) = 45.24$ baht

Thus, the total cost of raw material and pigmentation is 108.58 baht

The labor cost and the Factory overhead cost is 32.57 baht. (30% of the total cost of raw material and pigmentation)

Therefore, the production cost is 141.15 baht

According to the cost calculation method of the sample company, the current costing system has been used the estimative method of the overall expenses as mentioned above. As the result of the estimative method for calculating the manufacturing cost, the sample company did not know the actual production cost of each product. Therefore, the sample company should create the appropriate costing system that will help the company to know the actual production cost.

3.6.3 Problems of the defects and wastes during the production process

After studied and noticed the overview company and collected data in the production process of the sample company, it found many causes that make the

losses during the production process. According to the data collection, it can be divided the causes of losses into three main parts that are the problems from raw material, man, and working system.

- Loss from raw material problems

The sample company has the excessive stocks of raw materials because of purchasing the amount of raw materials more than it should be and keeping the stocks too long. Thus, the quality of raw materials, which are kept too long, will be out of order. Furthermore, if the workers use the inefficient raw materials to produce the products, it will be made a lot of defects. Moreover, the preservation cost of raw materials is also increased and the inventory control of the sample company is lack of efficiency and out of date.

Furthermore, the sample company did not check and test the quality of raw materials before received from the suppliers. Therefore, if the raw materials have problems, it can not return to the suppliers. And, if using the low quality of raw materials to produce the products, it will be also made many defects.

- Loss from man (direct labor) problems

After surveyed and observed the performance of labors in the shop floor, it found that some new labors are lack of skills and some labors are lack of attention and responsibility in theirs jobs. In case of new labors, sometimes they set the wrong specification of machines such as the number of needles, the velocity of motor, and the amount of products including using the wrong raw materials. Moreover, some labors are lack of attention, sleep during working, indiscretion, and making the mistaken steps of the production process. Therefore, they have made a lot of defects and wastes in the production process.

In order to assess the performance of workers, it was used the statistic method, which is work sampling, by getting random samples 20 times per day in 25-days period as shown in table below.

Table 3.1: Performance of Workers in Production Line (before improvement)

Number of Work Sampling					
	Worker 1	Worker 2	Worker 3	Worker 4	Worker 5
Work	349	333	322	341	317
Idle	151	167	178	159	183
Total (Times)	500	500	500	500	500
% Utilization	69.80%	66.60%	64.40%	68.20%	63.40%
% Idle	30.20%	33.40%	35.60%	31.80%	36.60%

Thus, it has to set the team for training the new labors in order to do the right jobs and reduce the mistakes. Furthermore, the owner has to set up the strict regulations and penalty in order to make the labors pay more attention to theirs jobs including appoint the head of the production line in order to closely control the workers.

- Loss from working system problems

According to the current working system, it did not clearly assign the job responsibilities to each labor. Thus, the labors did not know the scope of their jobs. Furthermore, they did not do the extra jobs that are not theirs normal responsibilities. Therefore, when the owner or the head of department has assigned the new jobs, they did not know who will take charge of those jobs or they may argue each other for finding who will agree to work.

Therefore, unclear job responsibility will lead to waste of time and production delay. So, it has to clearly allocate the job responsibilities to each labor in order to make the smooth work flow and decrease the production delay.

According to the data collection since October 2008 to December 2008, it can be divided the loss of raw material in the production process into 2 main groups that are defect and waste. Table 3.2 shows the amount of defect, waste and finished product since October 08 to December 08, the percentage of defect, waste and finished product is also shown in Table 3.3, and the pie chart of the percentage of defect, waste and finished product is shown in Figure 3.9. (See more details of defect and waste in Appendix C: Table C-3 to Table C-5.)

Table 3.2: Amount of Defect, Waste, and Finished Product (Oct 08 – Dec 08)

Month	Amount of Defect (Kg)	Amount of Waste (Kg)	Amount of Finished Product (Kg)	Total Product (Kg) (Included Waste and Defect)
Oct-08	345.78	87.32	2,983.02	3,416.12
Nov-08	242.45	68.27	2,660.23	2,970.95
Dec-08	164.11	49.19	2,217.76	2,431.06
Total	752.34	204.78	7,861.01	8,818.13

Table 3.3: Percentage of Defect, Waste, and Finished Product (Oct 08 – Dec 08)

Month	Percentage of Defect	Percentage of Waste	Percentage of Finished Product
Oct-08	10.12	2.56	87.32
Nov-08	8.16	2.30	89.54
Dec-08	6.75	2.02	91.23
Average	8.34	2.29	89.36

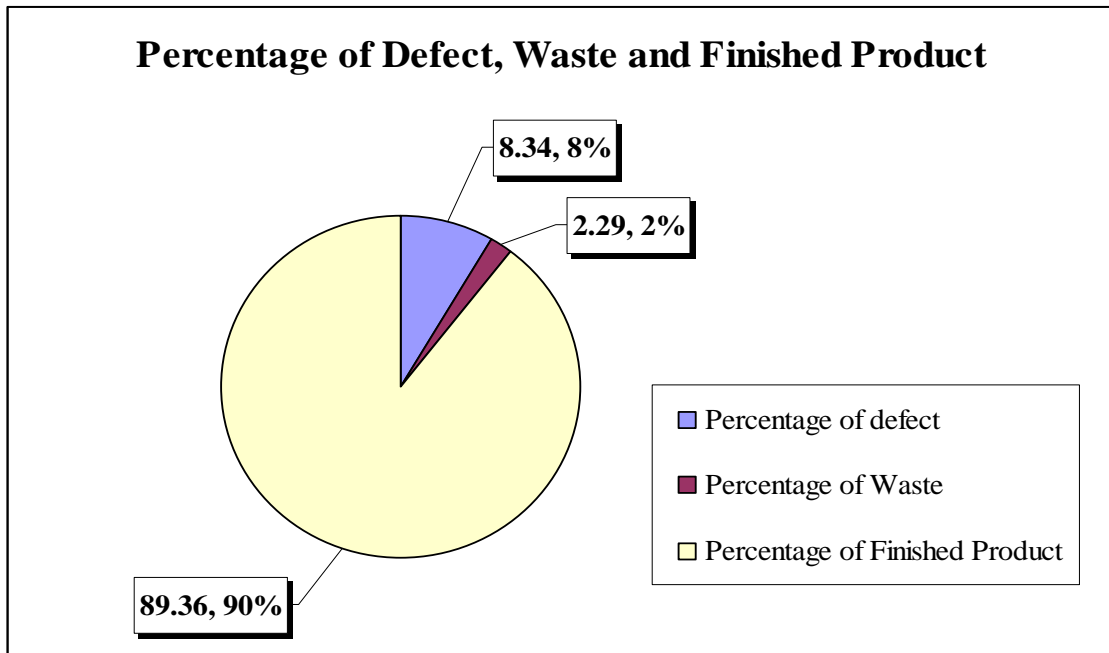


Figure 3.9: Pie Chart of Average Percentage of Defect, Waste, and Finished Product
(Oct 08 – Dec 08)

According to Table 3.3, it shows the average percentage of defect and waste was around 10% of the overall products since Oct-08 – Dec-08. As the result of data collection and data analysis, it can be divided the defects in the production process into 4 types: incorrect size, partly tear, stick-on yarn leavings, and untidy product. Table 3.4 and 3.5 show the amount and the percentage of each defect type respectively since October 2008 to December 2008. And, the pie chart of average percentage of each defect type is shown in Figure 3.10.

Table 3.4: Amount of Each Defect Type (Oct 08 – Dec 08)

Month	Amount of Incorrect Size (Kg)	Amount of Partly Tear (Kg)	Amount of Stick-on Yarn Leavings (Kg)	Amount of Untidy Product (Kg)	Total Defect (Kg)
Oct-08	236.79	84.24	13.68	11.07	345.78
Nov-08	171.23	54.89	8.04	8.29	242.45
Dec-08	113.85	40.56	5.24	4.46	164.11
Total	521.87	179.69	26.96	23.82	752.34

Table 3.5: Percentage of Each Defect Type (Oct 08 – Dec 08)

Month	Percentage of Incorrect Size	Percentage of Partly Tear	Percentage of Stick-on Yarn Leavings	Percentage of Untidy Product
Oct-08	68.48	24.36	3.96	3.20
Nov-08	70.62	22.64	3.32	3.42
Dec-08	69.37	24.72	3.19	2.72
Average	69.49	23.91	3.49	3.11

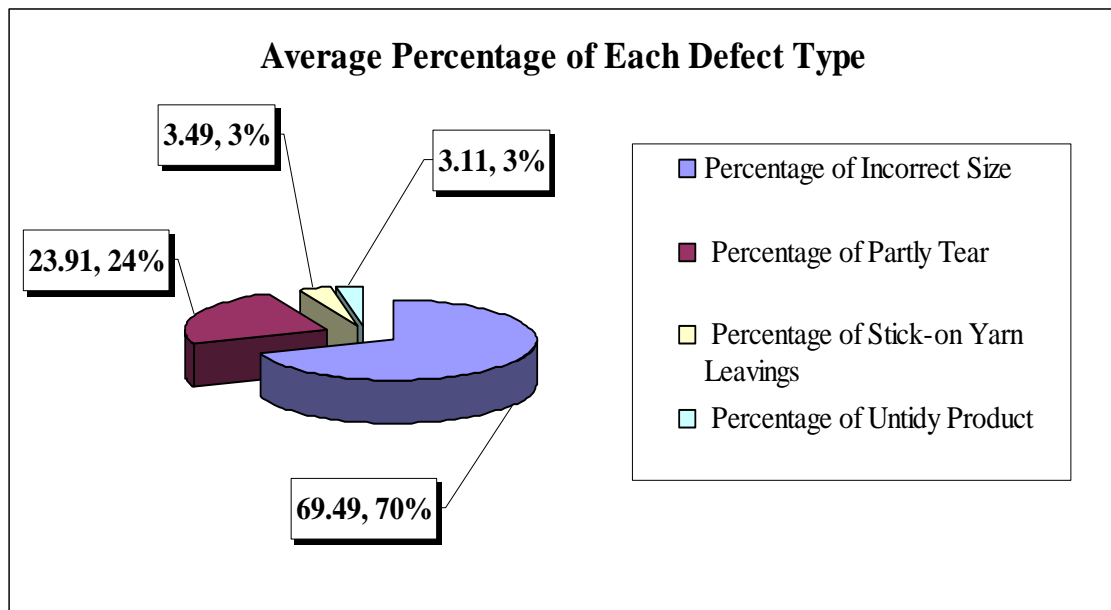


Figure 3.10: Pie Chart of Average Percentage of Each Defect Type
(Oct 08 – Dec 08)

According to Table 3.5, it shows the majority cause of defects in the production process is the incorrect size, which was about 69.49% of the overall defects since Oct-08 to Dec-08, and the next sequence was the partly tear, which was around 23.91% of the overall defects. And, the defective causes of stick-on yarn leavings and untidy product were about 3.49% and 3.11% of the overall defects respectively.

Therefore, the main causes of defect in the production process that should take into account and quickly solve are the incorrect size and the partly tear problems.

Furthermore, it can be divided the wastes in the production process into 2 types: over plus and overweight. Table 3.6 and 3.7 show the amount and the percentage of each waste type respectively since Oct-08 to Dec-08. And, the pie chart of average percentage of each waste type is shown in Figure 3.11.

Table 3.6: Amount of Each Waste Type (Oct-08 – Dec-08)

Month	Amount of Over plus (Kg)	Amount of Overweight (Kg)	Total Waste (Kg)
Oct-08	67.82	19.50	87.32
Nov-08	46.14	22.13	68.27
Dec-08	36.23	12.96	49.19
Total	150.19	54.59	204.78

Table 3.7: Percentage of Each Waste Type (Oct-08 – Dec-08)

Month	Percentage of Over plus	Percentage of Overweight
Oct-08	77.67	22.33
Nov-08	67.58	32.42
Dec-08	73.65	26.35
Average	72.97	27.03

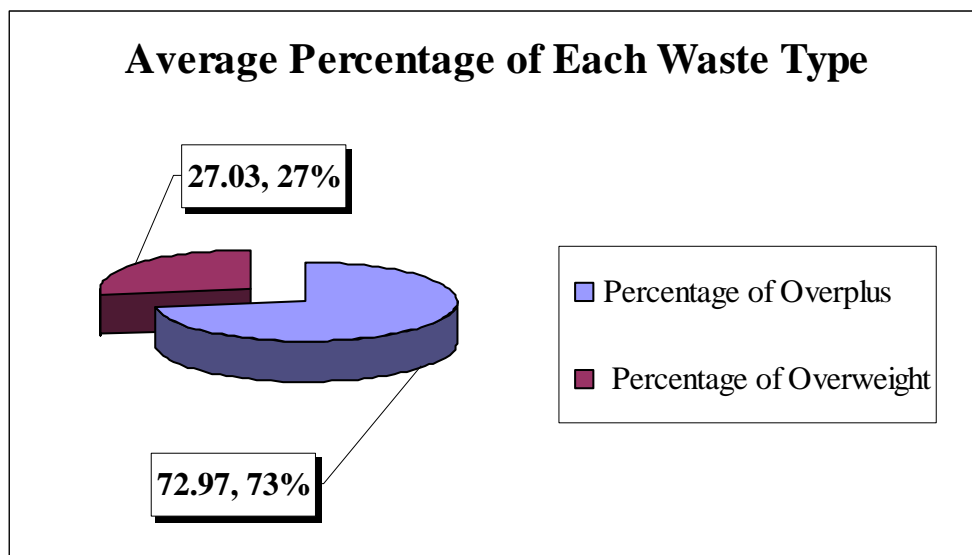


Figure 3.11: Pie Chart of Average Percentage of Each Waste Type (Oct 08 – Dec 08)

According to Table 3.7, it shows the main causes of waste in the production process are the excessive production and the overweight products, which were about 72.97% and 27.03% of the overall waste products respectively since Oct-08 to Dec-08.

The over plus production or the excessive production means producing the finished products more than the amount of the customer's orders. And, the overweight product means the finished product's weight is more than the standard weight. For example, producing one dozen of collar size 4" x 16" by using TC 34 (unbleached yarn) is used the raw material around 0.45 kg, which is the standard weight, but the weight of the actual products is 0.50 kg that means the wastes of producing the products is 0.05 kg.

3.7 Solutions of Current Problems in Sample Company

As mentioned in the previous section, all of the current problems, which are consisted of problems of communication and documentation system, current costing system and loss during the production process, are related to the high production cost. Thus, it has to jointly solve each problem in order to make the high efficient results and improve the company's performance including reduce the production cost.

Therefore, it has to modify and improve the documentation system of the sample company in order to efficiently and completely record the data from each department including making the smooth document flow. The complete documentation system will support the company to assess the company's performance and efficiency, the labors' attendance and performance, and the rates of loss. Furthermore, it will help the company to know what the weak points within the company and can find the methods to solve the problems.

Moreover, the current costing system is the estimative calculation so it is not shown the actual expenses in production process. Thus, developing the documentation system together with adapting the appropriate costing system will help the company

to know the actual expenditures of the company including the production cost of each product.

In case of loss during the production process, creating the production reports and the standard data of each product, which are the parts of the documentation system, will help to know the amount of defects and wastes in the production process. Furthermore, it is the guide for checking and finding the root causes of loss in the production process. Thus, it will help to know which the weak points are and can solve the right points.

However, according to the current documentation system of the sample company, it is inefficiency, unreliability, out of date, and not covered some important information so the current data can not use to assess the company's efficiency and performance. Furthermore, it can not use the data for estimating the production cost (cost estimation) that will be presented as follows:

Table 3.8: Average Rate of Direct Labor Cost per Direct Labor Hour in Year 2007

Month	Direct Labor Cost (Baht)	Direct Labor Hour (Hrs.)	Rate of Direct Labor Cost per Direct Labor Hour (Baht/Hr.)
Jan-07	180,265.00	5,401	33.38
Feb-07	162,803.00	4,703	34.62
Mar-07	181,734.00	5,336	34.06
Apr-07	171,081.00	4,947	34.58
May-07	153,955.00	4,109	37.47
Jun-07	179,235.00	5,359	33.45
Jul-07	186,515.00	5,337	34.95
Aug-07	199,705.00	5,883	33.95
Sep-07	194,061.00	5,739	33.81
Oct-07	175,080.00	5,043	34.72
Nov-07	169,935.00	4,980	34.12
Dec-07	195,390.00	5,644	34.62
Total	2,149,759.00	62,481	34.41

According to Table 3.8, it shows the average rate of direct labor cost per direct labor hour in year 2007 was 34.41 Baht/Hour. Moreover, according to the past record in year 2007, direct labor hour already included normal and overtime hours but cannot

be divided how many hours were used in normal and overtime periods because of no data record.

Furthermore, as the result of inefficient documentation system, the percentage of attendance and performance rate were also not considered and calculated in year 2007. Therefore, the rate of direct labor cost per direct labor hour in year 2007 is not reliability and not presented the actual direct labor cost per direct labor hour.

Table 3.9: Average Rate of Direct Labor Cost per Direct Labor Hour
(Jan-08 – Sep-08)

Month	Direct Labor Cost (Baht)	Direct Labor Hour (Hrs.)	Rate of Direct Labor Cost per Direct Labor Hour (Baht/Hr)
Jan-08	226,355.00	6,429	35.21
Feb-08	216,837.00	6,080	35.66
Mar-08	207,001.00	5,884	35.18
Apr-08	183,593.00	5,319	34.52
May-08	221,798.00	6,236	35.57
Jun-08	201,936.00	5,629	35.87
Jul-08	211,048.00	5,961	35.40
Aug-08	207,908.00	5,619	37.00
Sep-08	207,595.00	6,025	34.46
Total	1,884,071.00	53,182	35.43

According to Table 3.9, it shows the average rate of direct labor cost per direct labor hour since Jan-08 to Sep-08 was 35.43 Baht/Hour. Moreover, according to the past record since Jan-08 to Sep-08, direct labor cost already included normal and overtime rates and direct labor hour also included normal and overtime hours. Furthermore, the percentage of attendance rate has been recorded and considered since the beginning of year 2008 however the percentage of performance rate was still not taken into account.

Therefore, the rate of direct labor cost per direct labor hour since Jan-08 to Sep-08 is not reliability and not shown the actual direct labor cost per direct labor hour because the percentage of performance was not considered.

Table 3.10: Summary Information of Direct Labor Cost and Direct Labor Hour (Jan08 – Sep-08)

Item	MONTH												
	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08				
Direct Labor Cost	Normal	148,845	141,407	149,221	139,573	155,208	144,756	151,648	141,408	154,235			
	OT	77,510	75,430	57,780	44,020	66,590	57,180	59,400	66,500	53,360			
	Total	226,355	216,837	207,001	183,593	221,798	201,936	211,048	207,908	207,595			
Direct Labor Hour (Must Work)	Normal	4,856	4,544	4,788	4,516	4,976	4,592	4,792	4,248	5,012			
	OT	1,749	1,692	1,299	981	1,485	1,284	1,329	1,500	1,209			
	Total	6,605	6,236	6,087	5,497	6,461	5,876	6,121	5,748	6,221			
Direct Labor Hour (Come to Work)	Normal	4,737	4,464	4,638	4,400	4,833	4,433	4,724	4,178	4,906			
	OT	1,692	1,616	1,246	919	1,403	1,196	1,237	1,441	1,119			
	Total	6,429	6,080	5,884	5,319	6,236	5,629	5,961	5,619	6,025			
Direct Labor Hour (Actual Manufacturing)	Normal	-	-	-	-	-	-	-	-	-			
	OT	-	-	-	-	-	-	-	-	-			
	Total	-	-	-	-	-	-	-	-	-			
Direct Labor Cost per Direct Labor Hour (Baht/Hr.)	Normal	31.42	31.68	32.17	31.72	32.11	32.65	32.10	33.85	31.44			
	OT	45.81	46.68	46.37	47.90	47.46	47.81	48.02	46.15	47.69			
	Total	35.21	35.66	35.18	34.52	35.57	35.87	35.40	37.00	34.46			
Attendance (%)	Normal	97.55	98.24	96.87	97.43	97.13	96.54	98.58	98.35	97.89			
	OT	96.74	95.51	95.92	93.68	94.48	93.15	93.08	96.07	92.56			
	Total	97.34	97.50	96.67	96.76	96.52	95.80	97.39	97.76	96.85			
Performance (%)	Normal	-	-	-	-	-	-	-	-	-			
	OT	-	-	-	-	-	-	-	-	-			
	Total	-	-	-	-	-	-	-	-	-			

According to Table 3.10, it shows the summary information of direct labor since Jan-08 to Sep-08. The direct labor cost, direct labor hour, direct labor cost per direct labor hour and the percentage of attendance were separate calculated on normal and overtime rates. However, the average rate of direct labor cost per direct labor hour was not the actual rate because it was not calculated the percentage of performance.

According to the incomplete data, it can not estimate the actual direct labor cost per direct labor hour so it has to develop the documentation system. Therefore, the percentage of performance has been recorded and taken into account since Oct-08 because it is the first month, which has begun to record the new documentation system. (See more details in Chapter IV.)

In case of factory overhead estimation, it is divided into 2 types, which are fix factory overhead and variable factory overhead, in order to easily estimate the standard of factory overhead. However, according to the data analysis in year 2007 – 2008, it was shown that the current documentation system is inefficiency and unreliability.

Thus, both fix factory overhead and variable factory overhead, which were estimated from the past data, were not the actual factory overhead that will be presented as follows:

**Table 3.11: Average Rate of Fix Factory Overhead per Direct Labor Hour
in Year 2007**

Month	Fix Factory Overhead (Baht)	Direct Labor Hour (Hrs.)	Rate of Fix Factory Overhead per Direct Labor Hour (Baht/Hr)
Jan-07	77,824.91	5,401	14.41
Feb-07	77,824.91	4,703	16.55
Mar-07	77,824.91	5,336	14.58
Apr-07	77,824.91	4,947	15.73
May-07	77,824.91	4,109	18.94
Jun-07	77,824.91	5,359	14.52
Jul-07	77,824.91	5,337	14.58
Aug-07	77,824.91	5,883	13.23
Sep-07	77,824.91	5,739	13.56

Oct-07	77,824.91	5,043	15.43
Nov-07	77,824.91	4,980	15.63
Dec-07	77,824.91	5,644	13.79
Total	933,898.92	62,481	15.08

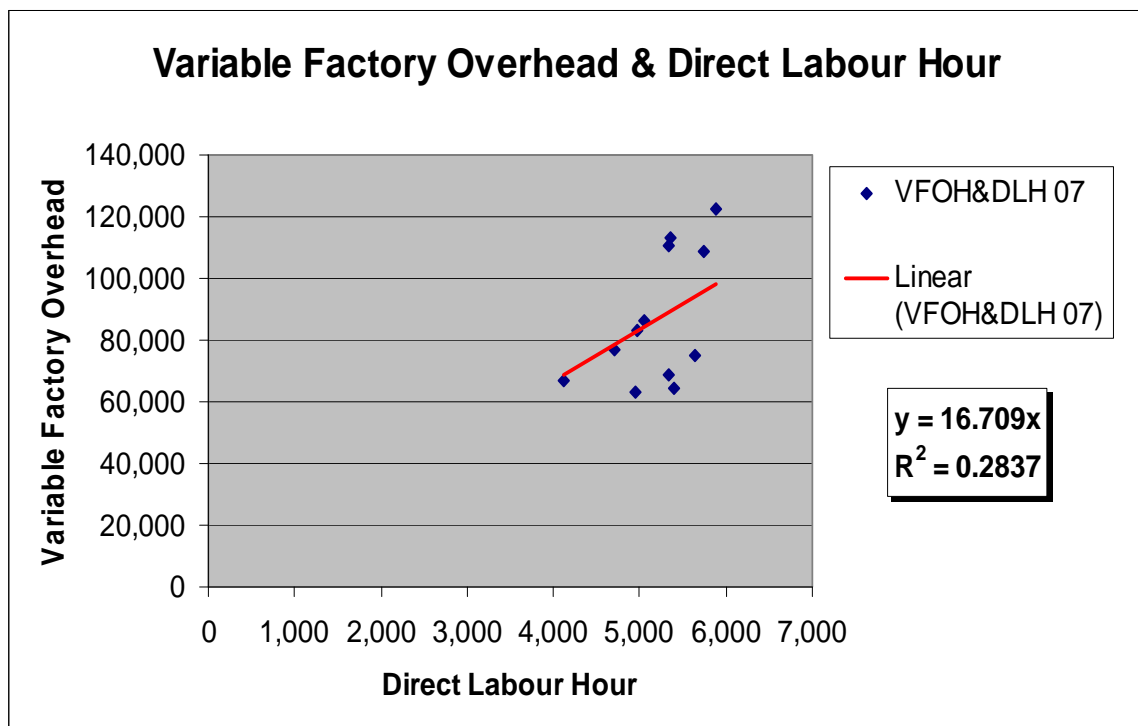
According to Table 3.11, the average rate of fix factory overhead per direct labor hour in year 2007 was 15.08 Baht/Hour. However, the direct labor hour was not considered and calculated the percentage of attendance and performance in year 2007 as mentioned above thus the average rate of fix factory overhead per direct labor hour, which was shown in table above, was not the actual fix factory overhead. Table 3.12 below shows the detail of fix factory overhead, which is divided into 4 parts: salary, insurance, depreciation, and property tax.

Table 3.12: Detail of Fix Factory Overhead in Year 2007

List	Detail of Fix Factory Overhead	Jan-07	Feb-07	Mar-07	Apr-07	
1	Salary	41,000.00	41,000.00	41,000.00	41,000.00	
2	Insurance	6,663.08	6,663.08	6,663.08	6,663.08	
3	Depreciation	24,620.58	24,620.58	24,620.58	24,620.58	
4	Property Tax	5,541.25	5,541.25	5,541.25	5,541.25	
List	Detail of Fix Factory Overhead	May-07	Jun-07	Jul-07	Aug-07	
1	Salary	41,000.00	41,000.00	41,000.00	41,000.00	
2	Insurance	6,663.08	6,663.08	6,663.08	6,663.08	
3	Depreciation	24,620.58	24,620.58	24,620.58	24,620.58	
4	Property Tax	5,541.25	5,541.25	5,541.25	5,541.25	
List	Detail of Fix Factory Overhead	Sep-07	Oct-07	Nov-07	Dec-07	Total
1	Salary	41,000.00	41,000.00	41,000.00	41,000.00	492,000.00
2	Insurance	6,663.08	6,663.08	6,663.08	6,663.08	79,956.96
3	Depreciation	24,620.58	24,620.58	24,620.58	24,620.58	295,446.96
4	Property Tax	5,541.25	5,541.25	5,541.25	5,541.25	66,495.00
					Total	933,898.92

Table 3.13: Variable Factory Overhead and Direct Labor Hour in Year 2007

Month	Variable Factory Overhead (Baht)	Direct Labor Hour (Hrs.)
Jan-07	64,471.18	5,401
Feb-07	76,870.94	4,703
Mar-07	68,772.06	5,336
Apr-07	63,147.08	4,947
May-07	66,988.40	4,109
Jun-07	113,186.38	5,359
Jul-07	110,671.18	5,337
Aug-07	122,551.91	5,883
Sep-07	108,921.36	5,739
Oct-07	86,475.31	5,043
Nov-07	82,976.12	4,980
Dec-07	74,888.30	5,644
Total	1,039,920.22	62,481

**Figure 3.12:** Relation Diagram between Variable Factory Overhead and Direct Labor Hour in Year 2007

According to Table 3.13, it shows the value of variable factory overhead and direct labor hour since Jan-07 to Dec-07 and both of them were plotted in the graph between variable factory overhead and direct labor hour as shown in figure above.

After plotted the points, which are represented the relation between direct labor hour and variable factory overhead, the straight line had been created in order to estimate the overall variable factory overhead. Furthermore, the linear equation and the coefficient of determination (R-square), which is used to check the accuracy of data, were also created.

The value of R-square has the range from 0 to 1 and the acceptable value of R-square should more than 0.6. However, the result of R-square in figure above was 0.2837 thus it was not only shown the variable factory overhead value in linear equation was unreliability but also the error or mistake of the data collection method of variable factory overhead and direct labor hour including the documentation system.

As the result of factory overhead estimation in year 2007, it can be concluded that the average rate of factory overhead per direct labor hour is 31.789 Baht/Hour. (Factory Overhead per Direct Labor Hour = Fix Factory Overhead per Direct Labor Hour + Variable Factory Overhead per Direct Labor Hour = 15.08+16.709 = 31.789 Baht/Hour)

However, the cost of fix and variable factory overhead were not shown the actual factory overhead because the data record of direct labor hour was not considered and calculated the percentage of attendance and performance, and the value of R-square below than 0.6.

Table below shows the detail of variable factory overhead, which is divided into 8 parts: packaging cost, spare parts & equipment cost, cost of utility (electricity), cost of utility (water), cost of utility (telephone), miscellaneous expenses, writing implements & printed form costs, and social security cost.

Table 3.14: Detail of Variable Factory Overhead in Year 2007

List	Detail of Variable Factory Overhead	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	
1	Packaging Cost	0.00	0.00	0.00	0.00	0.00	0.00	
2	Spare Parts & Equipment Cost	0.00	5,950.00	3,686.00	3,376.00	11,200.00	46,856.40	
3	Cost of Utility (Electricity)	43,154.27	41,319.36	42,308.58	41,000.74	35,422.54	48,900.42	
4	Cost of Utility (Water)	8,081.40	8,687.88	6,373.68	9,980.64	9,533.76	7,778.16	
5	Cost of Utility (Telephone)	4,165.50	3,326.00	3,166.00	2,846.00	1,931.00	1,763.00	
6	Miscellaneous Expenses	2,514.01	775.70	3,102.80	775.70	2,327.10	1,551.40	
7	Writing Implements & Printed Form Costs	0.00	11,025.00	3,570.00	0.00	0.00	0.00	
8	Social Security Cost	6,556.00	5,787.00	6,565.00	5,168.00	6,574.00	6,337.00	
List	Detail of Variable Factory Overhead	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Total
1	Packaging Cost	27,580.00	0.00	0.00	0.00	25,800.00	0.00	53,380.00
2	Spare Parts & Equipment Cost	0.00	5,587.60	0.00	0.00	0.00	0.00	76,656.00
3	Cost of Utility (Electricity)	64,853.72	95,364.00	87,903.63	67,948.52	40,128.42	54,443.89	662,748.09
4	Cost of Utility (Water)	7,299.36	8,177.16	8,911.32	7,586.64	6,820.56	6,166.20	95,396.76
5	Cost of Utility (Telephone)	1,925.00	3,929.00	2,734.26	2,304.00	1,869.00	2,229.26	32,188.02
6	Miscellaneous Expenses	2,327.10	2,355.15	2,355.15	2,355.15	2,355.14	5,057.95	27,852.35
7	Writing Implements & Printed Form Costs	0.00	0.00	0.00	0.00	0.00	0.00	14,595.00
8	Social Security Cost	6,686.00	7,139.00	7,017.00	6,281.00	6,003.00	6,991.00	77,104.00
							Total	1,039,920.22

According to Table 3.14, it is found that the record method of the expenses in the sample company has the error. As seen in the detail of variable factory overhead, the packaging, spare parts & equipment, and writing implement costs were not recorded in some months that is impossibility because all of this items should been used every month. Therefore, the documentation system of the sample company has to improve.

Table 3.15: Average Rate of Fix Factory Overhead per Direct Labor Hour
(Jan-08 – Sep-08)

Month	Fix Factory Overhead (Baht)	Direct Labor Hour (Hrs.)	Rate of Fix Factory Overhead per Direct Labor Hour (Baht/Hr)
Jan-08	92,238.82	6,429	14.35
Feb-08	92,238.82	6,080	15.17
Mar-08	92,238.82	5,884	15.68
Apr-08	92,238.82	5,319	17.34
May-08	92,238.82	6,236	14.79
Jun-08	92,238.82	5,629	16.39
Jul-08	92,238.82	5,961	15.47
Aug-08	92,238.82	5,619	16.42
Sep-08	92,238.82	6,025	15.31
Total	830,149.38	53,182	15.61

According to Table 3.15, the average rate of fix factory overhead per direct labor hour since Jan-08 to Sep-08 was 15.61 Baht/Hour. However, the percentage of performance was still not taken into account as mentioned above. Therefore, the average rate of fix factory overhead per direct labor hour, which was shown in table above, was not the actual fix factory overhead. Table below is shown the detail of fix factory overhead since Jan-08 to Sep-08.

Table 3.16: Detail of Fix Factory Overhead (Jan-08 - Sep-08)

List	Detail of Fix Factory Overhead	Jan-08	Feb-08	Mar-08	Apr-08	May-08
1	Salary	41,000.00	41,000.00	41,000.00	41,000.00	41,000.00
2	Insurance	6,206.38	6,206.38	6,206.38	6,206.38	6,206.38
3	Depreciation	38,052.44	38,052.44	38,052.44	38,052.44	38,052.44
4	Property Tax	6,980.00	6,980.00	6,980.00	6,980.00	6,980.00

List	Detail of Fix Factory Overhead	Jun-08	Jul-08	Aug-08	Sep-08	Total
1	Salary	41,000.00	41,000.00	41,000.00	41,000.00	369,000.00
2	Insurance	6,206.38	6,206.38	6,206.38	6,206.38	55,857.42
3	Depreciation	38,052.44	38,052.44	38,052.44	38,052.44	342,471.96
4	Property Tax	6,980.00	6,980.00	6,980.00	6,980.00	62,820.00
					Total	830,149.38

Table 3.17: Variable Factory Overhead and Direct Labor Hour (Jan-08 - Sep-08)

Month	Variable Factory Overhead (Baht)	Direct Labor Hour (Hrs.)
Jan-08	87,788.39	6,429
Feb-08	74,131.62	6,080
Mar-08	81,770.67	5,884
Apr-08	77,439.50	5,319
May-08	68,224.10	6,236
Jun-08	71,935.10	5,629
Jul-08	66,162.43	5,961
Aug-08	60,235.39	5,619
Sep-08	77,041.87	6,025
Total	664,729.07	53,182

According to Table 3.17, it shows the value of variable factory overhead and direct labor hour since Jan-08 to Sep-08 and both of values were plotted in the graph between variable factory overhead and direct labor hour as shown in Figure 3.13. Table below is shown the detail of variable factory overhead since Jan-08 to Sep-08.

After roughly scanned the detail of variable factory overhead (Table 3.18), it did not found something wrong or mistake. However, as the result of R-square, which was 0.0786 and shown in Figure 3.13, it was not only shown the incorrect value of variable factory overhead in the linear equation but also the error of the data collection method of variable factory overhead and direct labor hour because R-square value below than 0.6.

Table 3.18: Detail of Variable Factory Overhead (Jan-08 – Sep-08)

List	Detail of Variable Factory Overhead	Jan-08	Feb-08	Mar-08	Apr-08	May-08
1	Packaging Cost	7,700.00	5,550.00	5,900.00	3,050.00	7,250.00
2	Spare Parts & Equipment Cost	5,133.00	3,450.00	3,386.00	3,353.00	5,540.00
3	Cost of Utility (Electricity)	59,311.78	51,138.47	55,938.84	54,995.15	39,852.27
4	Cost of Utility (Water)	4,002.10	3,967.95	3,865.48	5,795.21	4,019.18
5	Cost of Utility (Telephone)	2,838.71	1,982.71	3,924.76	2,776.65	2,533.76
6	Miscellaneous Expenses	2,077.80	1,689.49	2,226.59	1,139.49	2,220.89
7	Writing Implements & Printed Form Costs	800.00	700.00	650.00	550.00	800.00
8	Social Security Cost	5,925.00	5,653.00	5,879.00	5,780.00	6,008.00
List	Detail of Variable Factory Overhead	Jun-08	Jul-08	Aug-08	Sep-08	Total
1	Packaging Cost	3,946.00	6,750.00	3,300.00	6,330.00	49,776.00
2	Spare Parts & Equipment Cost	4,500.40	3,450.00	3,251.60	6,256.00	38,320.00
3	Cost of Utility (Electricity)	49,625.25	42,231.32	39,212.83	48,952.35	441,258.26
4	Cost of Utility (Water)	3,814.25	3,814.25	3,967.95	4,019.18	37,265.55
5	Cost of Utility (Telephone)	2,255.65	2,116.97	1,978.43	1,947.40	22,355.04
6	Miscellaneous Expenses	1,355.55	1,990.89	1,968.58	2,018.94	16,688.22
7	Writing Implements & Printed Form Costs	655.00	725.00	895.00	1,100.00	6,875.00
8	Social Security Cost	5,783.00	5,084.00	5,661.00	6,418.00	52,191.00
				Total	Total	664,729.07

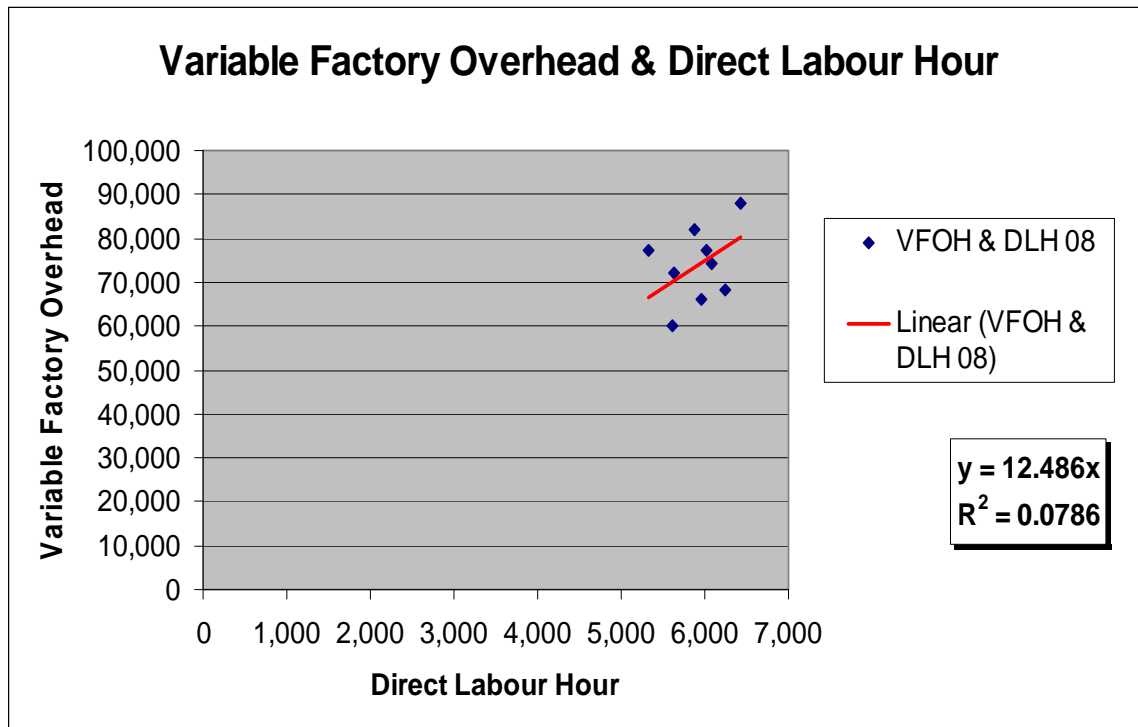


Figure 3.13: Relation Diagram between Variable Factory Overhead and Direct Labor Hour (Jan-08 to Sep-08)

As the result of factory overhead estimation since Jan-08 to Sep-08, it can be concluded that the average rate of factory overhead per direct labor hour is 28.096 Baht/Hour. (Factory Overhead per Direct Labor Hour = Fix Factory Overhead per Direct Labor Hour + Variable Factory Overhead per Direct Labor Hour = $15.61 + 12.486 = 28.096$ Baht/Hour)

However, the average rate of fix and variable factory overhead were not shown the actual factory overhead because the past data record of direct labor hour was not considered and calculated the percentage of performance, and R-square value less than 0.6 as mentioned above.

Therefore, the documentation system has to modify and develop in order to improve the efficiency of data record and documentation management, and increase the accuracy of cost estimation.

CHAPTER IV

Creating Production Cost System

As mentioned before, the structure of production cost is consisted of 3 main parts that are direct raw material cost, direct labor cost, and factory overhead. In order to create the appropriate production costing system and reduce the losses in the manufacturing process, the first thing, which the sample company should solve, is the documentation system.

The good data collection, thorough record and report, and the high efficiency of the document management system are very important factors for calculating and analyzing the production cost including controlling the wastes and defects in the manufacturing process.

4.1 Document Management System of Sample Company

According to the current documentation system of the sample company, it is inefficiency and did not thoroughly cover some important information. So, it can not bring the past data record to assess the company's efficiency and performance and to estimate the actual production cost.

Thus, this research will be designed and created the new documentation system in order to increase the efficiency of the documentation system of the sample company, to improve the accuracy of cost estimation, to create the appropriate costing system, and to control the losses in manufacturing process (cost reduction). The new document flow and the new document forms will be concluded and described as follows:

4.1.1 Flow of Document Forms

1. The flow of raw materials' request forms will be presented in figure below.

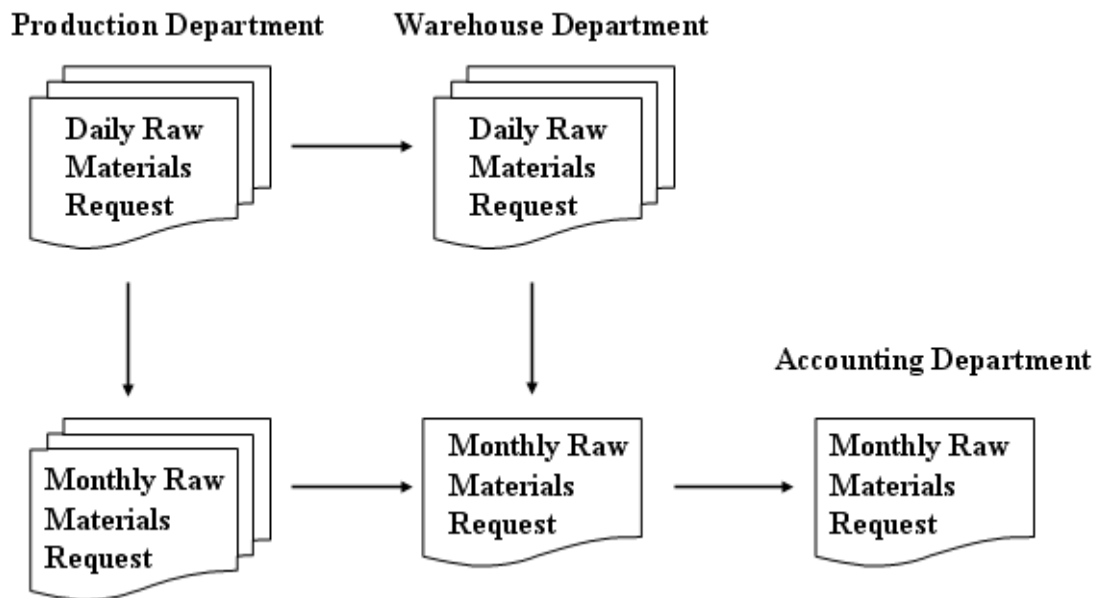


Figure 4.1: Flow of Raw Materials' Request

Procedures:

- Production department will prepare 2 copies of daily raw materials request: one copy for production department and another one for warehouse department.
- At the end of each month, production department will conclude and prepare 2 copies of monthly raw materials request: one copy for production department and another one for accounting department in order to record the stock account of each month. And, warehouse department will also conclude and make monthly raw materials request.

2. The flow of indirect raw materials' request forms will be shown in figure below.

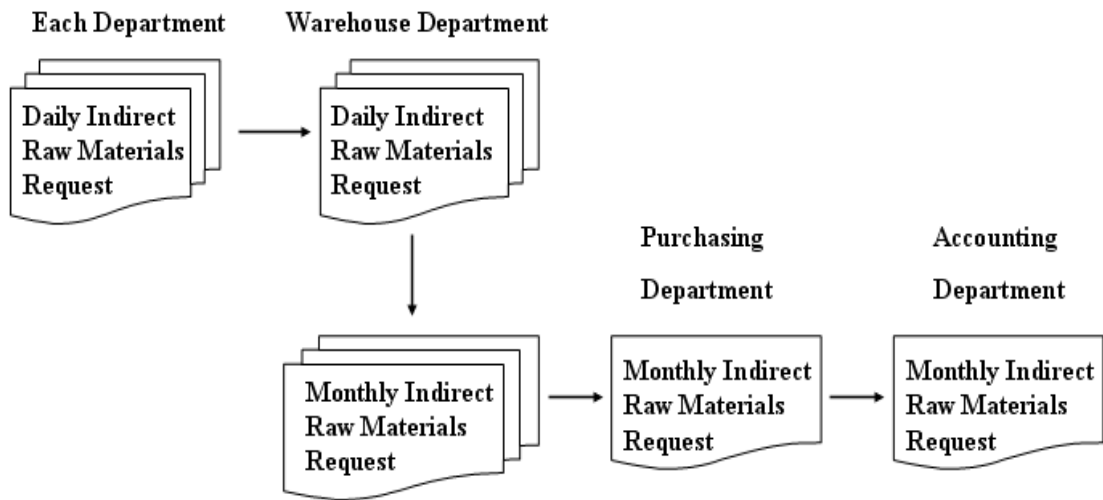


Figure 4.2: Flow of Indirect Raw Materials' Request

Procedures:

- When each department wants to make a requisition for indirect raw materials, each department will prepare 2 copies of daily indirect raw materials request: one copy for its department and another one for warehouse department.
 - At the end of each month, warehouse department will conclude and prepare 3 copies of monthly indirect raw materials request: one copy for its department, one copy for purchasing department and another one for accounting department in order to record the stock (indirect raw material) account of each month.
3. The flow of direct labor hour and direct labor cost reports will be shown in figure below.

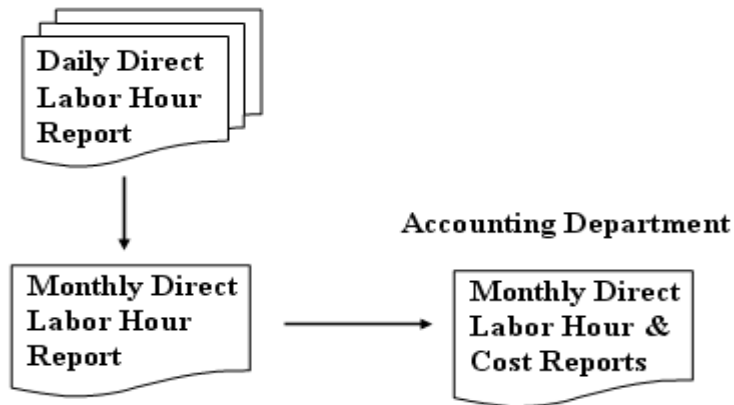
Human Resource Department

Figure 4.3: Flow of Direct Labor Hour Report

Procedures:

- Human resource department will check and record the time attendance of labor in daily direct labor hour report.
- At the end of each month, human resource department will conclude and prepare 2 copies of monthly direct labor hour report: one copy for human resource department and another one for accounting department in order to calculate the direct labor cost of each month.

(**Note:** In case of indirect labor hour report, it has the same procedures as the flow of direct labor hour report.)

4. The document flow of cost of utilities will be shown in figure below.

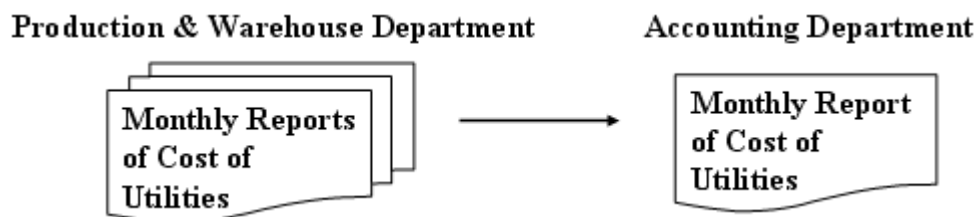


Figure 4.4: Document Flow of Cost of Utilities

Procedures:

- At the end of each month, production and warehouse department will gather and do 2 copies of the monthly report of cost of utilities, which is consisted of water, electricity, and telephone utilities: one copy for production department and another one for accounting department in order to record in the factory overhead cost.

5. The document flow of maintenance cost will be shown in figure below.

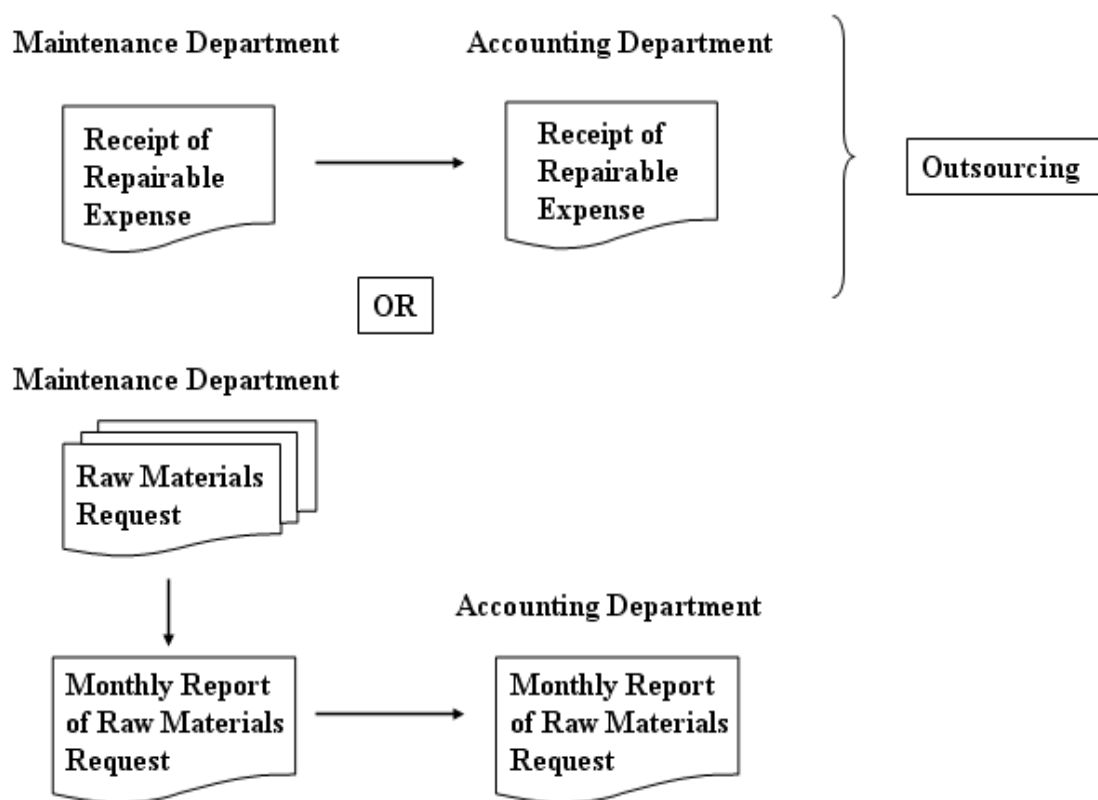


Figure 4.5: Document Flow of Maintenance Cost

Procedures:

- In case of outsourcing for hiring repairman, maintenance department has to gather and bring the receipts of repairable expense to accounting department in order to record in an account.
- In case of repair by maintenance department, maintenance department has to make the requisition for raw materials, which is

used for repair the machine, and conclude overall repairable expense at the end of each month including do 2 copies of monthly report of raw materials request: one copy for maintenance department and another one for accounting department.

6. The document flow of the production report will be shown in figure below.

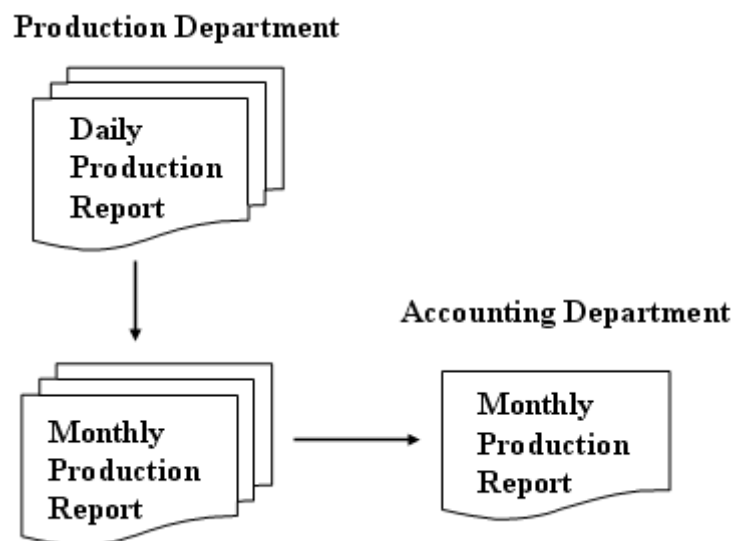


Figure 4.6: Document Flow of Production Report

Procedures:

- Production department will do the daily production report in order to summarize in the monthly production report.
- At the end of each month, production department will conclude and prepare 2 copies of monthly production report: one copy for production department and another one for accounting department.

7. The document flow of miscellaneous expenses will be shown in figure below.

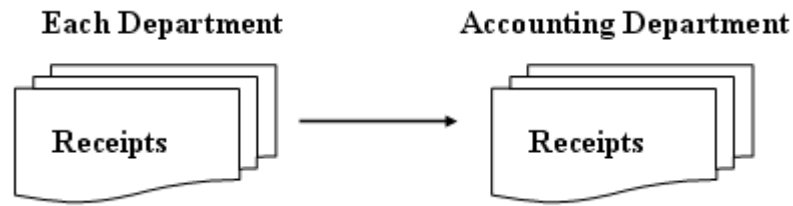


Figure 4.7: Document Flow of Miscellaneous Expenses

Procedures:

- Each department has to gather and bring all receipts to accounting department in order to record in the factory overhead cost.

4.1.2 New Document Forms

This section is shown the new document forms that will be used to record and collect the data in the sample company in order to modify the new documentation system and create the appropriate costing system including finding the methods to reduce wastes and defects. The new document forms have the document flows as mentioned in the previous section and the new document forms will be presented as follows: (See more details of the sample of the new document forms in Appendix B)

1. The raw materials' request form and the monthly raw materials' request form will be presented in Figure 4.8 and 4.9 respectively.

Direct Raw Material's Request Form

Date: _____ Job Order Number: _____

Department: _____

List	Item	Amount of Raw Material	Price of Each Unit	Total Price (Baht)

Required By: _____ Supplied By: _____ Approved By: _____

Figure 4.8: Direct Raw Materials' Request Form

Monthly Direct Raw Material's Request Form

Monthly: _____ Department: _____

List	Item	Amount of Raw Material	Price of Each Unit	Total Price (Baht)

Reporter: _____

Date: _____

Figure 4.9: Monthly Direct Raw Materials' Request Form

2. Forms about time attendance and direct labor hour report are shown in figures below.

Daily Time Attendance Report

Date: _____

Department: _____

List	Name - Surname	In	Out

Reporter: _____

Figure 4.10: Daily Time Attendance Report

Summary Report of Monthly Time Attendance

Monthly: _____

Department: _____

List	Name - Surname	Total Work Time (Hrs.)	Total Late Time (Hrs.)

Reporter: _____

Date: _____

Figure 4.11: Summary Report of Monthly Time Attendance

Daily Direct Labor Hour Report

Date: _____

Department: _____

List	Name - Surname	Normal Time (Hrs.)	Over Time (Hrs.)

Reporter: _____

Figure 4.12: Daily Direct Labor Hour Report

Monthly Direct Labor Hour Report

Monthly: _____

Department: _____

List	Name - Surname	Normal Time (Hrs.)	Over Time (Hrs.)

Reporter: _____

Date: _____

Figure 4.13: Monthly Direct Labor Hour Report

3. Forms about the production report are shown in figures below.

Daily Production Report

Date: _____

Department: _____

List	Order Number	Detail of Order	Amount of Product (DOZ)	Amount of Defect (Kg)	Production Time (Hrs.)		Note
					Normal	OT	

Reporter: _____

Figure 4.14: Daily Production Report

Monthly Production Report

Monthly: _____

Department: _____

List	Detail of Order	Amount of Product (DOZ)	Amount of Defect (Kg)	Production Time (Hrs.)		Note
				Normal	OT	

Reporter: _____

Date: _____

Figure 4.15: Monthly Production Report

Monthly Report of Defect

Monthly: _____

Department: _____

Date	Order Number	Detail of Order	Amount of Defect (Kg)	Incorrect Size (Kg)	Partly Tear (Kg)	Stick-on Yarn Leavings (Kg)	Untidy Product (Kg)
Total							

Reporter: _____

Date: _____

Figure 4.16: Monthly Report of Defect

Bill of Material (BOM)

Date: _____

List	Order Number	Detail & Item	Amount of Estimated Use (Kg)

Reporter: _____

Figure 4.17: Bill of Material (BOM)

Monthly Report of Waste

Monthly: _____

Date	Order Number	Detail of Order	Amount of Waste (Kg)	Over Plus (Kg)	Overweight (Kg)
Total					

Reporter: _____

Date: _____

Figure 4.18: Monthly Report of Waste

4. The daily and monthly indirect raw material's request form are shown in Figure 4.19 and 4.20 respectively.

Daily Indirect Raw Material's Request Form

Date: _____

Department: _____

List	Item	Amount of Raw Material	Price of Each Unit	Total Price (Baht)

Required By: _____ Supplied By: _____ Approved By: _____

Figure 4.19: Daily Indirect Raw Material's Request Form

Monthly Indirect Raw Material's Request Form

Monthly: _____

Department: _____

List	Item	Amount of Raw Material	Price of Each Unit	Total Price (Baht)

Reporter: _____

Date: _____

Figure 4.20: Monthly Indirect Raw Material's Request Form

5. The report form of cost of utilities, which is consisted of water, telephone, electricity, and fuel, is shown in figure below.

Monthly Report of Cost of Utilities

Monthly: _____

List	Item	Cost (Baht)
Total (Baht)		

Reporter: _____

Date: _____

Figure 4.21: Monthly Report of Cost of Utilities

6. The report form of repairable expense is shown in Figure 4.22. (In case of request the spare parts, it has to make the material's request form as shown in Figure 4.19.)

Monthly Report of Repairable Expense

Monthly: _____

List	Date	Item	Cost (Baht)
Total Cost (Baht)			

Reporter: _____

Date: _____

Figure 4.22: Monthly Report of Repairable Expense

4.2 Production Cost Analysis of Sample Company

Production cost analysis will help to know the product's cost structure, where each cost come from, and the actual production cost of each product. Furthermore, it will help to control the production cost and reduce the unnecessary cost including defects and wastes. In this case, the sample company has two main products, which are collar and sleeve. Both of them have the same principles for calculating the production cost that will be described below.

4.2.1 Direct Raw Material Cost

Calculating the direct raw material cost, it has to know the two main things that are the amount of direct raw materials, which will be used, and the price of each raw material. Therefore, total of direct raw materials cost of each product is come from the amount of direct raw materials, which are used to produce products, multiply by the price of each raw material.

The amount of direct raw materials, which are used to produce each product, can get from production department. Production Department will record the amount of daily raw materials request and summarize the amount of monthly raw materials request in the monthly report of raw material request. And, the price of each raw material, which is depended on the market price, can get the update data from purchasing department. (See more details of each raw material's price in Appendix A: Table A-26.)

4.2.2 Direct Labor Cost

Calculating the direct labor cost, it has to know the direct labor hour of each labor and the wage rate of each labor. Both data can get from human resource department and accounting department respectively.

According to the data of direct labor hour report and the wage rate, it can be summarized and calculated the direct labor cost as shown in Figure 4.23.

Monthly Report of Direct Labor Cost

Monthly: _____

Name - Surname	Wage Rate per Day (Baht)	Amount of Normal Time (Hrs.)	Normal Time Wage (Baht)	OT Rate per Day (Baht)	Amount of OT (Hrs.)	Over Time Wage (Baht)	Total Cost (Baht)
Total							

Reporter: _____

Date: _____

Figure 4.23: Monthly Report of Direct Labor Cost

4.2.3 Factory Overhead Cost

Factory overhead cost is the total costs of manufacturing except the direct raw materials cost and the direct labor cost. According to the same production processes of the both main products, it is not necessary to allocate the factory overhead cost to the both products. However, in order to easily estimate and calculate the standard of the factory overhead cost, the factory overhead cost of the sample company will be divided into 2 types that are fix factory overhead cost and variable factory overhead cost as shown in Figure 4.24.

Monthly Report of Factory Overhead Cost

Monthly: _____

List	Item	Type	Cost (Baht)
1	Packaging Cost	Variable Factory Overhead	
2	Spare Parts & Equipment Cost	Variable Factory Overhead	
3	Cost of Utility (Electricity)	Variable Factory Overhead	
4	Cost of Utility (Water)	Variable Factory Overhead	
5	Miscellaneous Expenses	Variable Factory Overhead	
6	Writing Implements & Printed Form Costs	Variable Factory Overhead	
7	Social Security Cost	Variable Factory Overhead	
Total Variable Factory Overhead Cost (Baht)			
8	Salary	Fix Factory Overhead	
9	Insurance	Fix Factory Overhead	
10	Depreciation	Fix Factory Overhead	
11	Property Tax	Fix Factory Overhead	
Total Fix Factory Overhead Cost (Baht)			
Total Factory Overhead Cost (Baht)			

Reporter: _____

Date: _____

Figure 4.24: Monthly Report of Factory Overhead Cost

4.2.4 Amount of Producing Products

Production department will do the monthly production report, which will be reported the amount of producing each product in each month.

4.2.5 Production Cost Calculation and Cost Structure

The production cost is consisted of three main parts that are the direct raw material cost, the direct labor cost and the factory overhead cost. Thus, the production cost of each product is the total cost of direct raw material plus direct labor cost, which is calculated by the rate of direct labor cost per direct labor hour multiply the amount of actually used hours, and plus the factory overhead cost, which is calculated by the rate of factory overhead cost per direct labor hour multiply the amount of actually used hours. Figure below shows the flow of standard cost calculation.

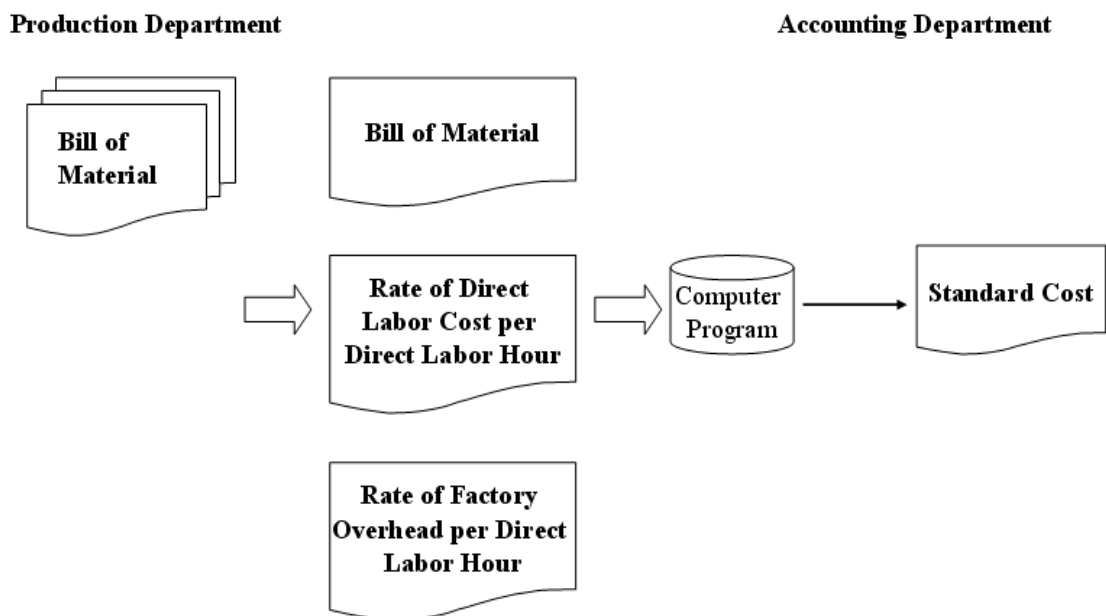


Figure 4.25: Flow of Standard Cost Calculation

The procedure of standard cost calculation will be described as follows:

1. The production department will do the bill of material (BOM) of each product that has details about the types of material and the amount of each raw material for producing the product per unit (as shows in Appendix C: Table C-4). According to bill of material, it can calculate the direct raw material cost by multiply the price of each material with the amount of each material. (See more details of the standard weight and the standard time for

producing each product and the price of each raw material in Appendix A: Table A-16 to Table A-24 and Table A-26 respectively.)

2. The data of actually used of direct labor hour will be received from the direct labor hour report (as shows in Figure 4.13) and the production report (as shows in Figure 4.14). (See more details of the standard time in each production process in Appendix A: Table A-14, 15, and 25.)
3. The data of actually used of indirect raw material and other expenses will be received from the other request forms. And, the summary of this expenses calls factory overhead cost.
4. The accounting department will collect the data and summarize the total direct labor cost (as shows in Figure 4.23) and the factory overhead cost (as shows in Figure 4.24) in each month. Furthermore, it will estimate the rate of direct labor cost per direct labor hour (as shows in Table 5.9) and the rate of factory overhead cost per direct labor hour (as shows in Table 5.11 and Figure 5.8) of each month in order to calculate the direct labor cost and the factory overhead cost for producing the product. (Note: The variance of the rate of direct labor cost per direct labor hour and the rate of factory overhead cost per direct labor hour in each month is depended on the performance efficiency in each month.)
5. The standard cost of each product is set up and also shown the cost structure of each product. Furthermore, the computer program is also created in order to help in the standard cost calculation. (See more details of computer program in Section 4.3)

According to the principles of the standard production cost calculation as mentioned above, it can be shown the standard production cost and the cost structure of each main product (collar and sleeve) as follows: (See more details of the amount of production in Appendix C: Table C-14 to Table C-16 and the rate of direct labor cost per direct labor hour shows in Table 5.8.)

Table 4.1: Manufacturing Expenses of Sample Company in June 2009

Item	Cost (Baht)	Total Cost (Baht)
Direct Raw Materials Cost	650,545.00	650,545.00
Direct Labor Cost	181,723.00	181,723.00
Variable Factory Overhead		64,395.82
<ul style="list-style-type: none"> • Packaging Cost • Spare Parts & Equipment Cost • Cost of Utility (Electricity & Water) • Miscellaneous Expenses • Writing Implements & Printed Form Costs • Social Security Cost 	3,590.00 4,955.75 46,714.50 2,489.57 740.00 5,906.00	
Fix Factory Overhead		88,258.94
<ul style="list-style-type: none"> • Salary • Insurance • Depreciation • Property Tax 	41,000.00 5,776.81 33,901.13 7,581.00	
Total Cost (Baht)		984,922.76

According to Table 4.1, it is shown the manufacturing expenses, which were consisted of the direct raw material costs, the direct labor cost and the factory overhead cost (Fix & Variable overhead), of the sample company in June 2009.

Furthermore, according to the data collection and analysis in June 2009, the rate of direct labor cost per direct labor hour is 47.93 baht/hour and the rate of factory overhead cost (Fix and Variable overhead) per direct labor hour is 40.469 baht/hour. (Both values are the average rate during Oct-o8 to Jun-09.) And, the total actual manufacturing hour is 3,842 hours (as shown in Table 5.9).

Thus, the example of the cost structure of collar and sleeve will be briefly summarized and described in tables below. (See more details of the standard time of each product in Appendix A: Table A-16 to Table A-25.)

Table 4.2: Standard Production Cost and Cost Structure of Collar
(Size 4" x 16", White Colour of C 20/1) in Jun 09

Item	Cost per Dozen (baht)	%
Direct Raw Materials Cost	71.02	61.56 %
Direct Labor Cost	24.04	20.84 %
Factory Overhead Cost	20.30	17.60 %
Total	115.36	100 %

Table 4.3: Standard Production Cost and Cost Structure of Collar
(Size 4" x 16", Blue Colour of TC 34/1) in Jun 09

Item	Cost per Dozen (baht)	%
Direct Raw Materials Cost	72.72	57.09 %
Direct Labor Cost	29.64	23.27 %
Factory Overhead Cost	25.02	19.64 %
Total	127.38	100 %

Table 4.4: Standard Production Cost and Cost Structure of Sleeve
(Size 1.5" x 17", White Colour of C 20/1) in Jun 09

Item	Cost per Dozen (baht)	%
Direct Raw Materials Cost	28.83	50.09 %
Direct Labor Cost	15.58	27.06 %
Factory Overhead Cost	13.15	22.85 %
Total	57.56	100 %

Table 4.5: Standard Production Cost and Cost Structure of Sleeve
(Size 1.5" x 17", Blue Colour of TC 34/1) in Jun 09

Item	Cost per Dozen (baht)	%
Direct Raw Materials Cost	28.79	46.48 %
Direct Labor Cost	17.97	29.02 %
Factory Overhead Cost	15.18	24.50 %
Total	61.94	100 %

As mentioned above, the data about overall expenses in the manufacturing process will be gathered and summarized at accounting department. Therefore, the procedure of cost control will be described below and the flow of cost control shows in Figure 4.26.

1. The data of actually used of direct raw material will be received from the direct raw material's request form (as shows in Figure 4.8 & 4.9).
2. The data of actually used of direct labor hour will be received from the direct labor hour report (as shows in Figure 4.13) and the production report (as shows in Figure 4.14).
3. The data of actually used of indirect raw material and other expenses will be received from the other request forms.
4. The accounting department will collect the data and summarize the total direct raw material cost, total direct labor cost (as shows in Figure 4.23) and the factory overhead cost (as shows in Figure 4.24) in each month.
5. The accounting department will calculate the actual production cost in each month as shows in Table 4.1 and do the report of production cost of each product as shows in Table 5.15.
6. Comparing the actual production cost with the standard cost of each product in order to control the production cost, to manage and improve the efficient performance and operation.

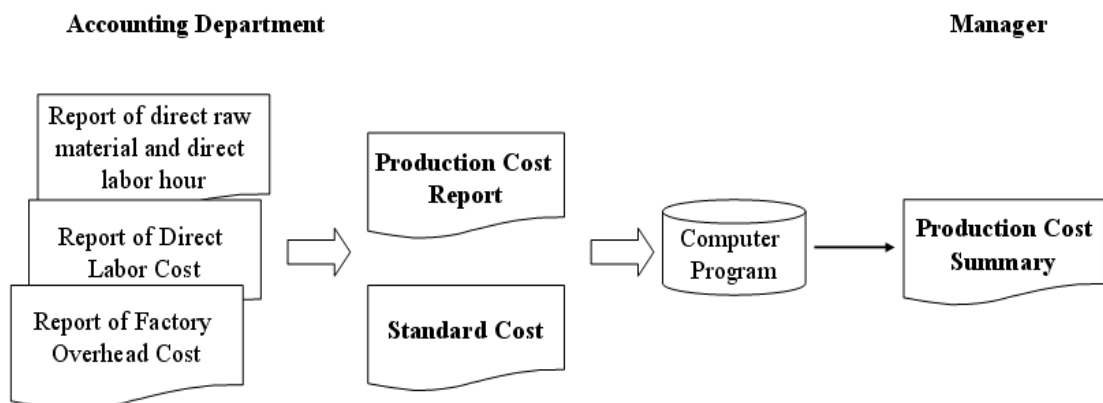


Figure 4.26: Flow of Cost Control

4.3 Example Program for Calculating Production Cost

After collected the data by using the new document system then it is designed the computer program for calculating the production cost of each product. In this case, it is created program by using Microsoft Office Access. Figure below shows the main page of program.

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
	Weight		Cost per Weight		Total Cost
Main Yarn	Kgs/dozen		Baht/Kg		Baht
Sub Yarn	Kgs/dozen		Baht/Kg		Baht
Pigmentation	Kgs/dozen		Baht/Kg		Baht
				Total Raw Material Cost	Percentage of Total Cost
				Baht	Percent
	Time		Cost per Time		
Tailoring	Minutes/dozen	Direct Labour		Total Direct Labour Cost	
	Hours/dozen		Baht/Hour	Baht	Percent
Finishing	Minutes/dozen	Overhead		Total Overhead Cost	
	Hours/dozen		Baht/Hour	Baht	Percent
Total Time	Hours			Total Cost	Percent

Figure 4.27: Main Page of Program

As shown in figure above, there are 6 items, which are number (dozen) of product, type of yarn, size of product, yarn colour, pigment colour, and steam oven, for putting the data in order to calculate the production cost. Moreover, the program will be calculated and categorized the production cost into 3 types that are raw material cost, direct labor cost, and overhead cost including display as percentage. Furthermore, it is shown the weight of raw material and the total time for producing the products.

Details of each item:

- **Number (dozen) of product:** Input the number of products as dozen.
- **Type of Yarn:** In this case, there are 4 types of yarn, which are C 20/1, C 60/2, POLY 75/1, and TC 34/1 as shown in Figure 4.28.

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven
<input type="text"/>	<input type="text" value="C 20/1"/> <input type="text" value="C 60/2"/> <input type="text" value="POLY 75/1"/> <input type="text" value="TC 34/1"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
			Cost per Weight	Total Cost	<input type="button" value="Run"/>
Main Yarn	Kgs/dozen		Baht/Kg	Baht	<input type="button" value="Clear"/>
Sub Yarn	Kgs/dozen		Baht/Kg	Baht	
Pigmentation	Kgs/dozen		Baht/Kg	Baht	<input type="button" value="Edit Price"/>
			Total Raw Material Cost	Percentage of Total Cost	
			Baht	Percent	
	Time		Cost per Time		
Tailoring	Minutes/dozen	Direct Labour		Total Direct Labour Cost	
	Hours/dozen		Baht/Hour	Baht	Percent
Finishing	Minutes/dozen	Overhead		Total Overhead Cost	
	Hours/dozen		Baht/Hour	Baht	Percent
Total Time	Hours			Total Cost	Baht
					Percent

Figure 4.28: Lists of Type of Yarn

- **Size (of product):** Choosing the size of products that are varied from 1 inch x 28 inches to 4 inches x 19 inches as shown in Figure 4.29.

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven
		1 x 28 1.5 x 12-13 1.5 x 14-15 1.5 x 16-17 1.5 x 24-25 1.5 x 26-27 1.5 x 28-29 1.5 x 30-31			
		Weight	Cost per Weight	Total Cost	
Main Yarn		Kgs/dozen	Baht/Kg	Baht	
Sub Yarn		Kgs/dozen	Baht/Kg	Baht	
Pigmentation		Kgs/dozen	Baht/Kg	Baht	
				Total Raw Material Cost	Percentage of Total Cost
				Baht	Percent
		Time	Cost per Time		
Tailoring		Minutes/dozen	Direct Labour	Total Direct Labour Cost	
		Hours/dozen	Baht/Hour	Baht	Percent
Finishing		Minutes/dozen	Overhead	Total Overhead Cost	
		Hours/dozen	Baht/Hour	Baht	Percent
Total Time		Hours		Total Cost	Percent
				Baht	Percent

Figure 4.29: Lists of Product's Size

- **Yarn Colour:** Choosing the raw material that is divided into 2 main types: unbleached yarn and colour yarn (light, middle, dark, and off-white colour).

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven
			Unbleached Yarn Light Colour Middle Colour Dark Colour White Colour Off-white Colour		
		Weight	Cost per Weight	Total Cost	
Main Yarn		Kgs/dozen	Baht/Kg	Baht	
Sub Yarn		Kgs/dozen	Baht/Kg	Baht	
Pigmentation		Kgs/dozen	Baht/Kg	Baht	
				Total Raw Material Cost	Percentage of Total Cost
				Baht	Percent
		Time	Cost per Time		
Tailoring		Minutes/dozen	Direct Labour	Total Direct Labour Cost	
		Hours/dozen	Baht/Hour	Baht	Percent
Finishing		Minutes/dozen	Overhead	Total Overhead Cost	
		Hours/dozen	Baht/Hour	Baht	Percent
Total Time		Hours		Total Cost	Percent
				Baht	Percent

Figure 4.30: Lists of Yarn Colour

- Pigment Colour:** In case of choosing unbleached yarn in Yarn Colour's item and would like to pigment the unbleached yarn, it has to select the colour in Pigment Colour's item. However, if already choosing the coloured yarn, it did not put data in Pigment Colour's item (select "None") as shown in Figure 4.31.

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven	
				<div style="border: 1px solid black; padding: 5px;"> None Light Colour Middle Colour Dark Colour White Colour Off-white Colour </div>		
	Weight		Cost per Weight		Cost	
Main Yarn	Kgs/dozen		Baht/Kg			
Sub Yarn	Kgs/dozen		Baht/Kg		Baht	
Pigmentation	Kgs/dozen		Baht/Kg		Baht	
Total Raw Material Cost					Percentage of Total Cost	
					Baht	Percent
	Time		Cost per Time			
Tailoring	Minutes/dozen	Direct Labour		Total Direct Labour Cost		
	Hours/dozen		Baht/Hour	Baht	Percent	
Finishing	Minutes/dozen	Overhead		Total Overhead Cost		
	Hours/dozen		Baht/Hour	Baht	Percent	
Total Time	Hours			Total Cost	Baht	
					Baht	Percent

Figure 4.31: Lists of Pigment Colour

In case of choosing the coloured yarn and also selected the colour in Pigment Colour's item, it will be shown the error of program as shown in figure below.

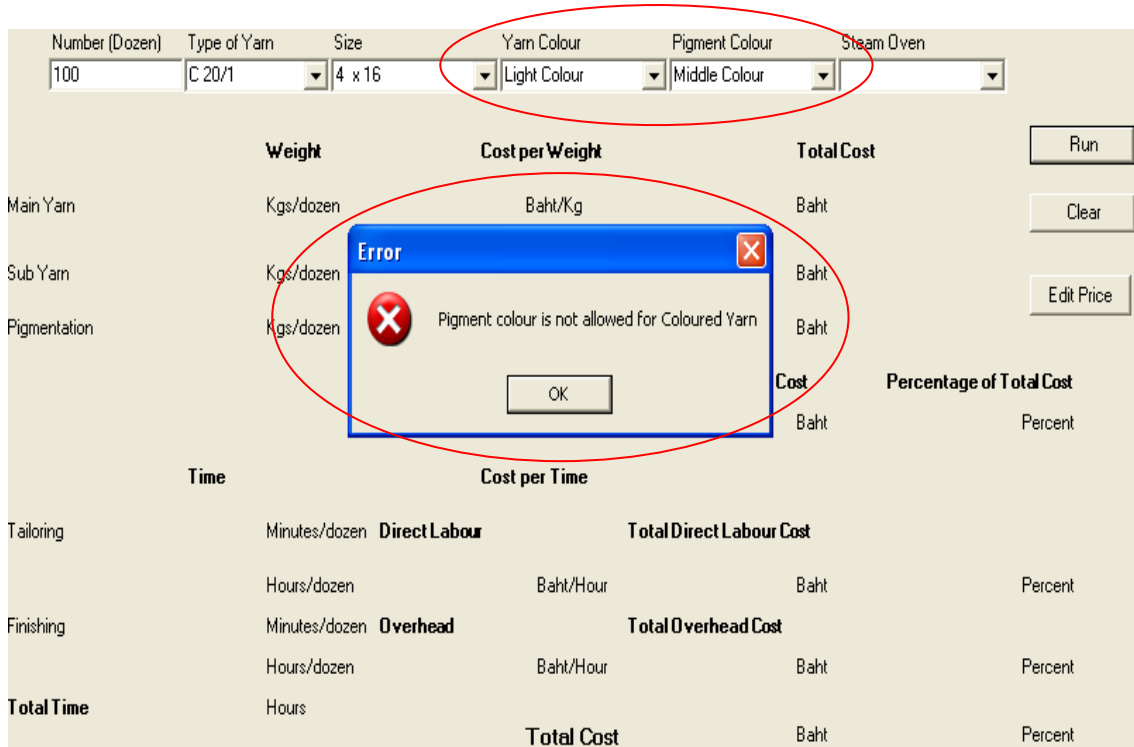


Figure 4.32: Error of Program (selected wrong data)

- **Steam Oven:** Will be heated the products in the stream oven or not?

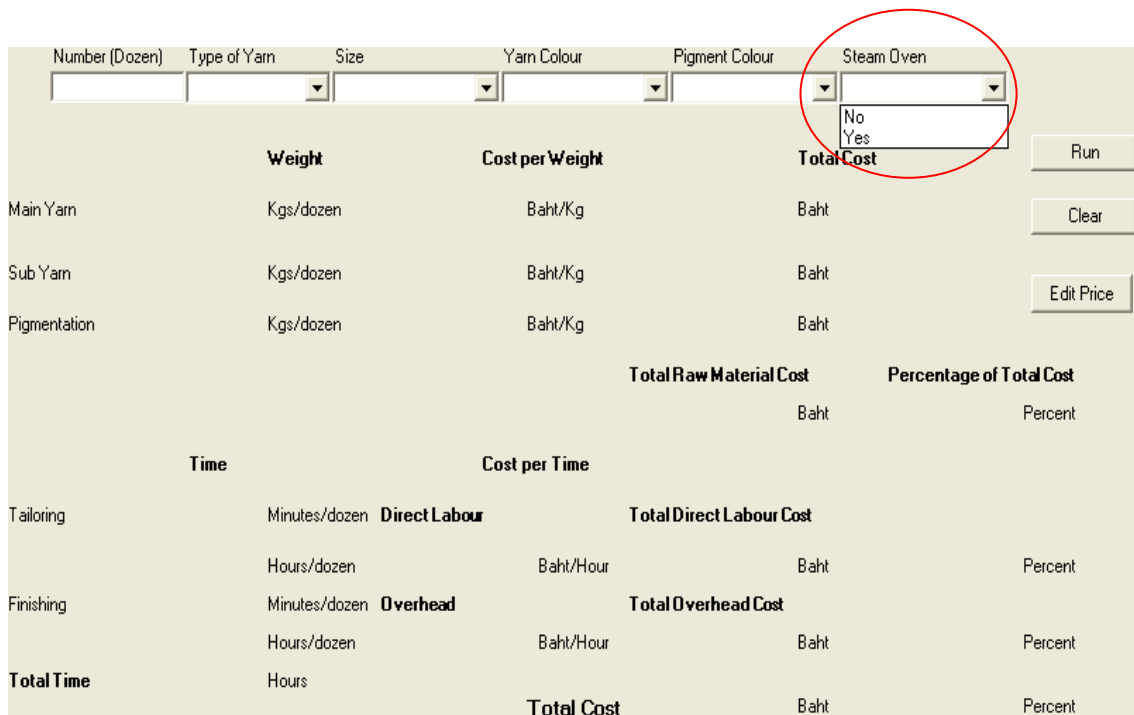


Figure 4.33: Lists of Steam Oven

After put all data in the six items then click the “Run” button in order to calculate the production cost. Figure below is shown the example of the production cost structure. And, the “Clear” button is used to clear the old data in order to put the new data in the main page as shows in Figure 4.34.

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven		
100	C 60/2	4 x 16	Unbleached Yarn	White Colour	No		
		Weight	Cost per Weight	Total Cost			<input type="button" value="Run"/>
Main Yarn	0.42	Kgs/dozen	286.598	Baht/Kg	12037.12	Baht	<input type="button" value="Clear"/>
Sub Yarn	0.0154	Kgs/dozen	108.0254	Baht/Kg	166.3591	Baht	<input type="button" value="Edit Price"/>
Pigmentation	0.42	Kgs/dozen	46.2966	Baht/Kg	1944.457	Baht	
				Total Raw Material Cost	Percentage of Total Cost		
				14147.93	Baht	72.65584	Percent
		Time	Cost per Time				
Tailoring	32	Minutes/dozen	Direct Labour	Total Direct Labour Cost			
	0.5333334	Hours/dozen	43.92	Baht/Hour	2788.92	Baht	14.32233
Finishing	6.1	Minutes/dozen	Overhead	Total Overhead Cost			
	0.1016667	Hours/dozen	39.932	Baht/Hour	2535.682	Baht	13.02184
Total Time	63.5	Hours		Total Cost	19472.53	Baht	100%
							Percent

Figure 4.34: Detail of Production Cost Structure

In term of edit the price of raw materials, the direct labor cost, and the factory overhead cost, it has to click the “Edit Price” button. The page of edit price is shown in figure below.

Change Yarn Cost					
Type of Yarn	Yarn Colour	Find Price	Current Price	Baht/pound	Change to
C 20/1	Unbleached Yarn				Baht/pound
					Baht/kg
					Change
Change Pigmentation Cost					
Type of Yarn	Pigment Colour	Find Price	Current Price	Baht/pound	Change to
C 20/1	None				Baht/pound
					Baht/kg
					Change
Change Direct Labour Cost					
Cost Type	Find Price	Current Value	Baht/hour	Change to	Baht/hour
Normal					Change
Change Overhead Cost					
Find Price	Current Value	Baht/hour	Change to	Baht/hour	Change

Figure 4.35: Edit Price Page

According to figure above, if would like to know the current price of each raw material or the pigmentation cost, it has to select the type of yarn, yarn colour, or pigment colour after that click the “Find Price” button as shows in Figure 4.36. Moreover, the current cost of direct labor and the factory overhead can be found by click the “Find Price” button as well.

For example, the current price of unbleached yarn of C 20/1 is 49 baht/pound, the pigmentation cost (light colour) of C 20/1 is 26 baht/pound, the direct labor cost for normal time is 43.92 baht/hour, and the factory overhead cost is 39.932 baht/hour as shown in Figure 4.36. Furthermore, the current price and current value, which are shown in this page, will be used to calculate the production cost in the program.

Change Yarn Cost

Type of Yarn	Yarn Colour	Find Price	Current Price		Change to
C 20/1	Unbleached Yarn		49	Baht/pound	
			108.0254	Baht/kg	

Change Pigmentation Cost

Type of Yarn	Pigment Colour	Find Price	Current Price		Change to
C 20/1	Light Colour		26	Baht/pound	
			57.3196	Baht/kg	

Change Direct Labour Cost

Cost Type	Find Price	Current Value		Change to
Normal		43.92	Baht/hour	

Change Overhead Cost

Find Price	Current Value		Change to
	39.932	Baht/hour	

Figure 4.36: Current Price and Value of Each Item

However, if you would like to change the price of each raw material, it has to select the item, which you would like to change, and put the new data after that click the “Change” button as shows in Figure 4.37. The new data will be recorded in the program and will be used to calculate the production cost.

Change Yarn Cost

Type of Yarn	Yarn Colour	Find Price	Current Price		Change to
C 20/1	Unbleached Yarn			Baht/pound	
				Baht/kg	

Change Pigmentation Cost

Type of Yarn	Pigment Colour	Find Price	Current Price		Change to
C 20/1	None			Baht/pound	
				Baht/kg	

Change Direct Labour Cost

Cost Type	Find Price	Current Value		Change to
Normal			Baht/hour	

Change Overhead Cost

Find Price	Current Value		Change to
		Baht/hour	

Figure 4.37: Box for Put New Data

Figure below shows the example of how to change the price of raw materials. In case of change the direct labor cost and the overhead cost, it just put the new data and clicked the “Change” button then the new data will be recorded.

Change Yarn Cost

Type of Yarn	Yarn Colour	Find Price	Current Price	Baht/pound	Change to	Baht/pound	Change
C 60/2	White Colour						
				Baht/kg			

1. Selected the type of yarn and yarn colour (Type of raw material)

Type of Yarn	Yarn Colour	Find Price	Current Price	Baht/pound	Change to	Baht/pound	Change
C 60/2	White Colour		172				
			379.1912	Baht/kg			

2. Clicked “Find Price” button in order to check the current price

Type of Yarn	Yarn Colour	Find Price	Current Price	Baht/pound	Change to	Baht/pound	Change
C 60/2	White Colour		172		200		
			379.1912	Baht/kg			

3. Put the new data (new raw material's price) and clicked “Change” button

Type of Yarn	Yarn Colour	Find Price	Current Price	Baht/pound	Change to	Baht/pound	Change
C 60/2	White Colour		200				
			440.92	Baht/kg			

4. The new data will be recorded in the program

Figure 4.38: Steps of Edit Price

CHAPTER V

Manufacturing Cost Reduction

As the result of the production cost analysis, it is found that the production cost is consisted of the direct raw materials cost (DM), the direct lab or cost (DL) and the factory overhead cost (FOH). Furthermore, after analyzed the production costs of collar and sleeve, it is shown that the majority cost of the both main product is come from the direct raw materials cost as mentioned in the previous section. Therefore, the direct raw materials cost is the first thing that has to take into account in order to reduce the production cost. However, the direct labor cost and the factory overhead cost are also taken into account in order to increase the efficiency of manufacturing cost reduction.

The production diagram is shown how to transform the input factors into output. In term of input, it is consisted of three main factors that are direct raw material cost (DM), direct labor cost (DL) and factory overhead cost (FOH). All of the input factors will be integrated in the production process and transformed into the finished products (output) and loss (wastes & defects) as shown in figure below.

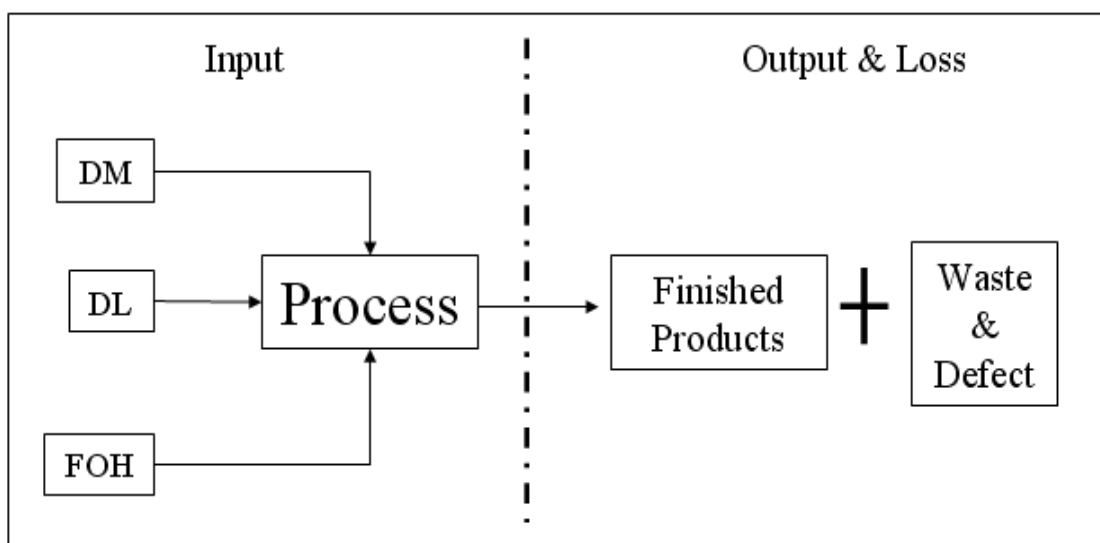


Figure 5.1: Production Diagram

As mentioned in Chapter III, it can be divided the loss in the production process into 2 groups that are waste and defect. In order to reduce the production cost, it has to find the root causes of losses and find the methods to eliminate them. As the result of data collection and data analysis, it can be divided the defects in the production process into 4 types: incorrect size, partly tear, stick-on yarn leavings, and untidy product. Moreover, the wastes in the production process can be divided into 2 types: over plus and overweight.

5.1 Analysis for the causes of loss and loss reduction

5.1.1 Defects from the production process

1. Defects from incorrect size can be analyzed the root causes of problem as shown in fish bone diagram (cause and effect diagram) below.

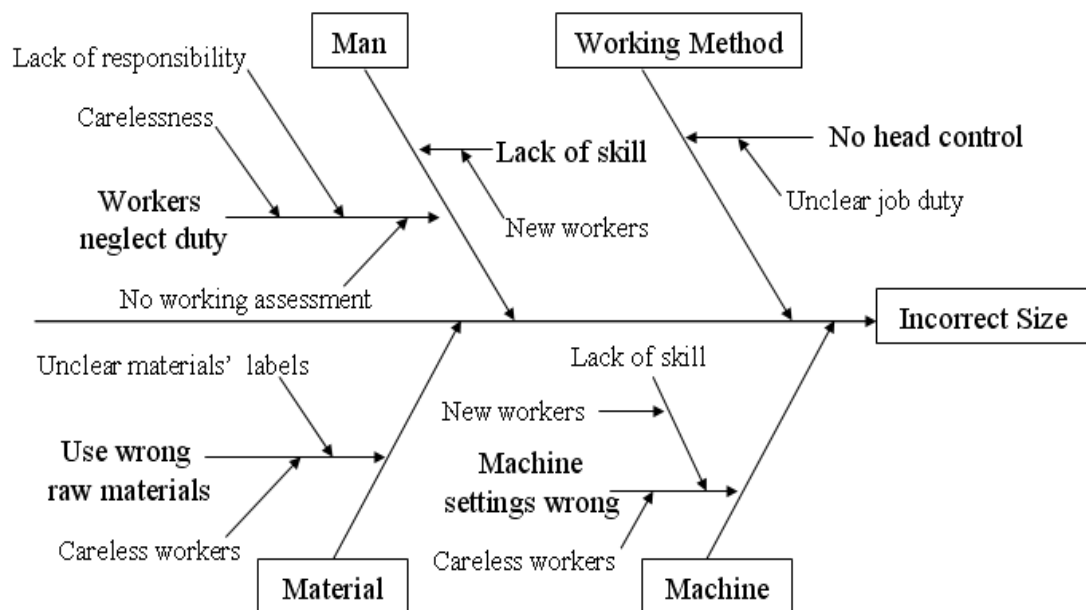


Figure 5.2: Cause and Effect Diagram of Defects from Incorrect Size

According to the cause and effect diagram in Figure 5.2, it can be summarized the solutions as shown in Table 5.1.

Table 5.1: Solutions of Defects from Incorrect Size

List of Problems	Cause	Solution
1. Man - Workers neglect duty - Lack of skill	1. Lack of responsibility 2. Carelessness 3. No working assessment - New workers	1. To admonish and caution the workers when they make the mistakes and set the penalties. 2. To evaluate and assess the performance of workers. - Should be training the new workers.
2. Working Method - No head control	- Unclear job duty	- Has to appoint the head of the production line in order to closely control the workers.
3. Material - Use wrong raw materials	1. Unclear materials' labels 2. Careless workers	1. To make the clear raw materials' labels. 2. To set the penalties
4. Machine - Machine settings wrong	1. Lack of skill 2. Careless workers	- Training the new workers to know how to set the machine and also set the penalties in case of make the mistakes.

2. Defects from partly tear can be analyzed the root causes of problem as shown in the cause and effect diagram below.

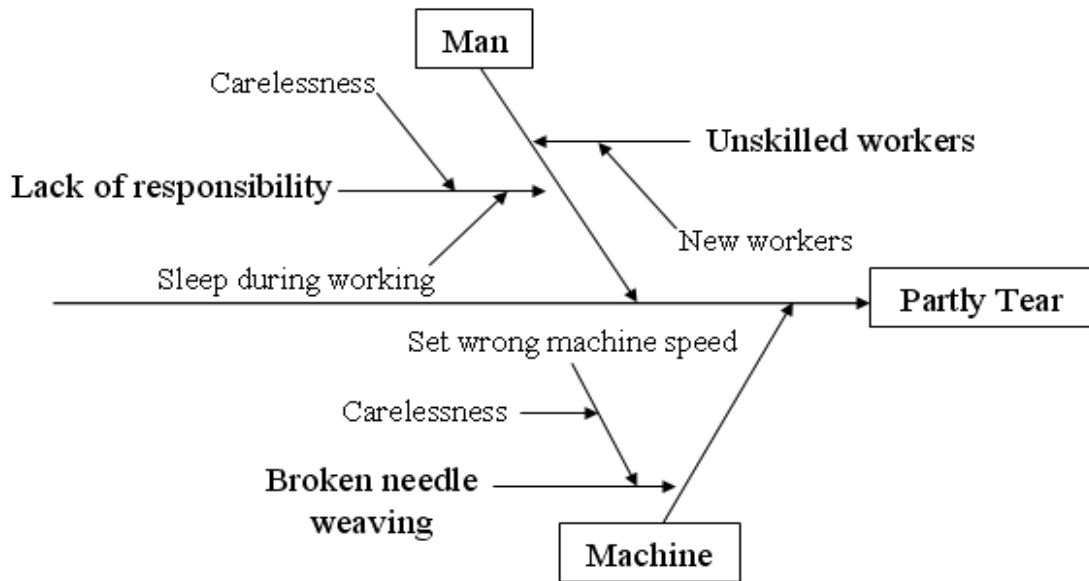


Figure 5.3: Cause and Effect Diagram of Defects from Partly Tear

According to the cause and effect diagram in Figure 5.3, it can be summarized the solutions as shown in Table 5.2.

Table 5.2: Solutions of Defects from Partly Tear

List of Problems	Cause	Solution
1. Man - Lack of responsibility - Unskilled workers	1. Carelessness 2. Sleep during working - New workers	- To admonish and caution the workers when they make the mistakes and also set the penalties. - Should be training the new workers.
2. Machine - Broken needle weaving	- Set wrong machine speed	- Training the new workers to know how to set the machine and also set the penalties in case of make the mistakes.

3. Defects from stick-on yarn leavings can be analyzed the root causes of problem as shown in the cause and effect diagram below.

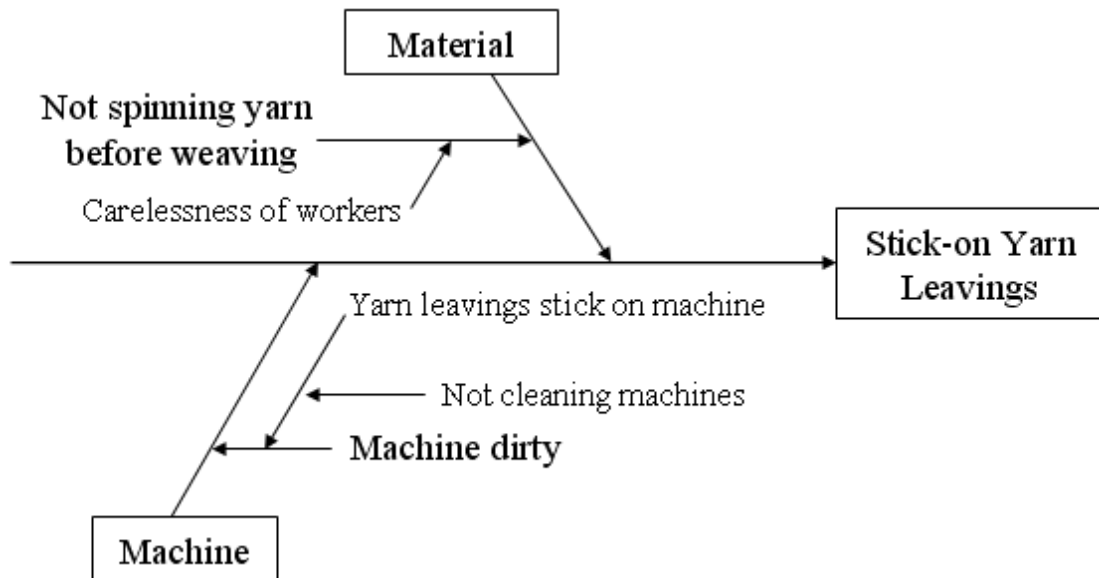


Figure 5.4: Cause and Effect Diagram of Defects from Stick-on Yarn Leavings

According to the cause and effect diagram in Figure 5.4, it can be summarized the solutions as shown in Table 5.3.

Table 5.3: Solutions of Defects from Stick-on Yarn Leavings

List of Problems	Cause	Solution
1. Material - Not spinning yarn before weaving	- Carelessness of workers	- To caution the workers when they make the mistakes and also set the penalties.
2. Machine - Machine dirty	- Yarn leavings stick on machine because workers do not clean the machines.	- Daily clean the machines after finished the production in everyday.

4. Defects from untidy product can be analyzed the root causes of problem as shown in the cause and effect diagram below.

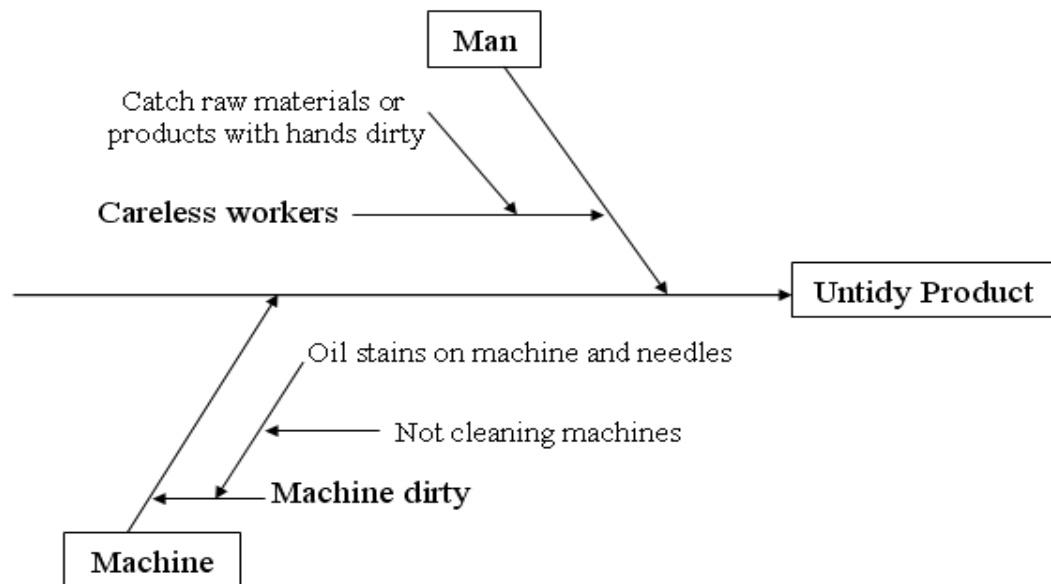


Figure 5.5: Cause and Effect Diagram of Defects from Untidy Product

According to the cause and effect diagram in Figure 5.5, it can be summarized the solutions as shown in Table 5.4.

Table 5.4: Solutions of Defects from Untidy Product

List of Problems	Cause	Solution
1. Man - Careless workers	- The workers catch raw materials or products with dirty hands.	- To caution the workers when they make the mistakes and also set the penalties in order to make them pay more attention to theirs jobs.
2. Machine - Machine dirty	- Oil stains on machines and needles because workers do not clean the machines.	- Daily clean the machines after finished the production in everyday.

5.1.2 Wastes from the production process

1. Wastes from over plus can be analyzed the root causes of problem as shown in the cause and effect diagram below.

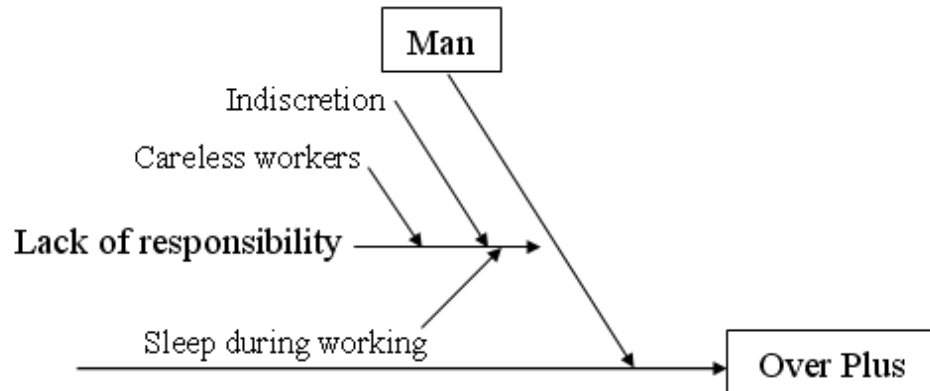


Figure 5.6: Cause and Effect Diagram of Wastes from Over Plus

According to the cause and effect diagram in Figure 5.6, it can be summarized the solutions as shown in Table 5.5.

Table 5.5: Solutions of Wastes from Over Plus

List of Problems	Cause	Solution
1. Man - Lack of responsibility	1. Careless workers 2. Sleep during working 3. Indiscretion	1. To caution the workers when they make the mistakes and also set the penalties. 2. To evaluate and assess the performance of workers. 3. To assign the head of production line to control and monitor the workers in order to carefully work.

2. Wastes from overweight can be analyzed the root causes of problem as shown in the cause and effect diagram below.

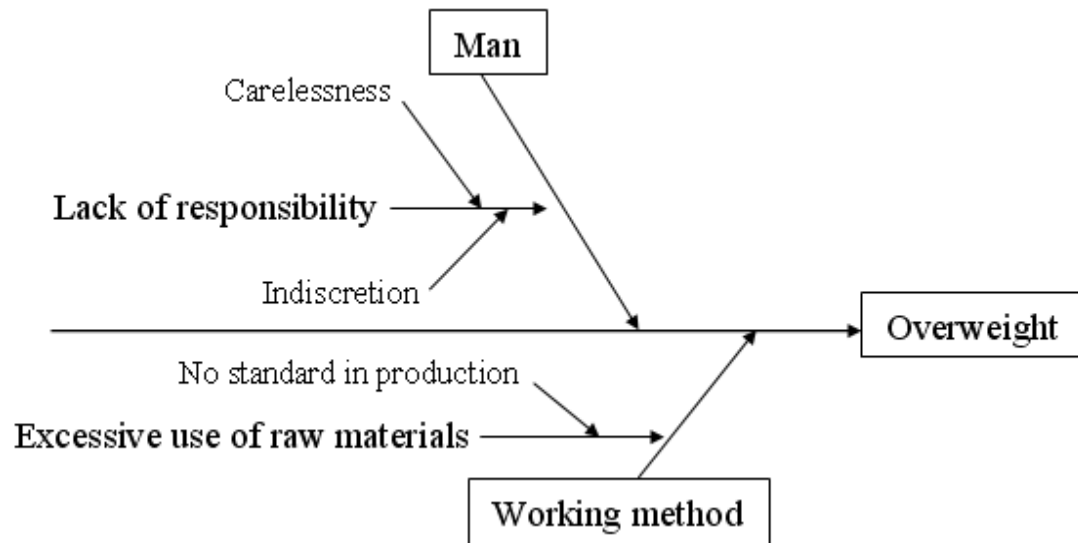


Figure 5.7: Cause and Effect Diagram of Wastes from Overweight

According to the cause and effect diagram in Figure 5.7, it can be summarized the solutions as shown in Table 5.6.

Table 5.6: Solutions of Wastes from Overweight

List of Problems	Cause	Solution
1. Man - Lack of responsibility	1. Carelessness 2. Indiscretion	1. To caution the workers when they make the mistakes and set the penalties. 2. To evaluate and assess the performance of workers.

<p>2. Working Method</p> <ul style="list-style-type: none"> - Excessive use of raw materials 	<ul style="list-style-type: none"> - No standard in production 	<ul style="list-style-type: none"> - To set the standard for producing each product. For example: How many raw materials will be used to produce each product. (See more details in Appendix A: Table A-16 – Table A-24)
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According to the pie chart of average percentage of each defect type (Figure 3.10) in Chapter III, it was shown that the defect from incorrect size was the majority defect, which was about 69.49%. Moreover, the pie chart of average percentage of each waste type (Figure 3.11) in Chapter III, it was also shown that the waste from over plus was the majority waste, which was about 72.97%. Therefore, both problems have been taken into account in order to find the root causes of both problems and also find the methods to reduce the loss.

As the result of cause and effect diagram of defects from incorrect size (Figure 5.2) and the result of investigation, it is found that the machine settings wrong and unskilled workers are the main causes of defects. Therefore, the head of production department has been ordered to set the training team in order to train the new workers about the steps of production process, how to set the machine and how to maintain the machine.

Furthermore, the manual machine, which is described about the number of needles, the number of rounds and times in the weaving, the standard time and weight for producing each product, was made in order to easy set the machines. (See more details of the standard time in each production process and the manual machine in Appendix A: Table A-14 – Table A-25.)

According to appoint the head of the production line, the workers have to pay more attention to their jobs because the head will closely control the workers. After that using the statistic method, which is work sampling, by getting random samples 20 times per day in 25-days period in order to check the performance of workers.

As the result of work sampling, it is shown that the performance of workers after improvement is higher as shown in table below. (See more detail of the work sampling after improvement in Appendix A: Table A-27 – Table A-31.)

Table 5.7: Performance of Workers in Production Line (after improvement)

Number of Work Sampling					
	Worker 1	Worker 2	Worker 3	Worker 4	Worker 5
Work	392	364	356	373	351
Idle	108	136	144	127	149
Total (Times)	500	500	500	500	500
% Utilization	78.40%	72.80%	71.20%	74.60%	70.20%
% Idle	21.60%	27.20%	28.80%	25.40%	29.80%

5.2 Result of Improvement

After developed the documentation system and created the appropriate costing system, the result of improvement will be described as follows.

5.2.1 Increase Accuracy of Cost Estimation

The new documentation system will improve the efficiency of data record and increase the accuracy of production cost estimation.

Table 5.8: Average Rate of Direct Labor Cost per Direct Labor Hour

(Oct 08 – Jun 09)

Month	Direct Labor Cost (Baht)	Direct Labor Hour (Hrs.)	Rate of Direct Labor Cost per Direct Labor Hour (Baht/Hr)
Oct-08	219,585.00	4,368	50.27
Nov-08	183,259.00	3,460	52.97

Dec-08	153,859.00	3,203	48.04
Jan-09	206,991.00	4,628	44.73
Feb-09	166,919.00	3,708	45.02
Mar-09	186,928.00	3,957	47.24
Apr-09	155,417.00	3,318	46.84
May-09	175,027.00	3,571	49.01
Jun-09	181,723.00	3,842	47.30
Total	1,629,708.00	34,055	47.93

According to Table 5.8, it shows the average rate of direct labor cost per direct labor hour since Oct-08 to Jun-09 was 47.93 Baht/Hour. As the result of improvement, the direct labor cost has already included normal and overtime rates and direct labor hour has also included normal and overtime hours. Furthermore, the percentage of attendance and performance rates have been recorded and taken into account. Therefore, the average rate of direct labor cost per direct labor hour since Oct-08 is reliability and has more accuracy than the past.

Table 5.9: Summary Information of Direct Labor Cost and Direct Labor Hour (Oct 08 – Jun 09)

Item	Month											
	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09			
Direct Labor Cost	Normal	153,625	128,629	138,709	148,013	113,249	134,098	139,127	124,358	129,983		
	OT	65,960	54,630	15,150	58,978	53,670	52,830	16,290	50,669	51,740		
	Total	219,585	183,259	153,859	206,991	166,919	186,928	155,417	175,027	181,723		
Direct Labor Hour (Must Work)	Normal	5,000	4,172	4,520	5,072	3,812	4,196	4,422	3,864	4,044		
	OT	1,488	1,236	342	1,389	1,242	1,328	389	1,187	1,214		
	Total	6,488	5,408	4,862	6,461	5,054	5,524	4,811	5,051	5,258		
Direct Labor Hour (Come to Work)	Normal	4,911	4,081	4,432	4,976	3,739	4,107	4,278	3,796	3,951		
	OT	1,413	1,155	322	1,315	1,174	1,226	340	1,128	1,152		
	Total	6,324	5,236	4,754	6,291	4,913	5,333	4,618	4,924	5,103		
Direct Labor Hour (Actual Manufacturing)	Normal	3,423	2,686	2,978	3,671	2,835	3,082	3,076	2,758	2,984		
	OT	945	774	225	957	873	875	242	813	858		
	Total	4,368	3,460	3,203	4,628	3,708	3,957	3,318	3,571	3,842		
Direct Labor Cost per Direct Labor Hour (Baht/Hr.)	Normal	44.88	47.89	46.58	40.32	39.95	43.51	45.23	45.09	43.56		
	OT	69.80	70.58	67.33	61.63	61.48	60.38	67.31	62.32	60.30		
	Total	50.27	52.97	48.04	44.73	45.02	47.24	46.84	49.01	47.30		
Attendance (%)	Normal	98.22	97.82	98.05	98.11	98.08	97.88	96.74	98.24	97.70		
	OT	94.96	93.45	94.15	94.67	94.52	92.32	87.40	95.03	94.89		
	Total	97.47	96.82	97.78	97.37	97.21	96.54	95.99	97.49	97.05		
Performance (%)	Normal	69.70	65.82	67.19	73.77	75.82	75.04	71.90	72.66	75.53		
	OT	66.88	67.01	69.88	72.78	74.36	71.37	71.18	72.04	74.48		
	Total	69.07	66.08	67.37	73.57	75.47	74.20	71.85	72.52	75.29		
Average Performance (%)	(During Improvement)						73.82 % (After Improvement)					
	67.51%						73.82 %					

According to Table 5.9, it shows the summary information of direct labor cost and direct labor hour since Oct-08 to Jun-09. The direct labor cost, direct labor hour, direct labor cost per direct labor hour, and the percentage of attendance and performance were separately calculated on the normal and overtime rates. Thus, the rate of direct labor cost per direct labor hour has more accurate than the past.

Furthermore, the average percentage of performance after improvement was around 73.82% that was increased from the past (during improvement) around 6.31% as shown in Table 5.9. Thus, as the result of the new documentation system and the working system development, it can be increased the average percentage of performance around 8.55% of the old working system (during improvement).

Table 5.10: Average Rate of Direct Labor Cost per Direct Labor Hour
(During and After Improvement)

Month	Direct Labor Cost per Direct Labor Hour (Baht/Hour) (Normal + OT)	Average Rate of Direct Labor Cost per Direct Labor Hour (Baht/Hour)	Differences Between During & After Improvement
Oct 08	50.27	50.43 (During Improvement)	Reduced 3.74 Baht/Hour or equal 7.42 % of the old working system (during improvement)
Nov 08	52.97		
Dec 08	48.04		
Jan 09	44.73	46.69 (After Improvement)	
Feb 09	45.02		
Mar 09	47.24		
Apr 09	46.84		
May 09	49.01		
Jun 09	47.30		

As the result of the new documentation system and the working system improvement, the average rate of direct labor cost per direct labor hour after improvement was reduced around 3.74 baht per hour or equal $(50.43 - 46.69) / 50.43 = 7.42\%$ of the old working system (during improvement since Oct 08 to Dec 08) as shown in Table 5.10.

As mentioned in Chapter III, the factory overhead cost will be divided into 2 types, which are fix factory overhead and variable factory overhead, in order to easily estimate the standard of factory overhead. After developed the new documentation system and created the appropriated costing system, the average rate of factory overhead per direct labor hour has also more accuracy than the past that will be presented as follows:

Table 5.11: Average Rate of Fix Factory Overhead per Direct Labor Hour
(Oct 08 – Jun 09)

Month	Fix Factory Overhead (Baht)	Direct Labor Hour (Hrs.)	Rate of Fix Factory Overhead per Direct Labor Hour (Baht/Hr)
Oct-08	92,238.82	4,368	21.12
Nov-08	92,238.82	3,460	26.66
Dec-08	92,238.82	3,203	28.80
Jan-09	88,258.94	4,628	19.07
Feb-09	88,258.94	3,708	23.80
Mar-09	88,258.94	3,957	22.30
Apr-09	88,258.94	3,318	26.60
May-09	88,258.94	3,571	24.72
Jun-09	88,258.94	3,842	22.97
Total	806,270.10	34,055	24.00

According to Table 5.11, the average rate of fix factory overhead per direct labor hour since Oct-08 to Jun-09 was 24.00 Baht/Hour. Table below shows the detail of fix factory overhead, which is divided into 4 parts: salary, insurance, depreciation, and property tax.

Table 5.12: Detail of Fix Factory Overhead
(Oct 08 – Jun 09)

List	Detail of Fix Factory Overhead	Oct-08	Nov-08	Dec-08	Jan-09	Feb-09
1	Salary	41,000.00	41,000.00	41,000.00	41,000.00	41,000.00
2	Insurance	6,206.38	6,206.38	6,206.38	5,776.81	5,776.81
3	Depreciation	38,052.44	38,052.44	38,052.44	33,901.13	33,901.13
4	Property Tax	6,980.00	6,980.00	6,980.00	7,581.00	7,581.00

List	Detail of Fix Factory Overhead	Mar-09	Apr-09	May-09	Jun-09	Total
1	Salary	41,000.00	41,000.00	41,000.00	41,000.00	369,000.00
2	Insurance	5,776.81	5,776.81	5,776.81	5,776.81	53,280.00
3	Depreciation	33,901.13	33,901.13	33,901.13	33,901.13	317,564.10
4	Property Tax	7,581.00	7,581.00	7,581.00	7,581.00	66,426.00
	Total					806,270.10

Table 5.13: Variable Factory Overhead and Direct Labor Hour (Oct 08 – Jun 09)

Month	Variable Factory Overhead (Baht)	Direct Labor Hour (Hrs.)
Oct-08	70,254.31	4,368
Nov-08	60,116.34	3,460
Dec-08	52,587.99	3,203
Jan-09	71,775.21	4,628
Feb-09	60,563.34	3,708
Mar-09	65,439.12	3,957
Apr-09	56,218.37	3,318
May-09	61,291.68	3,571
Jun-09	64,395.82	3,842
Total	559,642.18	34,055

According to Table 5.13, it shows the value of variable factory overhead and direct labor hour since Oct-08 to Jun-09 and both values were plotted in the graph between variable factory overhead and direct labor hour as shown in figure below.

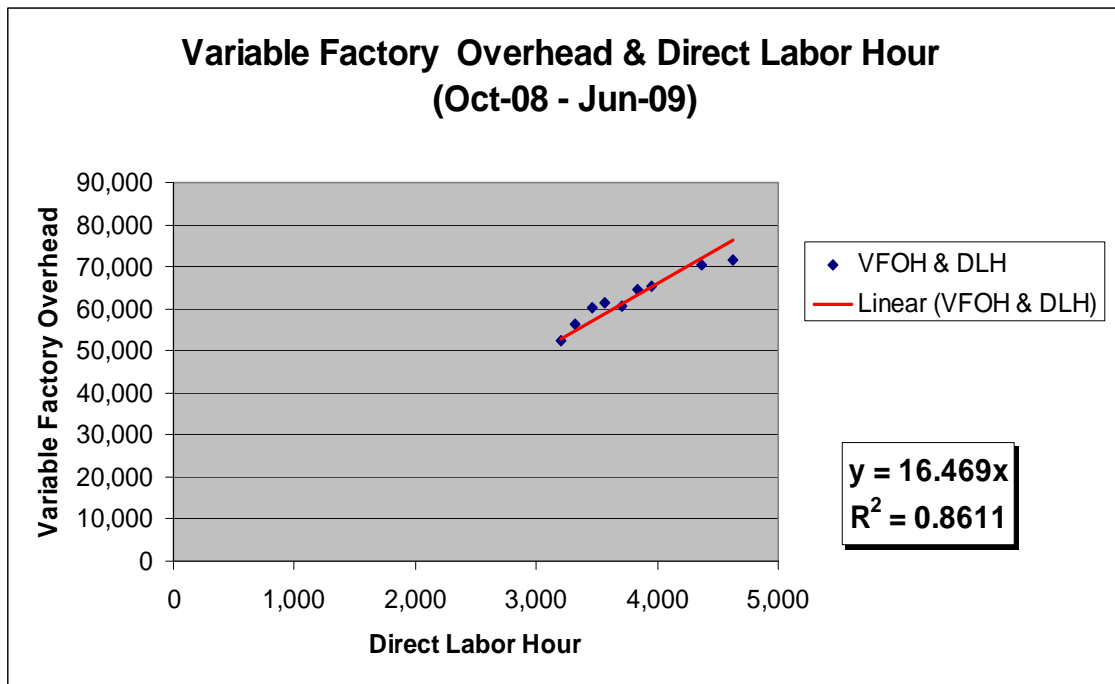


Figure 5.8: Relation Diagram between Variable Factory Overhead and Direct Labor Hour (Oct 08 – Jun 09)

After plotted the points, which are represented the relation between direct labor hour and variable factory overhead, the straight line had been created in order to estimate the overall variable factory overhead. Furthermore, the linear equation and the coefficient of determination (R-square), which is used to check the accuracy of data, were also created.

As mentioned in Chapter III, the value of R-square has the range from 0 to 1 and the acceptable value of R-square should more than 0.6. According to Figure 5.8, it is shown that the result of R-square was 0.8611. Therefore, the variable factory overhead value, which was shown in the linear equation, is reliability and high accuracy. Furthermore, the result of R-square in above figure was also shown that the efficiency of the new documentation system is good.

As the result of factory overhead estimation since Oct-08 to Jun-09, it can be concluded that the average rate of factory overhead per direct labor hour is 40.469 Baht/Hour. (Factory Overhead per Direct Labor Hour = Fix Factory Overhead per

Direct Labor Hour + Variable Factory Overhead per Direct Labor Hour =
24.00+16.469 = 40.469 Baht/Hour)

Table below shows the detail of variable factory overhead, which is divided into 7 parts: packaging cost, spare parts & equipment cost, cost of utility (electricity), cost of utility (water), miscellaneous expenses, writing implements & printed form costs, and social security cost.

Table 5.14: Detail of Variable Factory Overhead (Oct 08 – Jun 09)

List	Detail of Variable Factory Overhead	Oct-08	Nov-08	Dec-08	Jan-09	
1	Packaging Cost	7,200.00	2,800.00	2,600.00	6,740.00	
2	Spare Parts & Equipment Cost	6,450.00	2,950.00	2,200.00	6,350.00	
3	Cost of Utility (Electricity)	43,283.65	42,420.77	35,669.15	43,874.35	
4	Cost of Utility (Water)	4,138.72	3,899.64	3,780.10	4,787.49	
5	Miscellaneous Expenses	2,168.94	1,938.93	1,821.74	2,725.37	
6	Writing Implements & Printed Form Costs	655.00	720.00	750.00	850.00	
7	Social Security Cost	6,358.00	5,387.00	5,767.00	6,448.00	
List	Detail of Variable Factory Overhead	Feb-09	Mar-09	Apr-09	May-09	Jun-09
1	Packaging Cost	3,480.00	4,640.00	3,870.00	3,260.00	3,590.00
2	Spare Parts & Equipment Cost	3,280.00	5,101.11	4,431.51	5,115.86	4,955.75
3	Cost of Utility (Electricity)	41,577.72	43,247.99	37,035.45	40,426.33	42,969.22
4	Cost of Utility (Water)	3,829.38	3,497.18	3,256.87	3,765.25	3,745.28
5	Miscellaneous Expenses	2,087.24	2,157.84	1,973.54	2,354.24	2,489.57
6	Writing Implements & Printed Form Costs	725.00	720.00	600.00	680.00	740.00
7	Social Security Cost	5,584.00	6,075.00	5,051.00	5,690.00	5,906.00

The example below will be shown the comparison of the cost estimation between the old method and the new method (by using program) including comparing with the actual cost, which was occurred during the production process. And, the sample order has the details as described below.

The sizes of collar and sleeve are 4" x 16" and 1.5" x 17" respectively. The type of yarn is C20/1 and the yarn colour is white. And, the amount of collar is 150 dozens and the amount of sleeve is 90 dozens.

- Using the old method for cost estimation:

Collar size 4" x 16" uses raw material (C20/1: white colour) around 0.376 kg per dozen and sleeve size 1.5" x 17" uses raw material (C20/1: white colour) around 0.154 kg per dozen. (Both weight of collar and sleeve are already included the percentage of loss.)

Therefore, one hundred and fifty dozens of collar size 4" x 16" use the raw material around 56.40 kg and ninety dozens of sleeve size 1.5" x 17" use the raw material around 13.86 kg. Moreover, the market price of raw material (C20/1: white colour) is 194.0048 baht per kg. (See more details of the price of each raw material and price of pigmentation in Appendix A: Table A-26)

The total weight of raw material is $(56.40+13.86) = 70.26$ kg.

The total raw material cost is $(70.26 \times 194.0048) = 13,630.78$ baht.

The direct labor cost and the factory overhead cost is 6,133.85 baht. (Approximate 45 % of the total raw material cost that is depended on the manager's experiences.)

Therefore, the total production cost is **19,764.63** baht.

- Using the standard method (new method) for cost estimation:

The new method for cost estimation is the method for calculating the standard cost by using computer program, which has been developed to help to estimate the production cost. The production cost and the cost structure for producing 150 dozens of collar (size 4" x 16") and 90 dozens of sleeve (size 1.5" x 17") by using white colour of C20/1 are shown in figures below.

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven		
150	C 20/1	4 x 16	White Colour	None	No		
		Weight	Cost per Weight		Total Cost		<input type="button" value="Run"/>
Main Yarn	0.3575	Kgs/dozen	194.0048	Baht/Kg	10403.51	Baht	
Sub Yarn	0.0154	Kgs/dozen	108.0254	Baht/Kg	249.5387	Baht	
Pigmentation		Kgs/dozen	0	Baht/Kg	0	Baht	
					Total Raw Material Cost	Percentage of Total Cost	
					10653.05	Baht	61.56026 Percent
		Time	Cost per Time				
Tailoring	24	Minutes/dozen	Direct Labour	Total Direct Labour Cost			
	0.4	Hours/dozen	47.93	Baht/Hour	3606.732	Baht	20.84205 Percent
Finishing	6.1	Minutes/dozen	Overhead	Total Overhead Cost			
	0.1016667	Hours/dozen	40.469	Baht/Hour	3045.292	Baht	17.59769 Percent
Total Time	75.25	Hours			Total Cost	17305.07	Baht 100% Percent

Figure 5.9: Production Cost and Cost Structure of Collar
(Size 4" x 16" and white colour of C20/1)

As shown in Figure 5.9, the total raw material cost is 10,653.05 baht, the direct labor cost is 3,606.732 baht, and the factory overhead cost is 3,045.292 baht that are equal 61.56%, 20.84%, and 17.60% of total production cost respectively. Thus, the total production cost is 17,305.07 baht.

(**Note:** In this case, the average rate of direct labor cost per direct labor hour is 47.93 baht per hour as shown in Table 5.8 and the factory overhead cost is 40.469 baht per hour as described in the above section. Both values are the average rate during Oct-08 to Jun-09.)

According to Table 4.2, it is shown the standard production cost and the cost structure of collar (size 4" x 16" and white color of C 20/1) per dozen in June 2009. In case of production cost calculation, the total production cost can be calculated by using the standard cost multiply by the number of dozen as shown in table below.

Table 5.15: Calculating Production Cost By Using Standard Cost
(Size 4'' x 16'' and white color of C20/1) in Jun 09

Item	Standard Cost per Dozen (baht)	Number of Dozen	Total Production Cost	%
Direct Raw Materials Cost	71.02	150	10,653.00	61.56 %
Direct Labor Cost	24.04		3,606.00	20.84 %
Factory Overhead Cost	20.30		3,045.00	17.60 %
Total	115.36		17,304.00	100 %

(Note: Calculating the production cost by using the program and the standard cost will have a little different value because of round-half-up.)

Number (Dozen)	Type of Yarn	Size	Yarn Colour	Pigment Colour	Steam Oven
90	C 20/1	1.5 x 16-17	White Colour	None	No

	Weight	Cost per Weight	Total Cost
Main Yarn	0.1452 Kgs/dozen	194.0048 Baht/Kg	2535.255 Baht
Sub Yarn	0.0061 Kgs/dozen	108.0254 Baht/Kg	59.30594 Baht
Pigmentation	Kgs/dozen	0 Baht/Kg	0 Baht
Total Raw Material Cost			Percentage of Total Cost
2594.561 Baht			50.08581 Percent

	Time	Cost per Time	Total Cost
Tailoring	10 Minutes/dozen	Direct Labour	Total Direct Labour Cost
	0.1666667 Hours/dozen	47.93 Baht/Hour	1401.953 Baht
Finishing	9.5 Minutes/dozen	Overhead	Total Overhead Cost
	0.1583333 Hours/dozen	40.469 Baht/Hour	1183.718 Baht
Total Time	29.25 Hours		
Total Cost			100% Percent
5180.231 Baht			

Figure 5.10: Production Cost and Cost Structure of Sleeve
(Size 1.5'' x 17'' and white colour of C20/1)

As shown in Figure 5.10, the total raw material cost is 2,594.561 baht, the direct labor cost is 1,401.953 baht, and the factory overhead cost is

1,183.718 baht that are equal 50.09%, 27.06%, and 22.85% of total production cost respectively. Thus, the total production cost is 5,180.231 baht.

According to Table 4.4, it is shown the standard production cost and the cost structure of sleeve (size 1.5" x 17" and white color of C 20/1) per dozen in June 2009. In case of production cost calculation, the total production cost can be calculated by using the standard cost multiply by the number of dozen as shown in table below.

Table 5.16: Calculating Production Cost By Using Standard Cost
(Size 1.5" x 17" and white color of C20/1) in Jun 09

Item	Standard Cost per Dozen (baht)	Number of Dozen	Total Production Cost	%
Direct Raw Materials Cost	28.83	90	2,594.70	50.09 %
Direct Labor Cost	15.58		1,402.20	27.06 %
Factory Overhead Cost	13.15		1,183.50	22.85 %
Total	57.56		5,180.40	100 %

(**Note:** Calculating the production cost by using the program and the standard cost will have a little different value because of round-half-up.)

According to Figure 5.9 and Figure 5.10, they are shown that the production cost of collar and sleeve were 17,305.07 baht and 5,180.231 baht respectively. Thus, the total production cost of the sample order is **22,485.31** baht.

- The actual production cost of the sample order:

As the result of the new documentation system, it can be shown the details of each production cost more accurate than the past. (See more details of the data record for calculating the production cost of the sample order in Appendix C: Table C-1 - Table C-4.)

Table 5.17: Production Cost Calculation of Sample Order

Item	Process	Direct Labor Hour		Direct Labor Cost		FOH (baht)	Total Cost (baht)
		Normal Time (Hrs.)	OT (Hrs.)	Normal Time (baht)	OT (baht)		
Collar (4"x16")	Spinning	3	-	130.68	0	119.19	249.87
	Weaving	48	12	2,090.88	723.60	2,383.80	5,198.28
	Cutting	6	-	261.36	0	238.38	499.74
	Trimming	3	-	130.68	0	119.19	249.87
	Ironing	4	-	174.24	0	158.92	333.16
	Packing	1	-	43.56	0	39.73	83.29
Sleeve (1.5"x17")	Spinning	2	-	87.12	0	79.46	166.58
	Weaving	10	5	435.60	301.50	595.95	1,333.05
	Cutting	7	-	304.92	0	278.11	583.03
	Trimming	2	-	87.12	0	79.46	166.58
	Ironing	4	-	174.24	0	158.92	333.16
	Packing	1	-	43.56	0	39.73	83.29
Total		91	17	3,963.96	1,025.10	4,290.84	9,279.90

(Note: Assumed that the sample order was ordered in June 2009.)

Thus, the monthly variants in June 2009 are shown as follows:

The normal rate of direct labor cost per direct labor hour is 43.56 baht per hour.

The overtime rate of direct labor cost per direct labor hour is 60.30 baht per hour. (Both values are shown in Table 5.9.)

The factory overhead cost is 39.73 baht per hour.

(Factory overhead cost (FOH) is come from the summary of fix factory overhead cost and variable factory overhead cost divided by direct labor hour (actual manufacturing). Therefore, the summary of fix factory overhead cost and variable factory overhead cost is 152,654.76 baht as shown in Table 5.11 and 5.13 respectively. And, the direct labor hour (actual manufacturing) is 3,842 hours as shown in Table 5.9.)

The cost structure and the total production cost of the sample order will be described below:

- Direct raw material cost of sample order is 12,513.31 baht. (Represented 57.42%)
- Direct labor cost of sample order is 4,989.06 baht. (Represented 22.89%)
- Factory overhead cost is 4,290.84 baht. (Represented 19.69%)
- The total production cost of sample order is **21,793.21** baht. (Represented 100 %)

Table below is shown the calculated comparison of the cost structure and the production cost in 3 methods: old method, standard method (using program), and actual production cost.

Table 5.18: Calculated Comparison of Cost Structure and Production Cost
in 3 Methods

Cost Calculation:	Old Method	Standard Method	Actual Production Cost
Direct Raw Material Cost	13,630.78	13,247.61	12,513.31
Direct Labor Cost	6,133.85	5,008.69	4,989.06
Factory Overhead Cost		4,229.01	4,290.84
Total Production Cost	19,764.63	22,485.31	21,793.21

As the result of the new documentation system development and the appropriate costing system, the accuracy of cost estimation is increased. According to Table 5.18, it shows that the cost estimation by using the standard method (using program) has more accurate than the old method. The cost estimation by using program has difference around 3.08% of the actual production cost however the old method of cost estimation has difference around 9.31% of the actual production cost.

Therefore, it can be used the program in order to estimate the production cost because the cost estimation by using program has the value close to the actual production cost.

5.2.2 Reduce Wastes and Defects

According to Table 5.19 and Table 5.20, they show the amount of defect, waste, and finished product and the percentage of defect, waste, and finished product since Oct 08 to Jun 09 respectively. As shown in Table 5.20, the percentage of defect and the percentage of waste trend to be gradually decreased. (See more details of the amount of defect and waste in Appendix C: Table C-5 to Table C-13.)

Table 5.19: Amount of Defect, Waste, and Finished Product (Oct 08 – Jun 09)

Month	Amount of Defect (Kg)	Amount of Waste (Kg)	Amount of Finished Product (Kg)	Total Product (Kg) (Included Waste and Defect)
Oct-08	345.78	87.32	2,983.02	3,416.12
Nov-08	242.45	68.27	2,660.23	2,970.95
Dec-08	164.11	49.19	2,217.76	2,431.06
Jan-09	241.49	72.14	3,746.11	4,059.74
Feb-09	169.64	37.75	2,999.03	3,206.42
Mar-09	225.83	58.76	3,278.98	3,563.57
Apr-09	128.47	32.56	2,109.52	2,270.55
May-09	181.92	54.24	2,761.29	2,997.45
Jun-09	214.84	48.28	3,138.76	3,401.88
Total	1,914.53	508.51	25,894.70	28,317.74

Table 5.20: Percentage of Defect, Waste, and Finished Product (Oct 08 – Jun 09)

Month	Percentage of Defect	Percentage of Waste	Percentage of Finished Product
Oct-08	10.12	2.56	87.32
Nov-08	8.16	2.30	89.54
Dec-08	6.75	2.02	91.23
Jan-09	5.95	1.78	92.27
Feb-09	5.29	1.18	93.53
Mar-09	6.34	1.65	92.01
Apr-09	5.66	1.43	92.91
May-09	6.07	1.81	92.12

Jun-09	6.32	1.42	92.27
Average	6.74	1.79	91.47

Before improved the new documentation system and the working system, the percentage of wastes and defects was 10.85% as shown in Table 5.21. However, after improved the working system and the documentation system, the percentage of wastes and defects was 7.52% as shown in Table 5.21. Therefore, as the result of the new documentation system and the working system development, it can be reduced the average percentage of wastes and defects around 3.33% or equal $(10.85 - 7.52) / 10.85 = 30.69\%$ of the old production process (before improvement).

Table 5.21: Average Percentage of Waste and Defect
(Before and After Improvement)

Month	Amount of Waste and Defect (Kg)	Amount of Finished Product (Kg)	Total Product (Kg)	Percentage of Waste and Defect	Average Percentage of Waste & Defect
Oct-08	433.10	2,983.02	3,416.12	12.68	10.85 % (Before & During Improvement)
Nov-08	310.72	2,660.23	2,970.95	10.46	
Dec-08	213.30	2,217.76	2,431.06	8.77	
Jan-09	313.63	3,746.11	4,059.74	7.73	7.52 % (After Improvement)
Feb-09	207.39	2,999.03	3,206.42	6.47	
Mar-09	284.59	3,278.98	3,563.57	7.99	
Apr-09	161.03	2,109.52	2,270.55	7.09	
May-09	236.16	2,761.29	2,997.45	7.88	
Jun-09	263.12	3,138.76	3,401.88	7.73	

According to the data collection and data analysis, it can be divided the defects in the production process into 4 types: incorrect size, partly tear, stick-on yarn leavings, and untidy product. Table 5.22 and 5.23 show the amount and the percentage of each defect type respectively since October 2008 to June 2009. And, the pie chart of average percentage of each defect type is shown in Figure 5.11.

Table 5.22: Amount of Each Defect Type (Oct 08 – Jun 09)

Month	Amount of Incorrect Size (Kg)	Amount of Partly Tear (Kg)	Amount of Stick-on Yarn Leavings (Kg)	Amount of Untidy Product (Kg)	Total Defect (Kg)
Oct-08	236.79	84.24	13.68	11.07	345.78
Nov-08	171.23	54.89	8.04	8.29	242.45
Dec-08	113.85	40.56	5.24	4.46	164.11
Jan-09	167.63	61.43	6.56	5.87	241.49
Feb-09	121.47	41.72	3.79	2.66	169.64
Mar-09	161.87	53.96	5.42	4.58	225.83
Apr-09	85.78	35.17	4.31	3.21	128.47
May-09	123.54	47.82	5.08	5.48	181.92
Jun-09	149.97	54.91	4.21	5.75	214.84
Total	1,332.13	474.7	56.33	51.37	1,914.53

Table 5.23: Percentage of Each Defect Type (Oct 08 – Jun 09)

Month	Percentage of Incorrect Size	Percentage of Partly Tear	Percentage of Stick-on Yarn Leavings	Percentage of Untidy Product
Oct-08	68.48	24.36	3.96	3.20
Nov-08	70.62	22.64	3.32	3.42
Dec-08	69.37	24.72	3.19	2.72
Jan-09	69.41	25.44	2.72	2.43
Feb-09	71.60	24.59	2.23	1.57
Mar-09	71.68	23.89	2.40	2.03
Apr-09	66.77	27.38	3.35	2.50
May-09	67.91	26.29	2.79	3.01
Jun-09	69.81	25.56	1.96	2.68
Average	69.52	24.98	2.88	2.62

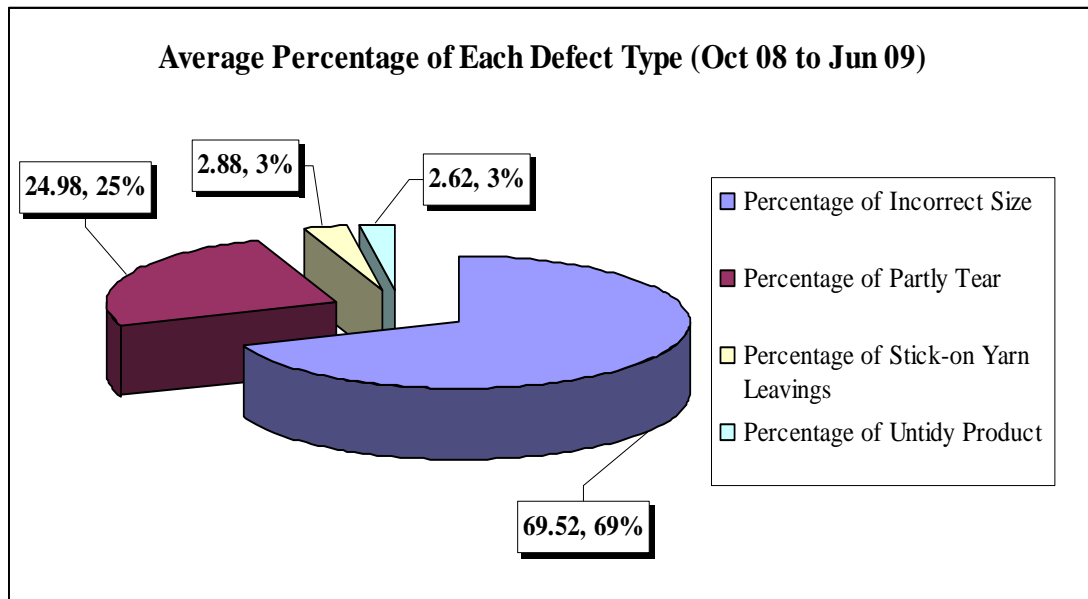


Figure 5.11: Pie Chart of Average Percentage of Each Defect Type
(Oct 08 – Jun 09)

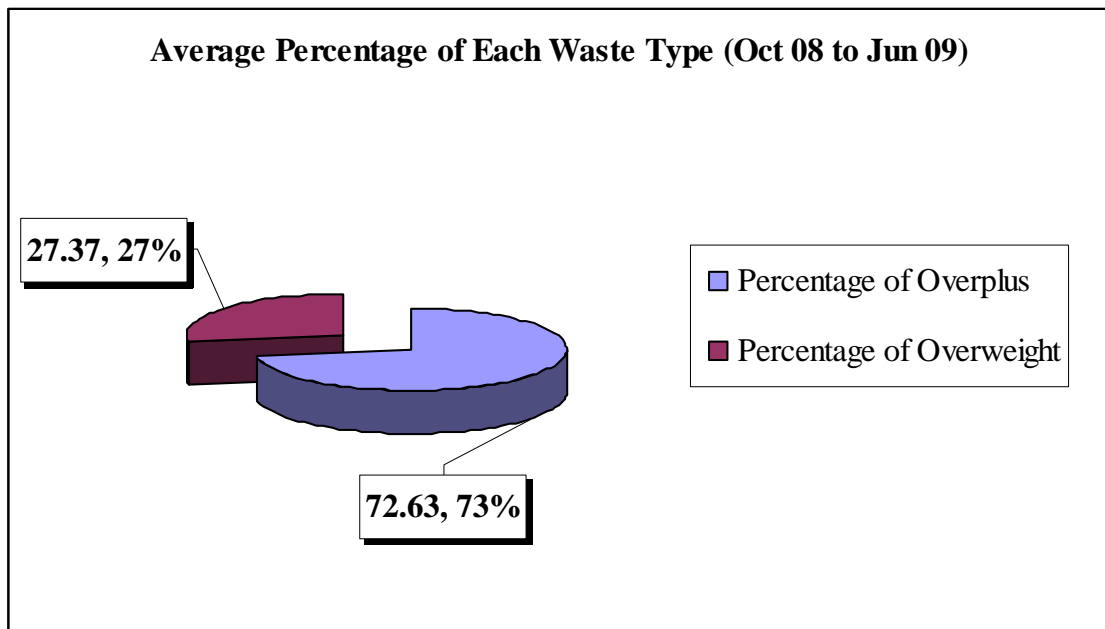
Furthermore, it can be divided the wastes in the production process into 2 types: over plus and overweight. Table 5.24 and 5.25 are shown the amount and the percentage of each waste type respectively since October 2008 to June 2009. And, the pie chart of average percentage of each waste type is shown in Figure 5.12.

Table 5.24: Amount of Each Waste Type (Oct 08 – Jun 09)

Month	Amount of Over plus (Kg)	Amount of Overweight (Kg)	Total Waste (Kg)
Oct-08	67.82	19.50	87.32
Nov-08	46.14	22.13	68.27
Dec-08	36.23	12.96	49.19
Jan-09	60.35	11.79	72.14
Feb-09	25.18	12.57	37.75
Mar-09	39.87	18.89	58.76
Apr-09	21.79	10.77	32.56
May-09	41.57	12.67	54.24
Jun-09	35.24	13.04	48.28
Total	374.19	134.32	508.51

Table 5.25: Percentage of Each Waste Type (Oct 08 – Jun 09)

Month	Percentage of Over plus	Percentage of Overweight
Oct-08	77.67	22.33
Nov-08	67.58	32.42
Dec-08	73.65	26.35
Jan-09	83.66	16.34
Feb-09	66.70	33.30
Mar-09	67.85	32.15
Apr-09	66.92	33.08
May-09	76.64	23.36
Jun-09	72.99	27.01
Average	72.63	27.37

**Figure 5.12: Pie Chart of Average Percentage of Each Waste Type (Oct 08 – Jun 09)**

According to the cost structure of the sample order as shown in Figure 5.9 and 5.10, after calculated the production cost and cost structure with using the new percentage of defect and waste equal 7.52% (after improvement), the production cost was decreased as shown in Table 5.26 and 5.27.

Table 5.26: Standard Production Cost Before and After Improvement

(Size 4" x 16" and white color of C20/1)

Cost Calculation:	Standard Cost (before) (baht/dozen)	Standard Cost (after) (baht/dozen)	Decrease (baht/dozen)
Direct Raw Material	71.02	69.46	1.56
Direct Labor Cost	24.04	23.51	0.53
Factory Overhead	20.30	19.79	0.51
Total Production Cost	115.36	112.76	2.60

Table 5.27: Standard Production Cost Before and After Improvement

(Size 1.5" x 17" and white color of C20/1)

Cost Calculation:	Standard Cost (before) (baht/dozen)	Standard Cost (after) (baht/dozen)	Decrease (baht/dozen)
Direct Raw Material	28.83	28.19	0.64
Direct Labor Cost	15.58	15.22	0.36
Factory Overhead	13.15	12.82	0.33
Total Production Cost	57.56	56.23	1.33

CHAPTER VI

Conclusions and Recommendations

6.1 Summary of Research

The purpose of this research is studied to develop the new documentation system and create the appropriate costing system in order to reduce the production cost in the sample factory. Therefore, the current problems in the sample company were analyzed and found the root causes of each problem in order to find the methods to eliminate the problems including reducing the losses.

After analyzed the current problems in the sample factory, it found that there are three main problems: problem of documentation system, problem of current costing system, and problem of losses in the production process. In case of the problem of losses in the production process, cause and effect (fish bone) diagram is not only used to analyze the root cause of each problem but also present the solutions of each problem.

The procedures of documentation development and appropriate costing system creation can summarize as follows:

1. To design and develop the new documentation system for collecting the data and the important information, which are used to calculate the production cost. The new document forms and the new flow of documentation system are described in Chapter IV.
2. To calculate and summarize the total direct raw material cost, direct labor cost, and factory overhead cost including direct labor hour from the new documentation system.
3. To assess the efficiency and accuracy of data collection of the new documentation system by using Scatter graph method.

4. To estimate the rate of direct labor cost per direct labor hour and the rate of factory overhead cost per direct labor hour in order to calculate and set the standard cost of each product.
5. To determine the standard time of each production process by using direct time study technique in order to estimate the production cost of each product.
6. To create the appropriate costing system by bring and gathering the data about each product, direct raw material cost, and the rate of direct labor cost per direct labor hour and the rate of factory overhead cost per direct labor hour in each month for estimating the production cost of each product. However, variance of the rate of direct labor cost per direct labor hour and the rate of factory overhead cost per direct labor hour in each month is depended on the performance efficiency in each month. (In this research, the computer program has been created in order to help in the production cost estimation.)
7. To compare the actual production cost and the standard cost of each product in order to control the production cost, to improve and increase the accuracy of the cost estimation.

After developed the new documentation system, improved the working system, and created the appropriate costing system, the computer program, which is Microsoft Office Access, has been created and used to calculate the production cost and the cost structure of each product. Furthermore, the result of the cost estimation by using program (new method) has more accurate than estimation by the old method.

Moreover, the standard time of each production process has been set in order to control the efficiency and performance of workers, design the production planning, and use to be the data for estimating the production cost in the program.

As the result of the documentation system development and the working system improvement, it can be reduced the average percentage of wastes and defects around 3.33% or equal 30.69% of the old production process (before improvement). Moreover, the average rate of direct labor cost per direct labor hour after improvement was reduced around 3.74 baht per hour or equal 7.42% of the old

working system (during improvement since Oct 08 to Dec 08). Furthermore, the average percentage of worker's performance after improvement was increased around 6.31%. Therefore, the total production cost was reduced around 144,660.96 baht within 6 months.

6.2 Problems during Performing and Solutions

This section will describe about the problems that occurred during performing this thesis and recommended the methods to solve those problems.

- **Problem in resistance of change**

Subordinates and employees always fear of change because they do not know what will happen in the future and they do not want uncertainty work. Moreover, they fear about demote, lay off, and downsizing. Furthermore, employees think when company changed something, they will have to work more and get the same wage. If the company uses the new technology or changes the working system, they have to learn new things that means work more and hard job too.

In addition, almost employees are old generation, so they did not want to change their working style and non-enthusiastic for learning new things. Moreover, they think the way they work is good enough. Thus, one of the main problems during implementation is about resistance of change.

Therefore, the company has to clearly communicate or inform with employees to make them understand why company must be changed, how they prepare for that change and what the benefits after changing. In addition, managers have to create incentive for employees, to motivate them feel would like to change, learn new things, and pride of their own responsibilities. For the long term plan, the managers should set the company's targets in order to reevaluate the payment system and the new base on reward. If you achieve the company's targets, you will get the reward.

- **Problem of data collection**

According to the new documentation forms, the employees may confuse about the method to record data in each form. Therefore, the developer has to explain how to record the data in each document form with the employees, who are appointed to do the data collection, including explain why the need to improve the document system and the benefits of the new documentation system.

- **Problem of unskilled and inattentive workers**

After surveyed in the shop floor, it found that some new labors are lack of skills and some labors are indiscretion, sleep during working, lack of attention and responsibility in their jobs. In case of new labors, they always set the wrong specification of machines such as the number of needles, the velocity of motor, and the amount of products including using the wrong raw materials. Therefore, they have made a lot of losses in the manufacturing process.

Thus, it has to set the team for training the new labors in order to do the right jobs and reduce the mistakes. Furthermore, the manager has to set up the strict regulations and penalty in order to make the labors pay more attention to theirs jobs including appoint the head of the production line in order to closely control the workers.

6.3 Recommendations

1. Organization structure of the sample company should be reorganized to formal organization in order to easily manage and control the working system because some works still have the redundant works. Moreover, the appropriate organization structure will make the smooth work flow including increase the efficiency and performance of working system.
2. For making the new documentation system, it should be able to verify the withdraw materials that are actually used or not.

3. Production Planning: Should be prepared the production plan in order to accurately plan the production, increase the production efficiency, reduce the loss in the production process and delivery the products to the customers on time.
4. Should be set the quality control department in order to check and test the quality of the raw materials before received from the suppliers including control the quality of products.
5. Warehouse system and purchasing system should be adapted to more systematic and both systems should coordinate the work in order to prevent the excessive stocks and lack of raw materials including increase the efficiency of both systems.
6. Should be created the data base for collecting the data and information of raw materials, production, employees, and customers including suppliers. Furthermore, developing the computer program, which is used to estimated the production cost, by integrating with the data base in order to increase the accuracy and efficiency of program for calculating the production cost.

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APPENDICES

APPENDIX A: Time Study & Work Sampling

Time Study

In this case, it is assumed that the current working method is the standard and proper method. Thus, it can be timed each working process for finding the standard time of each task.

Procedures of Time Study

1. Selecting Work: Production department did not have the information about the standard time of each production process. Thus, time study will be divided into 2 types that are the time study of machines and man.

- **Time study of machine:** Consisted of spinning and weaving processes.
- **Time study of man:** Consisted of cut, trim, ironing and packing processes.

2. Dividing into Sub-task:

- **Working by machine:** It will be studied the standard time of spinning and weaving processes of each product.
- **Working by man:**
 - **Cutting Process:** It is started from pick up the roll of product (collar or sleeve), cut into each piece and put down the collar or sleeve.
 - **Trimming Process:** It is started from pick up the collar or sleeve, trim the threads, which are protruded from collars or sleeves, and put down the collar or sleeve.
 - **Ironing Process:** It is started from pick up the collar or sleeve, iron the collar or sleeve and put down the product.
 - **Packing Process:** It is started from array the product, put the product in the plastic bag and seal the bag.

(**Note:** In this case, recording time of each round will be recorded time for working at 1 piece except packing process will be recorded time for working at 12 pieces or 1 dozen.)

3. Time Recording: Using accumulative timing method for recording time. And using the stop watch that has the precision 0.01 minute.

- 4. The Number of Data for Studying:** Use the statistical methods in order to estimate the suitable amount of data for finding the standard time.

Therefore, the formula for calculating the number of data at a 95% confidence level and a 5 % error is shown as follow:

$$N' = \left[\frac{40\sqrt{N\sum x^2 - (\sum x)^2}}{\sum x} \right]^2$$

Description:

N' = the number of required data at a 95% confidence level and a 5 % error

N = the number of sample data

X = the data of each sample

Note: If $N' \leq N$, That is correct (no need to record more sample data)

If $N' > N$, That is false (must keep more sample data equal $N'-N$)

- 5. Performance Rating Factor:** According to the difference performance of each worker and the unstable performance of the same worker, the performance rating factor will be used to adjust the actual time, which is recorded from the working time of sample worker, to the normal time. In this case, it is used the Westinghouse System of Rating, which is considered 4 factors: skill, effort, conditions, and consistency, for assessing the performance.
- 6. Determining Allowances:** Time allowance is the time to reserve some work in order to fit in with the reality of working such as personal allowance, fatigue allowance and delay allowance. Therefore, calculating the standard time has to consider the allowances. In this case, it is used ILO (International Labour Organization) allowances and the production department will set its allowances. The formula for calculating the time allowance is shown as follows:

$$\% \text{ Time Allowances} = \text{Fix Allowance} + \text{Variable Allowance}$$

- 7. Calculating Standard Time:** The formula for calculating the standard time is shown as follows:

Normal Time = Actual Time x Performance Rating Factor

Standard Time = Normal Time + (% Time Allowances x Normal Time)

Work Sampling

Work Sampling is the easily statistic method for analyzing the performance of machine or worker by observing. The period of observation should more than 2 weeks. The formula for calculating the number of required sample at a 95% confidence level is shown as follow.

Formula:

$$n = 4p \times (1 - p) / e^2$$

Description:

n = the number of required sample at a 95% confidence level

p = the percentage of actual events appear as a decimal display (proportion unemployment display as decimal)

e = margin of error at 5% (standard value of 0.05)

Table A-1: Time in Cutting Process (for collar)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	10.85	9.89	11.28	11.54
2	11.20	10.23	11.47	11.89
3	11.95	10.46	11.98	11.33
4	9.10	11.89	11.34	11.44
5	10.25	11.12	10.56	11.29
6	8.94	11.22	10.51	10.56
7	10.12	11.65	11.18	10.20
8	10.56	11.71	11.14	10.87
9	10.79	11.92	11.98	11.49
10	9.54	10.91	10.47	10.21
11	10.29	10.10	10.24	9.61
12	11.56	10.69	10.87	10.57
13	11.42	11.28	10.61	11.00
14	12.23	10.54	11.02	10.32
15	11.78	11.63	10.22	10.81
16	11.15	10.98	10.58	11.91
17	11.69	10.67	10.46	12.41
18	10.54	11.51	11.39	11.29
19	9.61	11.29	12.06	10.02
20	10.23	11.14	12.21	11.64
21	11.04	11.94	11.81	11.73
22	11.20	10.89	10.49	10.21
23	10.94	10.70	11.57	10.19
24	10.17	9.85	11.32	11.64
25	9.00	11.54	11.08	10.42
26	11.26	12.05	10.47	9.27
27	11.95	11.88	9.81	11.92
28	11.45	11.71	10.77	10.47
29	11.89	11.13	11.64	12.49
30	11.18	11.06	11.52	10.54
31	9.84	10.88	11.34	11.27
32	10.35	11.28	11.83	10.74
33	10.48	11.67	11.92	10.98
34	11.09	11.81	10.51	10.40
35	11.11	10.97	9.12	11.93
36	11.27	10.14	11.27	10.34
37	11.88	9.54	12.53	9.12
38	10.56	10.04	11.44	11.12
39	9.29	10.73	10.90	12.57

40	10.33	10.90	10.83	11.22
41	10.45	10.45	11.62	11.67
42	11.48	11.07	11.02	11.39
43	11.98	11.41	11.58	10.78
44	12.48	11.38	11.60	10.09
45	11.57	10.91	11.37	10.72
46	11.62	9.31	10.21	12.29
47	11.18	9.88	10.68	10.77
48	12.09	10.55	11.33	11.46
49	11.55	11.32	9.61	10.82
50	11.78	11.57	11.24	11.17
51	11.02	11.27	11.92	11.42
52	10.08	10.12	10.88	11.60
53	10.34	10.36	11.44	10.59
54	11.58	10.58	11.65	11.30
55	11.07	11.22	12.04	10.58
Average	10.92	10.96	11.13	11.01

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-2: Time in Trimming Process (for collar)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	2.52	2.87	2.79	3.24
2	2.89	2.54	2.56	2.84
3	3.12	2.22	3.25	2.71
4	3.03	2.63	3.54	2.60
5	4.58	2.78	3.67	2.34
6	2.95	2.51	2.81	2.87
7	3.74	2.46	2.46	2.98
8	3.12	3.04	2.57	2.71
9	4.23	2.89	2.77	2.42
10	3.22	2.61	2.96	2.85
11	2.51	3.54	3.04	2.09
12	2.12	4.51	2.14	2.37
13	3.12	2.81	3.87	2.84
14	2.20	2.47	4.20	2.61
15	2.78	3.20	3.71	2.37
16	2.31	2.88	2.85	2.55
17	2.10	2.47	2.65	4.01
18	3.14	2.91	2.27	3.24
19	2.64	3.57	2.38	2.80
20	2.87	3.02	2.49	2.27
21	2.19	3.17	2.80	3.29
22	3.40	2.54	2.63	2.74
23	2.91	1.97	3.03	2.45
24	2.34	2.49	2.74	3.04
25	2.58	3.10	2.55	2.90
26	3.19	2.53	2.29	2.64
27	2.97	2.81	2.64	2.85
28	3.21	4.22	3.42	2.19
29	2.95	3.74	3.15	2.47
30	2.37	2.44	2.32	3.33
31	3.31	2.12	2.80	2.51
32	3.02	2.70	2.47	4.12
33	2.55	2.38	2.34	2.54
34	2.84	2.69	2.90	2.48
35	2.67	2.02	2.71	2.87
36	3.44	2.86	2.46	3.34
37	2.08	2.95	2.37	2.17
38	3.15	2.41	2.69	2.91
39	3.88	2.59	2.19	3.10

40	2.52	2.54	2.87	2.80
41	2.77	3.28	2.60	3.31
42	2.09	3.07	3.08	2.44
43	3.01	2.66	2.96	2.39
44	3.57	2.14	2.82	2.97
45	2.48	2.36	2.97	2.22
46	2.26	2.57	2.14	2.73
47	2.34	2.83	2.76	3.38
48	3.57	3.18	2.41	2.57
49	2.41	3.23	2.45	3.69
50	2.98	2.72	3.72	2.91
51	3.00	2.67	2.54	2.45
52	2.53	2.96	4.14	2.77
53	2.12	3.09	2.91	3.50
54	2.65	2.94	2.61	2.63
55	2.39	3.58	2.59	2.27
Average	2.85	2.83	2.82	2.79

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-3: Time in Ironing Process (for collar)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	6.23	6.85	5.87	6.62
2	6.79	6.24	6.09	6.16
3	5.98	6.91	5.55	6.96
4	7.02	5.55	6.24	5.31
5	6.12	6.27	7.00	6.40
6	6.81	5.89	5.40	7.20
7	7.24	6.34	6.17	6.88
8	6.32	5.97	5.52	7.05
9	5.78	6.03	7.36	6.73
10	6.55	5.69	6.04	6.57
11	6.28	6.35	6.53	5.53
12	7.10	6.17	6.38	6.26
13	5.88	5.82	6.98	6.90
14	6.47	6.18	6.85	6.63
15	6.14	5.93	6.07	5.71
16	6.88	6.10	5.71	6.28
17	7.34	5.85	6.52	7.19
18	6.52	6.47	5.86	6.84
19	6.91	6.11	6.73	5.51
20	6.24	6.43	6.84	6.01
21	5.74	7.04	6.65	6.46
22	6.85	6.00	5.97	7.00
23	6.27	5.64	6.71	6.91
24	6.13	6.29	7.44	6.22
25	6.55	7.24	5.33	6.84
26	7.29	5.97	6.48	6.97
27	6.49	5.82	6.03	6.13
28	6.03	6.65	6.38	5.89
29	6.81	6.21	7.34	6.51
30	6.67	7.16	5.77	6.84
31	7.01	5.81	6.35	7.39
32	6.22	6.63	6.24	6.77
33	5.56	6.16	7.16	6.19
34	6.87	5.74	6.65	5.84
35	6.31	6.37	6.96	6.52
36	6.88	6.89	5.92	6.73
37	6.19	6.71	6.33	5.63
38	7.11	7.07	6.88	7.28
39	6.09	5.57	7.09	6.84

40	6.74	6.69	6.28	6.42
41	6.37	6.21	6.79	5.94
42	6.94	6.35	5.86	6.46
43	7.38	7.19	7.41	6.46
44	6.41	5.05	5.94	6.74
45	6.05	6.97	6.54	6.99
46	6.33	6.34	6.49	6.37
47	5.99	5.82	6.82	6.62
48	6.91	6.48	6.50	6.76
49	5.21	7.11	6.38	6.75
50	6.24	6.84	5.82	5.81
51	7.49	6.09	6.82	7.33
52	6.88	7.39	6.61	6.09
53	5.96	6.87	6.84	6.92
54	6.64	5.69	7.23	7.49
55	6.77	6.82	6.37	6.58
Average	6.51	6.33	6.44	6.54

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-4: Time in Packing Process (for collar)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	25.62	24.15	25.34	24.91
2	25.16	25.26	26.72	24.62
3	24.96	24.08	24.89	24.16
4	26.13	25.61	24.72	25.96
5	24.42	24.88	25.51	24.11
6	24.68	24.51	24.40	25.04
7	24.88	25.87	25.04	26.22
8	24.50	26.36	25.89	24.18
9	26.37	26.12	26.34	24.09
10	26.51	24.68	24.23	25.73
11	24.35	26.21	23.83	24.57
12	26.14	24.19	25.19	24.53
13	24.39	24.82	25.40	26.62
14	25.36	25.23	26.35	24.97
15	25.24	26.77	24.97	24.61
16	24.79	24.42	25.85	25.71
17	24.92	25.92	24.02	24.83
18	26.09	24.26	25.33	24.11
19	25.84	24.79	25.61	25.84
20	25.51	24.94	24.72	24.51
21	26.01	24.23	24.37	24.22
22	25.46	25.92	25.38	24.64
23	25.58	24.31	26.15	24.31
24	25.13	26.03	24.87	25.02
25	26.21	25.71	25.14	26.24
26	24.48	24.57	24.98	24.48
27	24.79	24.35	24.77	24.15
28	24.15	25.01	25.82	24.62
29	25.28	24.56	25.37	25.08
30	24.19	25.45	26.03	26.61
31	24.89	24.09	25.27	24.71
32	25.37	24.35	24.91	25.51
33	26.27	25.49	24.18	24.78
34	24.91	24.34	24.27	24.96
35	25.48	25.37	25.11	25.17
36	24.52	25.19	24.35	24.28
37	24.73	24.81	25.09	24.12
38	25.07	24.75	26.27	24.38
39	25.84	24.34	24.33	25.22

40	24.42	24.69	24.43	26.41
41	24.49	25.04	25.48	24.34
42	24.81	24.55	25.24	25.29
43	25.01	26.41	24.36	24.21
44	26.44	24.90	26.36	24.79
45	24.74	24.77	24.17	24.39
46	25.34	24.62	24.83	25.42
47	25.73	25.61	25.01	26.57
48	26.26	24.91	24.22	25.33
49	24.67	24.26	24.77	24.64
50	24.56	25.65	24.65	26.48
51	24.61	26.54	26.61	24.23
52	25.03	24.19	24.16	25.72
53	24.29	25.41	25.27	24.29
54	25.58	26.23	24.06	24.71
55	24.87	24.12	24.21	26.02
Average	25.18	25.05	25.07	24.99

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-5: Time in Cutting Process (for sleeve)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	18.34	18.76	18.62	18.15
2	18.27	18.14	18.61	18.26
3	17.89	17.98	17.96	17.08
4	18.71	19.02	19.31	19.61
5	19.26	18.23	17.44	18.82
6	18.04	17.42	17.29	17.14
7	17.74	17.09	17.84	19.78
8	18.37	18.55	17.55	17.69
9	17.23	17.42	19.73	17.04
10	19.38	19.01	19.17	18.25
11	17.19	17.49	17.35	19.12
12	18.42	18.62	17.95	17.84
13	17.53	17.55	19.26	18.32
14	18.79	19.24	17.09	18.78
15	17.58	18.17	17.36	17.15
16	18.64	18.25	17.82	17.08
17	19.31	18.62	17.18	19.46
18	17.69	17.04	19.09	18.34
19	18.72	17.53	19.28	17.25
20	17.84	19.61	18.15	18.32
21	17.48	17.98	18.07	19.09
22	18.53	18.04	18.48	18.68
23	18.87	17.77	17.64	17.49
24	18.71	17.52	17.05	17.52
25	19.62	18.86	17.31	17.91
26	17.18	18.37	19.23	18.22
27	18.69	17.48	19.41	19.14
28	19.23	17.65	18.91	19.91
29	17.54	18.97	17.83	20.22
30	18.83	19.11	17.34	18.65
31	17.12	17.44	18.53	18.41
32	18.74	17.52	19.28	17.17
33	19.54	18.18	17.61	17.94
34	17.72	17.33	17.55	18.02
35	18.43	18.24	17.96	17.65
36	18.22	17.43	19.27	17.44
37	17.21	19.12	18.18	18.21
38	19.61	18.20	18.17	18.57
39	17.39	17.16	17.79	17.92

40	18.02	18.54	17.68	18.01
41	18.21	17.96	18.41	18.47
42	17.45	18.29	18.29	17.23
43	17.91	17.66	17.45	17.14
44	18.14	17.28	17.02	19.07
45	17.51	17.73	18.38	18.33
46	17.32	18.29	18.60	17.57
47	18.18	17.41	17.91	16.58
48	19.24	19.15	17.03	17.78
49	17.42	17.94	19.17	17.69
50	17.09	18.71	17.53	18.27
51	18.11	18.13	17.17	18.41
52	17.48	17.45	18.31	17.84
53	17.67	18.32	18.32	16.59
54	18.52	17.07	17.08	18.74
55	17.98	17.12	17.55	17.05
Average	18.18	18.06	18.10	18.12

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-6: Time in Trimming Process (for sleeve)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	4.30	3.45	4.19	3.82
2	3.27	4.12	3.39	4.01
3	3.98	4.02	3.26	4.16
4	3.71	3.62	4.08	2.33
5	4.15	3.15	3.61	4.22
6	2.58	3.96	3.84	3.96
7	4.08	4.31	2.51	3.31
8	3.87	3.34	3.78	3.45
9	3.34	3.25	2.96	3.25
10	3.85	3.89	4.17	2.89
11	4.21	3.05	2.68	4.05
12	3.96	4.37	3.21	3.73
13	3.45	4.57	4.19	3.57
14	2.45	2.59	3.91	2.53
15	4.39	4.26	2.52	4.26
16	2.87	3.90	3.41	4.91
17	3.74	2.63	4.14	4.17
18	4.54	4.17	3.42	3.21
19	3.62	2.28	3.92	2.91
20	2.68	3.90	4.02	3.22
21	3.74	2.84	3.79	2.41
22	4.48	2.76	2.94	3.52
23	3.77	3.51	4.20	3.91
24	2.99	4.01	2.59	2.79
25	3.05	3.64	4.31	4.09
26	4.36	4.00	3.07	3.25
27	2.74	3.20	4.57	3.92
28	2.55	3.31	3.97	4.13
29	3.81	2.48	2.35	3.03
30	4.07	5.15	2.98	2.69
31	4.58	2.58	3.51	4.57
32	4.31	3.64	3.89	4.30
33	5.05	3.94	4.38	3.13
34	3.28	2.17	2.78	2.56
35	3.76	3.67	3.71	3.41
36	3.53	2.57	4.22	3.59
37	3.26	2.19	3.84	2.95
38	2.99	4.58	2.58	3.35
39	2.36	3.89	3.73	2.87

40	3.17	3.41	3.36	4.34
41	4.28	2.88	4.18	2.93
42	3.09	4.69	3.48	2.57
43	3.84	3.74	4.42	3.88
44	2.51	3.65	3.39	4.27
45	4.01	2.67	2.43	3.55
46	3.46	2.99	5.25	3.21
47	4.33	3.05	3.74	2.58
48	2.98	4.25	4.40	2.67
49	3.47	3.79	4.11	3.86
50	4.11	2.92	2.62	2.91
51	3.87	4.07	3.67	4.45
52	2.75	3.57	3.25	3.56
53	2.86	3.66	3.51	2.98
54	3.88	3.14	3.04	3.14
55	3.24	4.47	2.92	3.29
56	3.59	3.35	3.75	3.74
57	4.02	4.23	3.51	3.43
58	3.22	3.98	4.56	3.12
59	3.71	3.05	3.57	4.09
60	3.64	4.11	2.98	3.44
61	3.11	3.78	3.81	2.71
62	3.55	3.34	3.47	3.19
Average	3.59	3.54	3.58	3.46

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-7: Time in Ironing Process (for sleeve)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	11.30	11.15	10.89	11.35
2	12.27	11.26	10.61	12.62
3	10.89	10.08	10.96	11.81
4	11.71	12.61	11.31	12.18
5	10.51	11.88	10.40	10.84
6	11.04	11.51	11.22	10.52
7	11.58	12.78	12.05	11.23
8	11.89	11.96	10.73	11.57
9	10.34	10.68	12.57	10.69
10	10.49	10.91	11.35	10.71
11	11.19	11.22	10.26	11.86
12	12.48	12.14	11.90	12.12
13	10.51	10.42	10.63	10.19
14	11.97	11.92	10.72	11.22
15	11.85	11.49	10.28	13.14
16	11.02	9.52	12.28	10.34
17	11.56	10.94	12.49	9.24
18	10.72	10.42	12.68	10.29
19	11.23	11.92	10.46	11.82
20	12.38	10.18	11.39	10.97
21	11.25	12.03	11.21	10.49
22	10.87	11.07	11.48	11.24
23	10.17	10.57	10.57	10.36
24	11.47	10.38	10.23	11.59
25	11.09	11.43	13.41	9.85
26	10.55	11.57	11.55	10.32
27	11.24	12.19	11.18	10.72
28	10.12	10.04	10.74	11.88
29	12.62	10.16	9.85	11.17
30	9.58	11.56	10.48	11.51
31	10.98	10.69	10.33	10.09
32	10.85	11.38	11.11	11.43
33	11.12	11.22	11.43	12.63
34	12.25	10.88	10.48	11.91
35	10.76	10.39	10.42	13.24
36	11.37	11.28	10.59	11.53
37	11.65	12.37	11.40	10.12
38	10.44	9.68	10.83	10.71
39	10.97	10.41	10.24	11.28

40	11.22	11.94	11.03	10.22
41	12.02	11.45	12.47	11.64
42	11.28	10.55	10.22	12.01
43	10.57	11.38	9.55	10.29
44	10.13	9.25	11.65	9.57
45	10.89	10.29	11.21	10.77
46	11.41	13.12	9.81	11.03
47	12.88	10.98	10.36	10.42
48	11.92	11.26	11.14	10.56
49	10.20	10.62	11.78	10.09
50	9.87	10.27	13.41	11.37
51	11.55	10.43	11.32	12.11
52	10.68	11.63	11.26	12.05
53	10.34	11.87	10.78	11.55
54	11.07	10.49	9.89	10.21
55	11.74	10.32	10.44	11.16
Average	11.16	11.09	11.07	11.12

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-8: Time in Packing Process (for sleeve)

Round	Time (seconds)			
	Worker 1	Worker 2	Worker 3	Worker 4
1	40.43	41.19	40.98	41.56
2	39.93	40.38	41.53	41.34
3	40.62	41.26	41.59	41.06
4	40.15	40.47	40.43	40.54
5	42.27	41.54	40.77	41.55
6	41.55	40.38	40.38	40.64
7	40.61	40.93	41.51	41.88
8	41.26	41.52	42.36	40.32
9	40.89	41.22	42.82	41.94
10	41.24	42.53	42.34	39.98
11	40.96	42.04	41.85	39.37
12	41.08	40.36	40.65	41.41
13	40.71	43.14	41.59	40.12
14	42.07	41.97	42.22	40.47
15	41.13	41.57	41.38	40.64
16	41.56	39.77	40.97	41.44
17	40.55	40.34	40.27	42.49
18	40.35	41.48	40.42	40.22
19	39.34	41.85	41.73	40.89
20	40.48	42.62	40.76	41.57
21	40.04	40.32	42.18	40.36
22	41.17	41.82	40.66	41.34
23	41.32	40.85	39.17	41.43
24	41.41	41.36	40.35	42.57
25	41.34	39.42	40.84	40.83
26	42.52	40.24	41.13	40.32
27	40.38	40.59	40.27	41.26
28	42.78	41.28	40.58	42.52
29	42.59	40.63	40.43	40.62
30	40.62	40.37	40.07	40.95
31	41.36	41.84	41.55	41.56
32	40.05	41.79	40.42	40.66
33	43.69	40.46	39.39	41.42
34	40.48	41.54	42.47	39.26
35	41.64	40.55	40.88	40.24
36	40.53	39.39	41.81	41.87
37	41.17	40.37	40.33	41.99
38	40.43	39.72	41.39	40.51
39	40.51	41.46	42.84	40.34

40	41.57	41.61	40.75	42.22
41	40.46	42.02	40.28	41.87
42	42.68	41.23	41.11	39.88
43	39.21	41.97	40.55	40.23
44	40.43	40.46	41.37	41.19
45	40.35	41.92	39.26	40.88
46	41.21	40.38	40.51	40.19
47	41.19	41.71	41.68	40.57
48	40.39	40.04	40.94	41.44
49	41.26	41.31	41.85	41.55
50	40.91	40.16	41.34	40.26
51	42.54	40.45	41.44	41.81
52	40.39	39.98	41.19	40.32
53	41.37	40.11	39.24	41.78
54	40.22	41.75	42.56	40.33
55	41.53	41.99	40.71	40.05
Average	41.03	41.05	41.06	40.98

(**Note:** As the result of data review, it showed that the amount of collected data at a 95% confidence level and a 5 % error is adequate.)

Table A-9: Performance Rating Factor of Westinghouse System

Skill			Effort		
0.15	A1	Super Skill	0.13	A1	Excessive
0.13	A2		0.12	A2	
0.11	B1	Excellent	0.10	B1	Excellent
0.08	B2		0.08	B2	
0.06	C1	Good	0.05	C1	Good
0.03	C2		0.02	C2	
0	D	Average	0	D	Average
-0.05	E1	Fair	-0.04	E1	Fair
-0.10	E2		-0.08	E2	
-0.16	F1	Poor	-0.12	F1	Poor
-0.22	F2		-0.17	F2	
Conditions			Consistency		
0.06	A	Ideal	0.04	A	Perfect
0.04	B	Excellent	0.03	B	Excellent
0.02	C	Good	0.01	C	Good
0	D	Average	0	D	Average
-0.03	E	Fair	-0.02	E	Fair
-0.07	F	Poor	-0.04	F	Poor

(Source: Adapt from: Karanjkar, A. 2008)

Table A-10: International Labour Organization (ILO) Recommended Allowances

Type of Allowances	% of Time Allowances	
	Men	Women
A. Constant Allowances:		
1. Personal allowance	5	7
2. Basic fatigue allowance	4	4
B. Variable Allowances:		
1. Standing allowance	2	4
2. Abnormal position allowance:		
a. Slightly awkward	0	1
b. Awkward (bending)	2	3
c. Very awkward (lying, stretching)	7	7
3. Use of force, or muscular energy (lifting, pulling, or pushing):		
Weight lifted (pounds):		
5	0	1
10	1	2
15	2	3
20	3	4
25	4	6
30	5	8
35	7	10
40	9	13
45	11	16
50	13	20
60	17	-
70	22	-
4. Bad light:		
a. Slightly below recommended	0	0
b. Well below	2	2
c. Quite inadequate	5	5

Table A-10: International Labour Organization (ILO) Recommended Allowances
(cont.)

Type of Allowances	% of Time Allowances	
	Men	Women
5. Atmospheric conditions (heat and humidity)-variable	0-100	0-100
6. Close attention:		
a. Fairly fine work	0	0
b. Fine or exacting	2	2
c. Very fine or very exacting	5	5
7. Noise level:		
a. Continuous	0	0
b. Intermittent – loud	2	2
c. Intermittent – very loud	5	5
d. High-pitched – loud	5	5
8. Mental strain:		
a. Fairly complex process	1	1
b. Complex or wide span of attention	4	4
c. Very complex	8	8
9. Monotony:		
a. Low	0	0
b. Medium	1	1
c. High	4	4
10. Tediousness:		
a. Rather tedious	0	0
b. Tedious	2	1
c. Very tedious	5	2

(Source: Adapt from: Niebel, B. W. et al., 2003 and Patil, S. B. et al., 2008)

Table A-11: Assessment of Worker Performances in Each Process (for producing collar)

Worker / Process	Skill	Effort	Conditions	Consistency	Total	Evaluation (Total + 1)	Average Time Recording	Average Time of Each Worker	Normal Time	Note
1 / Cutting	0.03	0.02	-0.03	0	0.02	102%	10.92	11.14		seconds per piece
2 / Cutting	0	0	-0.03	0	-0.03	97%	10.96	10.63	10.51	
3 / Cutting	-0.05	0	-0.03	-0.02	-0.10	90%	11.13	10.02		
4 / Cutting	0	-0.04	-0.03	0	-0.07	93%	11.01	10.24		
1 / Trimming	0	0.02	-0.03	0	-0.01	99%	2.85	2.82		seconds per piece
2 / Trimming	0	0.02	-0.03	0.01	0	100%	2.83	2.83	2.78	
3 / Trimming	0.03	-0.04	-0.03	-0.02	-0.06	94%	2.82	2.65		
4 / Trimming	0.03	0	-0.03	0.01	0.01	101%	2.79	2.82		
1 / Ironing	0	-0.04	-0.03	-0.02	-0.09	91%	6.51	5.92		seconds per piece
2 / Ironing	0.06	0	-0.03	0.01	0.04	104%	6.33	6.58	6.24	
3 / Ironing	0.03	0	-0.03	0	0	100%	6.44	6.44		
4 / Ironing	-0.05	0.02	-0.03	-0.02	-0.08	92%	6.54	6.02		
1 / Packing	-0.05	0.05	-0.03	-0.02	-0.05	95%	25.18	23.92		seconds per dozen
2 / Packing	0.03	0	-0.03	0	0	100%	25.05	25.05	25.01	
3 / Packing	0	0	-0.03	0.01	-0.02	98%	25.07	24.57		
4 / Packing	0.06	0.02	-0.03	0.01	0.06	106%	24.99	26.49		

Table A-12: Assessment of Worker Performances in Each Process (for producing sleeve)

Worker / Process	Skill	Effort	Conditions	Consistency	Total	Evaluation (Total + 1)	Average Time Recording	Average Time of Each Worker	Normal Time	Note
1 / Cutting	-0.05	0	-0.03	-0.02	-0.10	90%	18.18	16.36		seconds
2 / Cutting	0.03	0.02	-0.03	0.01	0.03	103%	18.06	18.60	17.52	per piece
3 / Cutting	0	0.02	-0.03	0	-0.01	99%	18.10	17.92		
4 / Cutting	0	0	-0.03	-0.02	-0.05	95%	18.12	17.21		
1 / Trimming	-0.05	0.02	-0.03	-0.02	-0.08	92%	3.59	3.30		seconds
2 / Trimming	0	-0.04	-0.03	0	-0.07	93%	3.54	3.29	3.39	per piece
3 / Trimming	-0.05	0.02	-0.03	0.01	-0.05	95%	3.58	3.40		
4 / Trimming	0.03	0.02	-0.03	0.01	0.03	103%	3.46	3.56		
1 / Ironing	-0.05	0.02	-0.03	0.01	-0.05	95%	11.16	10.60		seconds
2 / Ironing	0.03	0	-0.03	-0.02	-0.02	98%	11.09	10.87	10.80	per piece
3 / Ironing	0.06	0	-0.03	0	0.03	103%	11.07	11.40		
4 / Ironing	0	-0.04	-0.03	0	-0.07	93%	11.12	10.34		
1 / Packing	0.03	0	-0.03	0	0	100%	41.03	41.03		seconds
2 / Packing	0	0.02	-0.03	0	-0.01	99%	41.05	40.64	40.41	per dozen
3 / Packing	0	-0.04	-0.03	0.01	-0.06	94%	41.06	38.60		
4 / Packing	0.06	0	-0.03	-0.02	0.01	101%	40.98	41.39		

As mentioned above, the production department will set its allowances and will be used International Labour Organization (ILO) recommended allowances, which was shown in Table A-10, for determining allowances. According to the same production process of collar and sleeve, they will be determined the same percentage of time allowances. Therefore, the percentage of time allowance in each production process will be shown as follows:

Table A-13: Determining Allowances of Production Department (both collar and sleeve)

Type of Allowances	% of Time Allowances			
	Cutting Process	Trimming Process	Ironing Process	Packing Process
1. Constant Allowances:				
• Personal allowance	7	7	7	7
• Basic fatigue allowance	4	4	4	4
2. Variable Allowances:				
• Abnormal position allowance: Slightly awkward	1	1	1	1
• Bad Light: Slightly below recommended	0	0	0	0
• Atmospheric conditions	0	0	0	0
• Close attention: Fairly fine work	0	0	0	0
• Noise level: Continuous	0	0	0	0
• Mental strain: Fairly complex process	1	1	1	1
• Monotony: High	4	4	4	4
• Tediousness	0	1	0	0
Total	17	18	17	17

According to Table A-13, it can be calculated the time allowance of each process by following the formula below.

$$\text{Time Allowances} = (\% \text{ of Time Allowance}) \times (\text{Normal Time})$$

Therefore, the standard time of each production process can be calculated by bringing normal time plus time allowance that will be shown in table below.

Table A-14: Standard Time of Each Process (for collar)

Process	Normal Time	Time Allowance	Standard Time
Cutting Process (seconds per piece)	10.51	1.7867	12.30
Trimming Process (seconds per piece)	2.78	0.5004	3.28
Ironing Process (seconds per piece)	6.24	1.0608	7.30
Packing Process (seconds per dozen)	25.01	4.2517	29.26

Table A-15: Standard Time of Each Process (for sleeve)

Process	Normal Time	Time Allowance	Standard Time
Cutting Process (seconds per piece)	17.52	2.9784	20.50
Trimming Process (seconds per piece)	3.39	0.6102	4.00
Ironing Process (seconds per piece)	10.80	1.8360	12.64
Packing Process (seconds per dozen)	40.41	6.8697	47.28

Table A-16: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for C 20/1 (unbleached yarn)

Size	Number of Needles	Number of Rounds and Times	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	222	6 Rounds + 39 Times	0.246	16
3" x 13"	241	6 Rounds + 39 Times	0.268	18
3" x 14"	259	6 Rounds + 39 Times	0.289	19
3" x 15"	278	6 Rounds + 39 Times	0.310	20
3" x 16"	296	6 Rounds + 39 Times	0.330	21
3.5" x 14"	259	6 Rounds + 46 Times	0.337	22
3.5" x 15"	278	6 Rounds + 46 Times	0.361	23
3.5" x 16"	296	6 Rounds + 46 Times	0.385	25
3.5" x 17"	315	6 Rounds + 46 Times	0.409	27
4" x 14"	259	6 Rounds + 53 Times	0.385	25
4" x 15"	278	6 Rounds + 53 Times	0.413	27
4" x 16"	296	6 Rounds + 53 Times	0.440	28
4" x 17"	315	6 Rounds + 53 Times	0.468	30
4" x 18"	333	6 Rounds + 53 Times	0.495	32
4" x 19"	352	6 Rounds + 53 Times	0.523	34
1.5" x 12"-13"	222 - 241	6 Rounds + 18 Times	0.134	9
1.5" x 14"-15"	259 - 278	6 Rounds + 18 Times	0.155	10
1.5" x 16"-17"	296 - 315	6 Rounds + 18 Times	0.176	12
1.5" x 24"-25"	444 - 463	6 Rounds + 18 Times	0.259	17
1.5" x 26"-27"	481 - 500	6 Rounds + 18 Times	0.279	18
1.5" x 28"-29"	518 - 537	6 Rounds + 18 Times	0.300	19
1.5" x 30"-31"	555 - 574	6 Rounds + 18 Times	0.321	21
1.5" x 32"-33"	592 - 611	6 Rounds + 18 Times	0.341	22
1.75" x 12"-13"	222 - 241	6 Rounds + 22 Times	0.157	10
1.75" x 14"-15"	259 - 278	6 Rounds + 22 Times	0.181	12
1.75" x 16"-17"	296 - 315	6 Rounds + 22 Times	0.206	14
1.75" x 24"-25"	444 - 463	6 Rounds + 22 Times	0.302	19
1.75" x 26"-27"	481 - 500	6 Rounds + 22 Times	0.326	21
1.75" x 28"-29"	518 - 537	6 Rounds + 22 Times	0.350	22
1.75" x 30"-31"	555 - 574	6 Rounds + 22 Times	0.375	24
1.75" x 32"-33"	592 - 611	6 Rounds + 22 Times	0.398	25
1" x 28"	518	6 Rounds + 11 Times	0.193	13

Table A-17: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for C 20/1 (yarn colour)

Size	Number of Needles	Number of Rounds and Times	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	204	6 Rounds + 32 Times	0.204	14
3" x 13"	223	6 Rounds + 32 Times	0.220	15
3" x 14"	241	6 Rounds + 32 Times	0.237	16
3" x 15"	260	6 Rounds + 32 Times	0.253	17
3" x 16"	278	6 Rounds + 32 Times	0.270	18
3.5" x 14"	241	6 Rounds + 39 Times	0.275	19
3.5" x 15"	260	6 Rounds + 39 Times	0.295	20
3.5" x 16"	278	6 Rounds + 39 Times	0.314	22
3.5" x 17"	297	6 Rounds + 39 Times	0.348	23
4" x 14"	241	6 Rounds + 46 Times	0.314	21
4" x 15"	260	6 Rounds + 46 Times	0.336	23
4" x 16"	278	6 Rounds + 46 Times	0.358	24
4" x 17"	297	6 Rounds + 46 Times	0.380	26
4" x 18"	315	6 Rounds + 46 Times	0.402	27
4" x 19"	334	6 Rounds + 46 Times	0.424	29
1.5" x 12"-13"	204 - 223	6 Rounds + 11 Times	0.112	8
1.5" x 14"-15"	241 - 260	6 Rounds + 11 Times	0.129	9
1.5" x 16"-17"	278 - 297	6 Rounds + 11 Times	0.145	10
1.5" x 24"-25"	426 - 4445	6 Rounds + 11 Times	0.211	15
1.5" x 26"-27"	463 - 482	6 Rounds + 11 Times	0.229	16
1.5" x 28"-29"	500 - 519	6 Rounds + 11 Times	0.234	17
1.5" x 30"-31"	537 - 556	6 Rounds + 11 Times	0.262	18
1.5" x 32"-33"	574 - 593	6 Rounds + 11 Times	0.278	19
1.75" x 12"-13"	204 - 223	6 Rounds + 15 Times	0.130	9
1.75" x 14"-15"	241 - 260	6 Rounds + 15 Times	0.150	10
1.75" x 16"-17"	278 - 297	6 Rounds + 15 Times	0.168	12
1.75" x 24"-25"	426 - 4445	6 Rounds + 15 Times	0.245	17
1.75" x 26"-27"	463 - 482	6 Rounds + 15 Times	0.265	18
1.75" x 28"-29"	500 - 519	6 Rounds + 15 Times	0.284	19
1.75" x 30"-31"	537 - 556	6 Rounds + 15 Times	0.304	21
1.75" x 32"-33"	574 - 593	6 Rounds + 15 Times	0.322	22
1" x 28"	500	6 Rounds + 5 Times	0.160	11

Table A-18: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for C 60/2 (unbleached yarn)

Size	Number of Needles	Number of Round and Time	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	231	6 Rounds + 37 Times	0.236	20
3" x 13"	250	6 Rounds + 37 Times	0.256	22
3" x 14"	269	6 Rounds + 37 Times	0.276	23
3" x 15"	288	6 Rounds + 37 Times	0.296	24
3" x 16"	307	6 Rounds + 37 Times	0.315	25
3.5" x 14"	269	6 Rounds + 44 Times	0.322	26
3.5" x 15"	288	6 Rounds + 44 Times	0.345	28
3.5" x 16"	307	6 Rounds + 44 Times	0.366	29
3.5" x 17"	327	6 Rounds + 44 Times	0.390	31
4" x 14"	269	6 Rounds + 50 Times	0.368	29
4" x 15"	288	6 Rounds + 50 Times	0.394	31
4" x 16"	307	6 Rounds + 50 Times	0.420	32
4" x 17"	327	6 Rounds + 50 Times	0.446	34
4" x 18"	346	6 Rounds + 50 Times	0.473	36
4" x 19"	365	6 Rounds + 50 Times	0.499	38
1.5" x 12"-13"	231 - 250	6 Rounds + 17 Times	0.128	13
1.5" x 14"-15"	269 - 288	6 Rounds + 17 Times	0.148	14
1.5" x 16"-17"	307 - 327	6 Rounds + 17 Times	0.168	16
1.5" x 24"-25"	461 - 481	6 Rounds + 17 Times	0.246	21
1.5" x 26"-27"	500 - 519	6 Rounds + 17 Times	0.266	22
1.5" x 28"-29"	538 - 557	6 Rounds + 17 Times	0.286	23
1.5" x 30"-31"	577 - 596	6 Rounds + 17 Times	0.305	25
1.5" x 32"-33"	615 - 634	6 Rounds + 17 Times	0.325	26
1.75" x 12"-13"	231 - 250	6 Rounds + 21 Times	0.150	14
1.75" x 14"-15"	269 - 288	6 Rounds + 21 Times	0.173	16
1.75" x 16"-17"	307 - 327	6 Rounds + 21 Times	0.196	17
1.75" x 24"-25"	461 - 481	6 Rounds + 21 Times	0.288	23
1.75" x 26"-27"	500 - 519	6 Rounds + 21 Times	0.310	25
1.75" x 28"-29"	538 - 557	6 Rounds + 21 Times	0.333	27
1.75" x 30"-31"	577 - 596	6 Rounds + 21 Times	0.356	28
1.75" x 32"-33"	615 - 634	6 Rounds + 21 Times	0.379	30
1" x 28"	538	6 Rounds + 11 Times	0.184	17

Table A-19: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for C 60/2 (yarn colour)

Size	Number of Needles	Number of Rounds and Times	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	211	6 Rounds + 31 Times	0.186	16
3" x 13"	231	6 Rounds + 31 Times	0.201	18
3" x 14"	250	6 Rounds + 31 Times	0.217	19
3" x 15"	269	6 Rounds + 31 Times	0.232	20
3" x 16"	288	6 Rounds + 31 Times	0.248	21
3.5" x 14"	250	6 Rounds + 38 Times	0.253	22
3.5" x 15"	269	6 Rounds + 38 Times	0.271	23
3.5" x 16"	288	6 Rounds + 38 Times	0.289	25
3.5" x 17"	307	6 Rounds + 38 Times	0.307	27
4" x 14"	250	6 Rounds + 44 Times	0.289	25
4" x 15"	269	6 Rounds + 44 Times	0.309	27
4" x 16"	288	6 Rounds + 44 Times	0.330	28
4" x 17"	307	6 Rounds + 44 Times	0.351	30
4" x 18"	327	6 Rounds + 44 Times	0.372	32
4" x 19"	346	6 Rounds + 44 Times	0.392	34
1.5" x 12"-13"	211 - 231	6 Rounds + 11 Times	0.100	9
1.5" x 14"-15"	250 - 269	6 Rounds + 11 Times	0.116	10
1.5" x 16"-17"	288 - 307	6 Rounds + 11 Times	0.131	12
1.5" x 24"-25"	442 - 462	6 Rounds + 11 Times	0.193	17
1.5" x 26"-27"	481 - 500	6 Rounds + 11 Times	0.208	18
1.5" x 28"-29"	519 - 538	6 Rounds + 11 Times	0.223	19
1.5" x 30"-31"	558 - 577	6 Rounds + 11 Times	0.239	21
1.5" x 32"-33"	596 - 615	6 Rounds + 11 Times	0.254	22
1.75" x 12"-13"	211 - 231	6 Rounds + 15 Times	0.118	10
1.75" x 14"-15"	250 - 269	6 Rounds + 15 Times	0.135	12
1.75" x 16"-17"	288 - 307	6 Rounds + 15 Times	0.154	14
1.75" x 24"-25"	442 - 462	6 Rounds + 15 Times	0.227	19
1.75" x 26"-27"	481 - 500	6 Rounds + 15 Times	0.244	21
1.75" x 28"-29"	519 - 538	6 Rounds + 15 Times	0.263	22
1.75" x 30"-31"	558 - 577	6 Rounds + 15 Times	0.281	24
1.75" x 32"-33"	596 - 615	6 Rounds + 15 Times	0.299	25
1" x 28"	519	6 Rounds + 6 Times	0.144	13

Table A-20: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for TC 34/1 (unbleached yarn)

Size	Number of Needles	Number of Round and Time	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	226	6 Rounds + 39 Times	0.254	21
3" x 13"	245	6 Rounds + 39 Times	0.275	22
3" x 14"	264	6 Rounds + 39 Times	0.296	24
3" x 15"	283	6 Rounds + 39 Times	0.317	26
3" x 16"	302	6 Rounds + 39 Times	0.338	27
3.5" x 14"	264	6 Rounds + 46 Times	0.345	28
3.5" x 15"	283	6 Rounds + 46 Times	0.370	30
3.5" x 16"	302	6 Rounds + 46 Times	0.394	32
3.5" x 17"	320	6 Rounds + 46 Times	0.420	34
4" x 14"	264	6 Rounds + 53 Times	0.394	32
4" x 15"	283	6 Rounds + 53 Times	0.422	34
4" x 16"	302	6 Rounds + 53 Times	0.450	37
4" x 17"	320	6 Rounds + 53 Times	0.479	39
4" x 18"	339	6 Rounds + 53 Times	0.507	41
4" x 19"	358	6 Rounds + 53 Times	0.535	43
1.5" x 12"-13"	226 - 245	6 Rounds + 18 Times	0.137	12
1.5" x 14"-15"	264 - 283	6 Rounds + 18 Times	0.159	13
1.5" x 16"-17"	302 - 320	6 Rounds + 18 Times	0.180	15
1.5" x 24"-25"	453 - 472	6 Rounds + 18 Times	0.264	22
1.5" x 26"-27"	490 - 509	6 Rounds + 18 Times	0.285	24
1.5" x 28"-29"	528 - 547	6 Rounds + 18 Times	0.306	25
1.5" x 30"-31"	566 - 585	6 Rounds + 18 Times	0.327	27
1.5" x 32"-33"	603 - 622	6 Rounds + 18 Times	0.348	29
1.75" x 12"-13"	226 - 245	6 Rounds + 22 Times	0.160	13
1.75" x 14"-15"	264 - 283	6 Rounds + 22 Times	0.186	15
1.75" x 16"-17"	302 - 320	6 Rounds + 22 Times	0.209	17
1.75" x 24"-25"	453 - 472	6 Rounds + 22 Times	0.308	25
1.75" x 26"-27"	490 - 509	6 Rounds + 22 Times	0.333	27
1.75" x 28"-29"	528 - 547	6 Rounds + 22 Times	0.357	29
1.75" x 30"-31"	566 - 585	6 Rounds + 22 Times	0.382	31
1.75" x 32"-33"	603 - 622	6 Rounds + 22 Times	0.406	33
1" x 28"	528	6 Rounds + 11 Times	0.197	16

Table A-21: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for TC 34/1 (yarn colour)

Size	Number of Needles	Number of Rounds and Times	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	207	6 Rounds + 32 Times	0.182	17
3" x 13"	226	6 Rounds + 32 Times	0.197	19
3" x 14"	245	6 Rounds + 32 Times	0.212	20
3" x 15"	264	6 Rounds + 32 Times	0.227	22
3" x 16"	283	6 Rounds + 32 Times	0.242	23
3.5" x 14"	245	6 Rounds + 39 Times	0.246	24
3.5" x 15"	264	6 Rounds + 39 Times	0.264	25
3.5" x 16"	283	6 Rounds + 39 Times	0.282	27
3.5" x 17"	302	6 Rounds + 39 Times	0.299	28
4" x 14"	245	6 Rounds + 46 Times	0.282	27
4" x 15"	264	6 Rounds + 46 Times	0.303	29
4" x 16"	283	6 Rounds + 46 Times	0.322	31
4" x 17"	302	6 Rounds + 46 Times	0.342	33
4" x 18"	320	6 Rounds + 46 Times	0.363	34
4" x 19"	339	6 Rounds + 46 Times	0.383	36
1.5" x 12"-13"	207 - 226	6 Rounds + 11 Times	0.098	10
1.5" x 14"-15"	245 - 264	6 Rounds + 11 Times	0.113	11
1.5" x 16"-17"	283 - 302	6 Rounds + 11 Times	0.128	13
1.5" x 24"-25"	434 - 453	6 Rounds + 11 Times	0.188	18
1.5" x 26"-27"	471 - 490	6 Rounds + 11 Times	0.204	20
1.5" x 28"-29"	510 - 529	6 Rounds + 11 Times	0.219	21
1.5" x 30"-31"	548 - 567	6 Rounds + 11 Times	0.233	22
1.5" x 32"-33"	585 - 604	6 Rounds + 11 Times	0.249	24
1.75" x 12"-13"	207 - 226	6 Rounds + 15 Times	0.114	11
1.75" x 14"-15"	245 - 264	6 Rounds + 15 Times	0.132	13
1.75" x 16"-17"	283 - 302	6 Rounds + 15 Times	0.150	15
1.75" x 24"-25"	434 - 453	6 Rounds + 15 Times	0.220	21
1.75" x 26"-27"	471 - 490	6 Rounds + 15 Times	0.238	23
1.75" x 28"-29"	510 - 529	6 Rounds + 15 Times	0.255	25
1.75" x 30"-31"	548 - 567	6 Rounds + 15 Times	0.273	26
1.75" x 32"-33"	585 - 604	6 Rounds + 15 Times	0.290	28
1" x 28"	509	6 Rounds + 5 Times	0.141	14

Table A-22: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for Poly 75/1 (unbleached yarn)

Size	Number of Needles	Number of Round and Time	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	242	6 Rounds + 48 Times	0.235	21
3" x 13"	262	6 Rounds + 48 Times	0.255	22
3" x 14"	282	6 Rounds + 48 Times	0.275	24
3" x 15"	302	6 Rounds + 48 Times	0.294	26
3" x 16"	322	6 Rounds + 48 Times	0.315	27
3.5" x 14"	282	6 Rounds + 56 Times	0.321	28
3.5" x 15"	302	6 Rounds + 56 Times	0.344	30
3.5" x 16"	322	6 Rounds + 56 Times	0.366	32
3.5" x 17"	343	6 Rounds + 56 Times	0.391	34
4" x 14"	282	6 Rounds + 64 Times	0.366	32
4" x 15"	302	6 Rounds + 64 Times	0.393	34
4" x 16"	322	6 Rounds + 64 Times	0.419	36
4" x 17"	343	6 Rounds + 64 Times	0.446	38
4" x 18"	363	6 Rounds + 64 Times	0.472	41
4" x 19"	383	6 Rounds + 64 Times	0.497	43
1.5" x 12"-13"	242 - 262	6 Rounds + 23 Times	0.128	11
1.5" x 14"-15"	282 - 302	6 Rounds + 23 Times	0.147	13
1.5" x 16"-17"	322 - 343	6 Rounds + 23 Times	0.167	15
1.5" x 24"-25"	484 - 504	6 Rounds + 23 Times	0.245	22
1.5" x 26"-27"	524 - 544	6 Rounds + 23 Times	0.265	23
1.5" x 28"-29"	564 - 585	6 Rounds + 23 Times	0.285	25
1.5" x 30"-31"	605 - 625	6 Rounds + 23 Times	0.305	27
1.5" x 32"-33"	645 - 665	6 Rounds + 23 Times	0.323	28
1.75" x 12"-13"	242 - 262	6 Rounds + 27 Times	0.149	13
1.75" x 14"-15"	282 - 302	6 Rounds + 27 Times	0.172	15
1.75" x 16"-17"	322 - 343	6 Rounds + 27 Times	0.195	17
1.75" x 24"-25"	484 - 504	6 Rounds + 27 Times	0.286	25
1.75" x 26"-27"	524 - 544	6 Rounds + 27 Times	0.308	27
1.75" x 28"-29"	564 - 585	6 Rounds + 27 Times	0.331	29
1.75" x 30"-31"	605 - 625	6 Rounds + 27 Times	0.354	31
1.75" x 32"-33"	645 - 665	6 Rounds + 27 Times	0.377	33
1" x 28"	564	6 Rounds + 14 Times	0.184	16

Table A-23: Standard Weight, Standard Time, Number of Rounds and Times, and Number of Needles of Each Size for Poly 75/1 (yarn colour)

Size	Number of Needles	Number of Rounds and Times	Weight (Kg) per Dozen	Time (min.) per Dozen
3" x 12"	222	6 Rounds + 41 Times	0.168	16
3" x 13"	242	6 Rounds + 41 Times	0.183	17
3" x 14"	262	6 Rounds + 41 Times	0.197	18
3" x 15"	282	6 Rounds + 41 Times	0.210	19
3" x 16"	302	6 Rounds + 41 Times	0.224	21
3.5" x 14"	262	6 Rounds + 49 Times	0.229	21
3.5" x 15"	282	6 Rounds + 49 Times	0.245	23
3.5" x 16"	302	6 Rounds + 49 Times	0.262	24
3.5" x 17"	322	6 Rounds + 49 Times	0.278	26
4" x 14"	262	6 Rounds + 57 Times	0.262	24
4" x 15"	282	6 Rounds + 57 Times	0.281	26
4" x 16"	302	6 Rounds + 57 Times	0.299	27
4" x 17"	322	6 Rounds + 57 Times	0.318	29
4" x 18"	343	6 Rounds + 57 Times	0.337	31
4" x 19"	363	6 Rounds + 57 Times	0.355	33
1.5" x 12"-13"	222 - 242	6 Rounds + 16 Times	0.091	9
1.5" x 14"-15"	262 - 282	6 Rounds + 16 Times	0.106	10
1.5" x 16"-17"	302 - 322	6 Rounds + 16 Times	0.120	11
1.5" x 24"-25"	464 - 484	6 Rounds + 16 Times	0.176	17
1.5" x 26"-27"	504 - 524	6 Rounds + 16 Times	0.189	18
1.5" x 28"-29"	544 - 565	6 Rounds + 16 Times	0.204	19
1.5" x 30"-31"	585 - 605	6 Rounds + 16 Times	0.218	20
1.5" x 32"-33"	625 - 645	6 Rounds + 16 Times	0.232	22
1.75" x 12"-13"	222 - 242	6 Rounds + 20 Times	0.107	10
1.75" x 14"-15"	262 - 282	6 Rounds + 20 Times	0.123	11
1.75" x 16"-17"	302 - 322	6 Rounds + 20 Times	0.140	13
1.75" x 24"-25"	464 - 484	6 Rounds + 20 Times	0.206	19
1.75" x 26"-27"	504 - 524	6 Rounds + 20 Times	0.221	20
1.75" x 28"-29"	544 - 565	6 Rounds + 20 Times	0.238	22
1.75" x 30"-31"	585 - 605	6 Rounds + 20 Times	0.254	23
1.75" x 32"-33"	625 - 645	6 Rounds + 20 Times	0.271	25
1" x 28"	544	6 Rounds + 7 Times	0.131	12

Table A-24: Standard Weight of Sub Yarn

Size	Weight (Kg) per Dozen	Size	Weight (Kg) per Dozen
3" x 12"	0.0087	1.5" x 14"-15"	0.0054
3" x 13"	0.0094	1.5" x 16"-17"	0.0061
3" x 14"	0.0102	1.5" x 24"-25"	0.0090
3" x 15"	0.0109	1.5" x 26"-27"	0.0098
3" x 16"	0.0116	1.5" x 28"-29"	0.0105
3.5" x 14"	0.0118	1.5" x 30"-31"	0.0112
3.5" x 15"	0.0127	1.5" x 32"-33"	0.0119
3.5" x 16"	0.0135	1.75" x 12"-13"	0.0055
3.5" x 17"	0.0143	1.75" x 14"-15"	0.0063
4" x 14"	0.0135	1.75" x 16"-17"	0.0072
4" x 15"	0.0144	1.75" x 24"-25"	0.0106
4" x 16"	0.0154	1.75" x 26"-27"	0.0114
4" x 17"	0.0164	1.75" x 28"-29"	0.0123
4" x 18"	0.0173	1.75" x 30"-31"	0.0131
4" x 19"	0.0183	1.75" x 32"-33"	0.0140
1.5" x 12"-13"	0.0047	1" x 28"	0.0067

(Note: Weight per dozen of sub yarn, which is used to separate each piece of collar or sleeve.)

Table A-25: Standard Time of Each Process (using in program for cost estimation)

Process	Time (min) per Dozen	
	Collar	Sleeve
Spinning	1.00	1.00
Cut	2.25	4.25
Trim	0.40	0.55
Ironing	1.35	2.40
Packing	0.30	0.50
Total	6.10	9.50
Steam Oven (extra)	2.00	3.00
Total	8.10	12.50

(Note: Spinning and steam oven processes are working by machine)

Table A-26: Price of Each Raw Material and Price of Pigmentation

Type of Yarn		Price of Raw Material (baht) per Kg	Price of Pigmentation (baht) per Kg
TC 34/1	Unbleached Yarn	81.57	-
	Light Colour	180.78	55.12
	Middle Colour	198.41	70.55
	Dark Colour	220.46	92.59
	White Colour	167.55	37.48
	Off-white Colour	163.14	35.27
C 20/1	Unbleached Yarn	108.03	-
	Light Colour	207.23	57.32
	Middle Colour	220.46	74.96
	Dark Colour	242.51	90.39
	White Colour	194.00	39.68
	Off-white Colour	187.39	37.48
C 60/2	Unbleached Yarn	286.60	-
	Light Colour	392.42	61.73
	Middle Colour	418.87	83.77
	Dark Colour	440.92	101.41
	White Colour	379.19	46.30
	Off-white Colour	374.78	44.09
Poly 75/1	Unbleached Yarn	70.55	-
	Light Colour	149.91	37.48
	Middle Colour	158.73	44.09
	Dark Colour	171.96	48.50
	White Colour	145.50	30.86
	Off-white Colour	141.09	28.66

Table A-27: Example Schedule of Work Sampling (after improvement for worker 1)

Time Day	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	Work	Idle	Total
1	//0	0/	//	///	0/	/00	/0	//0	13	7	20
2	/	/0/	/0//	0/	//	/0	//0	//0	14	6	20
3	//	//0	//	///	/0	//0	//	/0/	16	4	20
4	///0	/	/0/	/0	/	0//	0//	///	15	5	20
5	//	/	///	//0	//0	//0	/0	/0/	15	5	20
6	/	/0/	//	0//	0///	/	//0	///	16	4	20
7	/0	////	//	//0	0/	//	//	//0	16	4	20
8	//	//	/	/0/	//	///0	///	/0/	17	3	20
9	///	/	//	////	0/	///	//	/00	17	3	20
10	0/	//	//0	//	///	/0	////	/0	16	4	20
11	///	//	/	/0	//	///	//0	///0	17	3	20
12	/0	//	///	//	///	//0	//0/	/	17	3	20
13	//	0//	//0	///	/	0/	0//	//0	15	5	20
14	0	//0	//	//	////	///	///	//	18	2	20
15	/	//	0//	///	0//	/0/	/	////	17	3	20
16	////	/	/	0/	///	///	/0/	///	18	2	20
17	//0	/0/	//	//	/0/	0	///	///	16	4	20
18	0//	///	//0	/	//	0//	///	//	17	3	20
19	///	///	/0/	///	0//0	/	//	/	17	3	20
20	//	/0/	//	0/0	//0	/0	//	/0/	14	6	20
21	/0	0//	///	//0	/	/	//0	//00	14	6	20
22	//	///0	//	/0/	00	/0	//	///	15	5	20
23	/0/	/0	///	0/	/	/0/	/00	//0	13	7	20
24	0//	//0	//	///	/0/	/	//	/00	15	5	20
25	/	///	///	/0/	/	0//	00	/0/0	14	6	20
Total									392	108	500

(**Note:** / means work and 0 means idle. As the result of data review, it showed that the number of work sampling at a 95% confidence level and a 5 % error is adequate.)

Table A-28: Example Schedule of Work Sampling (after improvement for worker 2)

Time Day	8:00 -9:00	9:00 -10:00	10:00 -11:00	11:00 -12:00	13:00 -14:00	14:00 -15:00	15:00 -16:00	16:00 -17:00	Work	Idle	Total
	1	//0	00	/0	//0	0/	/0/	/0	//0	11	9
2	/	/00	/0//	0/	//	/0	//0	//0	13	7	20
3	/0	//0	//	///	/0	//0	/0	/0/	14	6	20
4	///0	/	/0/	/0	/	0//	0//	//0	14	6	20
5	/0	/	///	//0	//0	//0	/0	/00	13	7	20
6	/	/0/	//	0//	0///	/	//0	0//	15	5	20
7	/0	////	//	//0	0/	00	//	//0	14	6	20
8	//	//	/	/0/	//	///0	/00	/0/	15	5	20
9	/00	/	//	////	0/	///	//	/00	15	5	20
10	0/	//	//0	//	/0/	/0	////	/0	15	5	20
11	///	//	/	/0	//	///	//0	0//0	16	4	20
12	/0	//	///	//	//0	//0	//0/	/	16	4	20
13	//	0//	//0	///	/	0/	0//	//0	15	5	20
14	0	//0	//	//	/00/	///	///	//	16	4	20
15	/	//	0//	///	0//	/0/	/	/0//	16	4	20
16	////	/	0	0/	/0/	///	/0/	///	16	4	20
17	//0	/0/	//	//	/0/	0	///	///	16	4	20
18	0//	///	//0	/	//	0//	///	00	15	5	20
19	///	/0/	/0/	///	0//0	/	//	/	16	4	20
20	//	/0/	//	0/0	//0	/0	0/	/0/	13	7	20
21	/0	0//	///	//0	/	/	//0	//00	14	6	20
22	//	/0/0	//	/0/	00	/0	//	///	14	6	20
23	/0/	/0	///	0/	/	/0/	/00	//0	13	7	20
24	0//	//0	//	///	/0/	/	//	/00	15	5	20
25	/	///	///	/0/	/	0//	00	/0/0	14	6	20
Total									364	136	500

(**Note:** / means work and 0 means idle. As the result of data review, it showed that the number of work sampling at a 95% confidence level and a 5 % error is adequate.)

Table A-29: Example Schedule of Work Sampling (after improvement for worker 3)

Time Day	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	Work	Idle	Total
1	//0	0/	0/	///	0/	/00	/0	//0	12	8	20
2	/	/0/	/0//	0/	//	/0	//0	//0	14	6	20
3	//	//0	//	/00	/0	//0	//	/0/	14	6	20
4	///0	/	/0/	/0	/	0//	0//	00/	13	7	20
5	00	/	///	//0	//0	//0	/0	/0/	13	7	20
6	/	/0/	//	0//	00//	/	//0	///	15	5	20
7	/0	////	//	/00	0/	//	//	//0	15	5	20
8	//	//	/	/0/	//	///0	///	000	15	5	20
9	/0/	/	//	////	0/	///	//	/00	16	4	20
10	0/	//	//0	//	00/	/0	////	/0	14	6	20
11	///	//	/	/0	//	///	//0	/000	15	5	20
12	/0	//	///	//	00/	//0	//0/	/	15	5	20
13	//	0//	//0	/00	/	0/	0//	//0	13	7	20
14	0	//0	//	//	00//	///	///	/0	15	5	20
15	/	//	0//	///	0//	/0/	/	////	17	3	20
16	////	/	/	0/	///	///	/0/	/00	16	4	20
17	//0	/0/	//	//	/0/	0	///	000	13	7	20
18	0//	///	//0	/	00	0//	///	//	15	5	20
19	00/	///	/0/	///	0//0	/	//	/	15	5	20
20	//	/0/	//	000	//0	/0	//	/0/	13	7	20
21	/0	0//	///	//0	/	/	//0	//00	14	6	20
22	//	///0	//	/0/	00	/0	//	/0/	14	6	20
23	/0/	/0	///	0/	0	/0/	/00	//0	12	8	20
24	0//	//0	//	///	/0/	/	//	/00	15	5	20
25	/	///	/0/	/0/	/	0//	00	/0/0	13	7	20
Total									356	144	500

(**Note:** / means work and 0 means idle. As the result of data review, it showed that the number of work sampling at a 95% confidence level and a 5 % error is adequate.)

Table A-30: Example Schedule of Work Sampling (after improvement for worker 4)

Time Day	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	Work	Idle	Total
1	0/0	0/	//	///	0/	/00	/0	//0	12	8	20
2	0	/0/	/0//	0/	//	/0	//0	//0	13	7	20
3	//	//0	//	///	/0	//0	//	/0/	16	4	20
4	///0	/	/0/	/0	/	0//	0//	000	12	8	20
5	//	/	///	//0	0/0	//0	/0	/0/	14	6	20
6	/	/0/	//	0//	0///	/	//0	///	16	4	20
7	/0	////	//	//0	00	//	//	//0	15	5	20
8	//	//	/	/0/	//	///0	///	/00	16	4	20
9	///	/	//	///0	0/	///	//	/00	16	4	20
10	0/	//	//0	//	///	/0	////	/0	16	4	20
11	///	//	/	/0	0/	///	//0	///0	16	4	20
12	/0	//	///	//	///	//0	//0/	0	16	4	20
13	//	0//	//0	///	0	0/	0//	//0	14	6	20
14	0	//0	//	/0	0///	/0/	///	//	15	5	20
15	/	//	0//	///	0//	/0/	/	//0/	16	4	20
16	/0//	/	/	0/	///	///	/0/	///	17	3	20
17	//0	/0/	//	//	/0/	0	///	///	16	4	20
18	0//	///	//0	/	//	0//	///	//	17	3	20
19	///	///	/0/	///	00/0	/	//	/	16	4	20
20	//	/0/	//	0/0	//0	/0	//	0//	14	6	20
21	/0	0//	///	//0	/	/	//0	//00	14	6	20
22	//	///0	//	/0/	00	/0	//	///	15	5	20
23	/0/	/0	///	0/	/	/0/	/00	/0/	13	7	20
24	0//	//0	//	///	/0/	/	//	/00	15	5	20
25	/	///	///	/0/	/	0//	00	/000	13	7	20
Total									373	127	500

(**Note:** / means work and 0 means idle. As the result of data review, it showed that the number of work sampling at a 95% confidence level and a 5 % error is adequate.)

Table A-31: Example Schedule of Work Sampling (after improvement for worker 5)

Time Day	8:00 - 9:00	9:00 - 10:00	10:00 - 11:00	11:00 - 12:00	13:00 - 14:00	14:00 - 15:00	15:00 - 16:00	16:00 - 17:00	Work	Idle	Total
1	//0	0/	//	///	0/	/00	/0	/00	12	8	20
2	/	/0/	/0//	0/	00	/0	//0	//0	12	8	20
3	//	//0	//	/00	/0	//0	//	/0/	14	6	20
4	///0	/	/0/	/0	0	0//	0//	///	14	6	20
5	//	/	///	0/0	0/0	//0	/0	/0/	13	7	20
6	/	/0/	//	0//	0///	/	//0	0//	15	5	20
7	/0	////	//	000	0/	//	//	//0	14	6	20
8	//	//	/	/0/	//	///0	0/0	/0/	15	5	20
9	///	/	//	//00	0/	///	//	/00	15	5	20
10	0/	//	//0	//	///	00	////	/0	15	5	20
11	///	//	/	/0	//	///	//0	/000	15	5	20
12	/0	//	///	//	///	//0	//00	/	16	4	20
13	00	0//	//0	///	/	0/	0//	//0	13	7	20
14	0	//0	//	//	000/	///	///	//	15	5	20
15	/	00	0//	///	0//	/0/	/	////	15	5	20
16	/00/	/	/	0/	///	///	/0/	///	16	4	20
17	//0	/0/	//	//	/0/	0	0//	///	15	5	20
18	0//	///	//0	/	//	00/	///	//	16	4	20
19	///	///	/0/	/00	0//0	/	//	/	15	5	20
20	//	/00	//	0/0	//0	/0	//	00/	12	8	20
21	/0	0//	///	000	/	/	//0	//00	12	8	20
22	//	///0	//	/0/	00	/0	//	/0/	14	6	20
23	/0/	00	///	0/	/	/0/	/00	//0	12	8	20
24	0//	//0	//	/00	/0/	/	//	/00	13	7	20
25	/	///	///	/00	/	0//	00	/0/0	13	7	20
Total									351	149	500

(**Note:** / means work and 0 means idle. As the result of data review, it showed that the number of work sampling at a 95% confidence level and a 5 % error is adequate.)

APPENDIX B: Sample of Document Forms

ใบรายงานการใช้วัตถุดิบประจำวัน

วันที่: 12/1/52เลขที่บิล: 12/521-523แผนก: ผลิต

รายการ	รายละเอียด	ปริมาณของวัตถุดิบ (กก.)	ราคาต่อหน่วย	รวมราคาทั้งหมด (บาท)
1	C 20/1 : ขาว	60	194	11,640
	C 20/1 : ห้าเงิน	20	242.51	4,850.20
	C 20/1 : แดง	20	220.46	4,409.20
2	C 20/1 : ดิบ	50	108.03	5,401.50
3	TC 34/1 : ไข่ขาว	32	198.41	6,349.12
	TC 34/1 : ขาว	4	167.55	670.20
				33,320.22

ผู้ขอเบิก: ก้องผู้ส่งของ: ทวีผู้อนุมัติ: แดง

Figure B-1: Daily Raw Material's Request Form

ใบรายงานการใช้วัสดุทางอ้อมประจำเดือน

ประจำเดือน: ก.พ. 52

แผนก: ผลิต

รายการ	จำนวน	ราคาต่อหน่วย	รวมราคา ทั้งหมด (บาท)
ไม้ 14 "	425	4	1,700
ไม้ 16 "	80	2.5	200
ยาง	2	150	300
น้ำมันหล่อลื่น	1	90	90
			2,290

ผู้รายงาน: ๒๒๑

วันที่: 2 มี.ค. 52

Figure B-2: Monthly Indirect Material's Request Form

ใบรายงานการผลิตประจำวัน

วันที่: 12/1/52แผนก: ผลิต

รายการ	เลขที่ปิด	รายละเอียด	จำนวนของ สินค้า (โหลด)	ปริมาณของ เสีย (กก.)	เวลาในการผลิต (ชม.)		หมายเหตุ
					ชม. ทำงาน ปกติ	ชม. ว่างเวลา	
1	Jan 12/521	C 20/1: ๗๖					
		4" x 16"	30	} 4.45	16	-	
		1.5" x 27"	40		16	1	
		C 20/1: หน้า 16	25		13	-	
C 20/1: 1๑๓	25	14	-				
2	Jan 12/522	C 20/1: ๑๒๒					
		3" x 15"	35	} 1.2	16	4	
		1.5" x 24"	40		16	2	
3	Jan 12/523	TC 34/1: เขียว + ๗๖	20	0.55	8	2	

ผู้รายงาน: ๖๖๑

Figure B-3: Daily Production Report

ใบรายงานปริมาณการสูญเสียประจำวัน

วันที่: 12/1/52

แผนก: ผลิต

เลขที่บิล	ปริมาณของ เสีย (กก.)	ขนาดไม่ ถูกต้อง (กก.)	ขาด บางส่วน (กก.)	ขีดจำกัด (กก.)	เกิน / ละเอียด (กก.)
Jan 12/521	4.85	4.45	—	0.22	0.18
Jan 12/522	1.2	0.96	—	0.12	0.12
Jan 12/523	0.55	0.32	—	0.08	0.15
รวม	6.6	5.73	—	0.42	0.45

ผู้รายงาน: 1609

วันที่: 13/1/52

Figure B-4: Daily Report of Defects

ใบรายงานสรุปการใช้วัสดุซ่อมบำรุง

ประจำเดือน: มี.ค. 52

ลำดับ	วันที่	รายการ	ราคา (บาท)
1	9 มี.ค. 52	ลวอ 1303	2,580
2	20 มี.ค. 52	ส่วขพานยาง	940
รวมราคาทั้งหมด (บาท)			3,520

ผู้รายงาน: สมาน

วันที่: 3 เม.ย. 52

Figure B-5: Monthly Report of Repairable Expense

ใบบันทึกเวลาเข้าทำงาน

วันที่: ๗.๖.๕๑

แผนก: ผลิต ๓

เวลาทำงานปกติ

ล่วงเวลา

รหัส	ชื่อ - สกุล	เข้า	ออก
1.	พ.ส. 11๓1	8:05	17:10
2.	นาง สมใจ	7:45	16:45
3.	นาง พิณศิริ	7:50	14:00
4.	พ.ส. 11๓๖	8:15	17:15
5.	นาง ประมวล	8:10	16:50
6.	นาง รัชฎา	8:00	16:55
๗.	พ.ส. ไชยม	8:00	17:05
8.	นาง นงน	7:55	17:10
9.	นาง นงน	7:50	17:15
10.	นาง สมานิตรา	8:10	17:00
11.	นาง นริศ	8:10	17:10
12.	นาง สัจฉิรา	8:05	17:15
13.	นาง กัญญา	8:15	17:05
14.	พ.ส. นงน	7:55	16:55
15.	นาง นงน	8:00	16:55
16.	นาง อธิษฐาน	8:00	17:10
17.	นาง อธิษฐาน	8:10	17:15
18.	นาง อธิษฐาน	7:50	17:00
19.	นาง รัชฎา	7:45	17:00
20.	นาง สมาน	8:00	17:15
21.	นาง สมน	7:45	16:55
22.	พ.ส. จิราภรณ์	7:50	16:55
23.	นาง สมบัติ	7:55	17:00
24.	นาง สัจฉิรา	7:50	17:00

ผู้รายงาน: สมใจ

Figure B-6: Daily Time Attendance Report

ใบรายงานชั่วโมงแรงงานประจำเดือน

ประจำงวด: ๐.๓.๕๑

แผนก: ผลิต

รหัส	ชื่อ - สกุล	ชม. ทำงานปกติ (ชม.)	ชม. ทำงานล่วงเวลา (ชม.)
1	ผ.ส. แฉ	80	5
2	นาย สมนะ	200	0
3	นาย สมนะ	96	0
4	ผ.ส. สมนะ	200	0
5	ผ.ส. สมนะ	208	0
6	นาย สมนะ	216	0
7	ผ.ส. สมนะ	152	3
8	นาย สมนะ	176	5
9	นาย สมนะ	216	5
10	นาย สมนะ	192	5
11	นาย สมนะ	184	5
12	นาย สมนะ	120	5
13	นาย สมนะ	216	5
14	ผ.ส. สมนะ	204	5
15	นาย สมนะ	200	5
16	นาย สมนะ	216	14
17	นาย สมนะ	216	1
18	นาย สมนะ	216	25
19	นาย สมนะ	176	6
20	นาย สมนะ	200	0
21	นาย สมนะ	184	0
22	ผ.ส. สมนะ	216	0
23	นาย สมนะ	216	0
24	นาย สมนะ	216	0

ผู้รายงาน: สมานะ

Figure B-7: Monthly Report of Direct Labor Hour

ใบรายงานค่าใช้จ่ายน้ำและไฟฟ้า

ประจำเดือน ธ.ค. 2559

รายการ	ราคา (บาท)
ค่าไฟ ค่าน้ำ	35,669.15 3,780.10
รวมราคาทั้งหมด (บาท)	39,449.25

ผู้รายงาน: พนั

วันที่: 5.1.1. 92

Figure B-8: Monthly Report of Cost of Utilities

APPENDIX C: Results of Data Collection

Table C-1: Raw Materials' Request of Sample Order

List	Item	Amount of Raw Material (Kg)	Price of Each Unit (baht/kg)	Total Price (Baht)
1	C20/1: White Colour	64.50	194.0048	12,513.31

Table C-2: Production Report of Sample Order

List	Order Number	Detail of Order	Amount of Product (DOZ)	Amount of Defect (Kg)	Production Time (Hrs.)		Note
					Normal	OT	
1	Jun 345	(C20/1: White) 4" x 16"	150	2.4	65	12	
2	Jun 346	1.5" x 17"	90	0.9	26	5	

Table C-3: Defect Report of Sample Order

Order Number	Detail of Order	Amount of Defect (Kg)	Incorrect Size (Kg)	Partly Tear (Kg)	Stick-on Yarn Leavings (Kg)	Untidy Product (Kg)
Jun 345	(C20/1: White) 4" x 16"	2.4	1.7	0.44	0.14	0.12
Jun 346	1.5" x 17"	0.9	0.42	0.22	0.18	0.08
Total		3.3	2.12	0.66	0.32	0.20

Table C-4: Bill of Material of Sample Order

List	Order Number	Detail & Item	Amount of Estimated Use (Kg)
1	Jun 345: 4" x 16"	C 20/1: White	53.63
		C 20/1: Unbleached	2.30
2	Jun 346: 1.5" x 17"	C 20/1: White	13.10
		C 20/1: Unbleached	0.55

Table C-5: Data Collection of Defects and Wastes in October 2008

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
1-Oct-08	8.45	3.20	0.85	0.08	3.35	0.82
2-Oct-08	7.94	0.00	1.20	0.15	4.20	0.34
3-Oct-08	7.15	2.56	0.05	0.40	2.58	0.46
4-Oct-08	7.24	2.41	0.00	0.59	3.64	0.25
6-Oct-08	8.67	3.80	0.00	0.44	2.75	0.87
7-Oct-08	6.71	0.00	1.80	0.00	1.36	0.14
8-Oct-08	7.29	0.00	0.45	0.00	3.76	0.36
9-Oct-08	8.05	2.73	2.35	0.42	2.19	0.41
10-Oct-08	10.58	7.45	0.05	0.38	3.50	0.44
11-Oct-08	15.47	8.59	1.29	0.84	4.81	0.50
13-Oct-08	8.25	4.64	2.15	0.00	1.94	0.72
14-Oct-08	7.61	0.00	0.04	1.21	5.29	0.29
15-Oct-08	9.39	5.48	0.09	0.00	1.78	0.33
16-Oct-08	6.14	4.89	0.00	2.57	2.04	0.61
17-Oct-08	4.45	0.00	0.00	1.84	2.19	0.18
18-Oct-08	8.09	5.76	1.90	0.04	1.54	0.22
20-Oct-08	6.60	0.00	0.00	0.00	3.33	0.90
21-Oct-08	12.95	9.12	0.00	0.28	0.86	0.78
22-Oct-08	8.81	0.00	0.00	0.00	1.23	0.45
23-Oct-08	9.27	2.98	0.00	0.84	2.88	1.14
24-Oct-08	11.84	2.33	0.00	0.00	1.91	0.95
25-Oct-08	8.83	0.00	0.42	0.00	1.05	2.38
27-Oct-08	9.12	3.67	0.10	0.44	2.70	0.54
28-Oct-08	10.57	0.00	0.44	0.50	1.17	1.04
29-Oct-08	12.79	11.09	0.08	0.00	1.20	1.95
30-Oct-08	7.23	3.54	0.12	0.00	3.61	0.64
31-Oct-08	7.30	0.00	0.30	0.05	0.96	1.79
Total	236.79	84.24	13.68	11.07	67.82	19.5

Table C-6: Data Collection of Defects and Wastes in November 2008

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
1-Nov-08	6.58	3.21	1.20	1.45	1.78	0.91
3-Nov-08	7.82	4.28	0.42	0.84	2.48	1.04
4-Nov-08	5.49	5.50	0.08	0.25	2.09	0.42
5-Nov-08	5.87	2.68	0.00	0.42	3.57	0.36
6-Nov-08	6.32	0.00	0.00	0.00	2.15	1.48
7-Nov-08	6.71	0.00	0.36	0.00	3.38	0.48
8-Nov-08	5.39	2.54	1.84	2.56	1.29	2.31
10-Nov-08	7.54	3.81	0.44	0.00	0.96	0.63
11-Nov-08	5.25	0.00	0.00	0.00	0.55	0.29
12-Nov-08	10.24	0.00	0.00	0.04	1.12	0.55
13-Nov-08	8.86	0.00	1.49	0.00	2.07	0.77
14-Nov-08	12.80	1.89	0.67	0.00	0.48	1.81
15-Nov-08	6.53	2.69	0.00	0.00	1.65	0.45
17-Nov-08	7.20	3.47	0.50	0.00	1.34	3.14
18-Nov-08	4.82	0.00	0.08	0.36	2.59	0.50
19-Nov-08	6.34	3.79	0.00	1.04	0.24	1.22
20-Nov-08	5.26	5.25	0.04	0.08	1.98	0.18
21-Nov-08	3.87	8.73	0.00	0.00	2.24	0.90
22-Nov-08	10.84	0.00	0.06	0.00	0.88	1.11
24-Nov-08	8.41	1.38	0.24	0.06	4.59	0.96
25-Nov-08	5.94	2.05	0.00	0.48	2.35	0.25
26-Nov-08	6.50	2.40	0.00	0.05	1.68	0.74
27-Nov-08	4.65	0.00	0.00	0.00	2.71	0.30
28-Nov-08	7.81	1.22	0.62	0.09	0.44	1.09
29-Nov-08	4.19	0.00	0.00	0.57	1.53	0.24
Total	171.23	54.89	8.04	8.29	46.14	22.13

Table C-7: Data Collection of Defects and Wastes in December 2008

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
1-Dec-08	5.39	2.45	0.00	0.25	1.55	0.51
2-Dec-08	4.12	0.00	0.00	0.55	0.96	0.36
3-Dec-08	4.50	3.65	0.45	0.00	3.79	0.24
4-Dec-08	3.24	1.24	0.00	0.00	2.35	0.85
6-Dec-08	2.67	0.00	0.08	0.08	0.44	0.19
8-Dec-08	3.48	0.00	0.24	0.00	1.26	0.40
9-Dec-08	4.82	0.00	0.36	0.06	0.55	0.33
10-Dec-08	7.64	1.85	0.00	0.42	3.18	1.26
11-Dec-08	3.35	3.58	0.00	0.00	1.09	0.72
12-Dec-08	2.90	0.00	0.00	0.09	0.42	0.44
13-Dec-08	1.50	0.00	1.24	0.00	2.75	0.59
15-Dec-08	2.34	3.87	0.00	0.00	0.80	1.21
16-Dec-08	3.72	5.32	0.88	0.00	1.41	0.68
17-Dec-08	8.94	0.00	0.00	0.12	0.89	0.87
18-Dec-08	5.67	2.86	0.49	0.08	0.63	0.34
19-Dec-08	4.31	3.67	0.00	0.00	2.52	0.21
20-Dec-08	6.43	0.00	0.55	0.24	1.38	0.49
22-Dec-08	2.54	6.89	0.00	1.45	0.72	0.22
23-Dec-08	3.21	0.00	0.00	0.00	0.48	0.38
24-Dec-08	7.55	3.22	0.00	0.50	3.71	0.12
25-Dec-08	9.28	0.00	0.09	0.28	0.51	0.50
26-Dec-08	3.64	1.33	0.04	0.05	1.44	0.24
27-Dec-08	6.41	0.00	0.00	0.00	1.78	0.72
29-Dec-08	1.30	0.00	0.69	0.29	0.67	0.40
30-Dec-08	4.90	0.63	0.13	0.00	0.95	0.69
Total	113.85	40.56	5.24	4.46	36.23	12.96

Table C-8: Data Collection of Defects and Wastes in January 2009

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
5-Jan-09	8.54	3.58	0.00	0.25	2.43	0.45
6-Jan-09	6.32	0.00	2.48	0.00	1.54	0.24
7-Jan-09	7.12	0.00	0.00	0.42	0.96	0.96
8-Jan-09	7.56	4.56	0.00	0.00	1.48	1.08
9-Jan-09	4.28	2.47	1.24	0.36	1.07	0.42
10-Jan-09	5.97	0.00	0.00	0.24	2.54	0.50
12-Jan-09	5.73	0.00	0.42	0.45	1.95	0.61
13-Jan-09	10.41	1.85	0.00	0.30	2.88	0.34
14-Jan-09	8.64	5.94	0.28	0.00	2.09	0.85
15-Jan-09	5.39	3.96	0.64	0.00	1.93	0.72
16-Jan-09	7.81	0.00	0.00	0.85	2.72	0.26
17-Jan-09	4.19	3.12	0.00	0.74	1.52	0.42
19-Jan-09	7.25	4.23	0.36	0.00	3.49	0.58
20-Jan-09	9.84	0.00	0.48	0.84	2.50	0.40
21-Jan-09	3.67	8.25	0.00	0.40	5.87	0.74
22-Jan-09	5.89	2.24	0.09	0.55	2.91	0.88
23-Jan-09	9.97	0.00	0.00	0.08	3.58	0.19
24-Jan-09	5.48	0.00	0.04	0.00	3.93	0.50
27-Jan-09	12.95	5.18	0.12	0.00	2.84	0.33
28-Jan-09	8.46	4.95	0.00	0.07	4.22	0.11
29-Jan-09	10.57	0.00	0.00	0.10	2.16	0.28
30-Jan-09	5.12	7.84	0.41	0.00	3.19	0.66
31-Jan-09	6.47	3.26	0.00	0.22	2.55	0.27
Total	167.63	61.43	6.56	5.87	60.35	11.79

Table C-9: Data Collection of Defects and Wastes in February 2009

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
2-Feb-09	5.58	0.00	0.16	0.08	1.15	0.47
3-Feb-09	3.56	0.00	0.09	0.00	0.49	0.96
4-Feb-09	4.84	1.85	0.00	0.15	0.37	0.53
5-Feb-09	7.45	2.42	0.00	0.30	0.82	0.78
6-Feb-09	3.98	0.00	0.24	0.00	2.41	0.26
7-Feb-09	4.20	3.12	0.00	0.24	0.74	0.55
9-Feb-09	5.24	1.45	0.38	0.00	0.24	0.39
10-Feb-09	8.52	0.00	0.21	0.00	1.72	1.05
11-Feb-09	3.51	0.00	0.11	0.38	0.28	0.09
12-Feb-09	5.95	4.49	0.00	0.12	0.59	0.12
13-Feb-09	2.88	3.35	0.00	0.36	2.60	0.57
14-Feb-09	7.25	0.00	0.42	0.00	0.55	0.33
16-Feb-09	4.29	0.00	0.12	0.00	0.33	0.44
17-Feb-09	4.41	0.00	0.00	0.33	1.60	0.18
18-Feb-09	5.37	5.55	0.00	0.28	2.49	1.07
19-Feb-09	3.38	2.48	1.18	0.00	0.39	0.62
20-Feb-09	12.92	0.00	0.06	0.00	0.44	0.35
21-Feb-09	8.23	0.00	0.00	0.14	1.88	0.71
23-Feb-09	2.19	5.87	0.00	0.09	0.76	0.24
24-Feb-09	3.55	8.39	0.07	0.00	0.26	0.32
25-Feb-09	5.20	0.00	0.65	0.00	1.02	0.29
26-Feb-09	1.54	1.59	0.00	0.11	2.29	0.45
27-Feb-09	4.99	1.16	0.00	0.00	0.96	1.38
28-Feb-09	2.44	0.00	0.10	0.08	0.80	0.42
Total	121.47	41.72	3.79	2.66	25.18	12.57

Table C-10: Data Collection of Defects and Wastes in March 2009

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
2-Mar-09	6.58	0.00	0.00	0.18	1.58	1.19
3-Mar-09	8.54	3.35	0.00	0.00	2.46	0.96
4-Mar-09	4.91	4.84	0.28	0.00	0.96	0.64
5-Mar-09	5.67	0.00	0.00	0.22	1.16	0.72
6-Mar-09	3.29	0.00	0.63	0.00	0.42	1.00
7-Mar-09	5.55	2.34	0.00	0.00	0.80	1.40
9-Mar-09	7.41	0.00	1.24	0.12	2.05	0.58
10-Mar-09	3.28	5.98	0.00	0.00	0.44	0.96
11-Mar-09	4.15	3.67	0.00	0.42	0.65	1.11
12-Mar-09	5.89	0.00	0.55	0.00	0.33	0.44
13-Mar-09	8.48	0.00	0.96	0.00	0.55	0.18
14-Mar-09	6.59	0.00	0.00	0.08	1.28	0.77
16-Mar-09	3.74	7.50	0.12	0.00	3.90	0.65
17-Mar-09	10.52	3.89	0.00	0.11	0.76	0.56
18-Mar-09	4.63	0.00	0.30	0.00	2.56	0.70
19-Mar-09	7.12	0.00	0.24	0.25	0.45	1.07
20-Mar-09	5.25	5.27	0.00	0.44	3.54	0.88
21-Mar-09	2.90	2.18	0.00	0.00	0.78	0.31
23-Mar-09	3.30	6.39	0.09	0.00	1.85	0.97
24-Mar-09	4.78	0.00	0.18	0.00	2.80	0.48
25-Mar-09	9.65	0.00	0.00	0.84	1.11	0.55
26-Mar-09	4.18	2.54	0.42	0.55	2.54	0.10
27-Mar-09	6.57	4.16	0.00	0.00	0.92	0.67
28-Mar-09	11.92	0.00	0.08	0.00	4.19	0.28
30-Mar-09	8.36	1.85	0.00	0.96	1.21	0.42
31-Mar-09	8.61	0.00	0.33	0.41	0.58	1.30
Total	161.87	53.96	5.42	4.58	39.87	18.89

Table C-11: Data Collection of Defects and Wastes in April 2009

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
1-Apr-09	4.10	0.00	0.24	0.24	0.98	0.38
2-Apr-09	3.54	0.00	0.00	0.15	0.24	0.44
3-Apr-09	3.19	0.00	0.48	0.00	1.19	0.20
4-Apr-09	2.35	1.68	0.30	0.00	2.34	0.55
6-Apr-09	1.88	2.95	0.00	0.10	0.90	0.61
7-Apr-09	5.27	0.00	0.00	0.12	0.36	0.36
8-Apr-09	2.61	0.00	0.18	0.00	1.02	0.20
9-Apr-09	3.95	3.27	0.42	0.08	2.49	0.19
10-Apr-09	3.14	0.00	0.00	0.28	0.42	0.89
11-Apr-09	2.26	2.49	0.00	0.19	0.86	0.46
16-Apr-09	3.37	0.00	0.08	0.00	1.48	0.10
17-Apr-09	4.81	5.19	0.36	0.00	0.55	1.15
18-Apr-09	5.50	2.00	0.00	0.32	0.38	0.40
20-Apr-09	1.38	0.00	0.80	0.00	0.84	0.24
21-Apr-09	2.44	0.00	0.00	0.08	1.00	0.48
22-Apr-09	2.69	1.63	0.42	0.44	0.58	1.01
23-Apr-09	4.31	6.08	0.00	0.00	1.96	0.94
24-Apr-09	4.28	0.00	0.10	0.56	0.72	0.58
25-Apr-09	5.49	4.45	0.25	0.00	0.40	0.22
27-Apr-09	3.72	1.25	0.00	0.36	0.44	0.30
28-Apr-09	6.72	0.00	0.50	0.00	1.24	0.37
29-Apr-09	3.05	2.40	0.18	0.00	0.65	0.42
30-Apr-09	5.73	1.78	0.00	0.29	0.75	0.28
Total	85.78	35.17	4.31	3.21	21.79	10.77

Table C-12: Data Collection of Defects and Wastes in May 2009

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
1-May-09	5.94	0.00	0.00	0.25	2.33	0.28
2-May-09	4.15	0.00	0.21	0.00	1.70	0.50
4-May-09	3.53	3.84	0.14	0.00	1.68	0.44
6-May-09	2.28	4.19	0.00	0.33	2.94	0.33
7-May-09	5.12	0.00	0.00	0.00	1.37	0.20
8-May-09	8.41	1.55	0.38	0.12	0.83	0.40
9-May-09	3.05	0.00	0.42	0.20	1.86	0.38
11-May-09	5.18	2.36	0.00	0.00	3.27	0.24
12-May-09	1.90	5.28	0.00	0.18	2.44	0.15
13-May-09	3.48	3.08	0.11	0.42	1.09	0.52
14-May-09	4.33	0.00	0.08	0.00	0.47	0.36
15-May-09	6.14	0.00	0.29	0.59	1.55	1.97
16-May-09	2.55	1.42	0.00	0.00	0.87	0.18
18-May-09	3.89	2.24	0.00	0.34	1.96	0.48
19-May-09	2.52	0.00	0.64	0.00	3.82	0.63
20-May-09	5.08	1.98	0.30	0.00	1.24	1.06
21-May-09	3.44	0.00	0.00	0.88	2.16	0.32
22-May-09	4.56	3.97	0.00	0.10	1.49	0.55
23-May-09	3.79	0.00	1.05	0.00	2.57	0.41
25-May-09	6.67	5.51	0.20	0.00	1.18	0.25
26-May-09	5.81	0.00	0.00	1.04	1.65	0.20
27-May-09	8.88	0.00	0.44	0.00	1.36	1.18
28-May-09	9.62	5.96	0.75	0.86	0.87	0.44
29-May-09	7.45	6.44	0.00	0.17	0.63	0.24
30-May-09	5.77	0.00	0.07	0.00	0.24	0.96
Total	123.54	47.82	5.08	5.48	41.57	12.67

Table C-13: Data Collection of Defects and Wastes in June 2009

Date	Amount of Defect (Kg)				Amount of Waste (Kg)	
	Incorrect Size	Partly Tear	Stick-on Yarn Leavings	Untidy Product	Over plus	Overweight
1-Jun-09	5.58	0.00	0.19	0.00	1.11	0.37
2-Jun-09	6.49	0.00	0.00	0.23	0.72	0.48
3-Jun-09	3.31	3.34	0.00	0.32	2.54	0.36
4-Jun-09	4.55	5.48	0.22	0.00	1.35	0.99
5-Jun-09	9.22	0.00	0.42	0.00	1.14	0.22
6-Jun-09	4.34	2.12	0.00	0.28	1.77	0.50
8-Jun-09	5.94	0.00	0.15	0.00	1.35	0.28
9-Jun-09	8.17	0.00	0.28	0.45	1.19	0.47
10-Jun-09	4.26	1.98	0.00	0.39	0.44	0.84
11-Jun-09	10.23	3.55	0.00	0.00	2.18	0.52
12-Jun-09	3.99	0.00	0.34	0.19	1.54	0.63
13-Jun-09	5.81	0.00	0.17	0.00	3.79	0.78
15-Jun-09	2.84	2.94	0.00	0.25	1.02	0.39
16-Jun-09	4.45	6.19	0.00	0.37	2.25	0.42
17-Jun-09	1.74	2.05	1.13	0.00	0.48	1.10
18-Jun-09	4.44	4.39	0.86	0.00	0.41	0.55
19-Jun-09	11.87	0.00	0.00	0.14	1.49	0.72
20-Jun-09	5.41	0.00	0.10	0.88	0.76	0.44
22-Jun-09	3.81	3.61	0.00	0.00	1.28	0.25
23-Jun-09	2.50	0.00	0.30	0.00	1.55	0.32
24-Jun-09	4.22	5.09	0.00	1.18	0.89	0.58
25-Jun-09	5.66	0.00	0.05	0.00	2.12	0.19
26-Jun-09	10.46	4.76	0.00	0.44	0.96	0.40
27-Jun-09	4.72	2.52	0.00	0.63	0.39	0.38
29-Jun-09	8.80	0.00	0.00	0.00	1.68	0.24
30-Jun-09	7.16	6.89	0.00	0.00	0.84	0.62
Total	149.97	54.91	4.21	5.75	35.24	13.04

Table C-14: Amount of Production in January 2009 and February 2009

Item		Jan-09		Item	Feb-09	
		(DOZ)	(Kg)		(DOZ)	(Kg)
C 20/1	3 x 16 (L)	390.00	105.30	3 x 16 (UN)	527.00	173.91
	3 x 17 (L)	175.00	50.05	3.5 x 16 (L)	815.00	255.91
	3.5 x 16 (D)	1,439.00	451.85	3.5 x 17 (D)	197.00	68.56
	4 x 15 (UN)	400.00	165.2	4 x 15 (M)	395.00	132.72
	4 x 15 (M)	140.00	47.04	4 x 16 (M)	331.00	118.50
	4 x 16 (W)	1,200.00	429.60	4 x 17 (M)	230.00	87.40
	1.5 x 17 (W)	350.00	50.75	4 x 18 (W)	255.00	102.51
	1.5 x 25 (D)	520.00	109.72	4 x 18 (OW)	140.00	56.28
	1.5 x 30 (D)	844.00	221.13	1.5 x 25 (L)	412.00	86.93
				1.5 x 29 (L)	210.00	49.14
			1.5 x 30 (D)	854.00	223.75	
C 60/2	3 x 15 (L)	280.00	64.96	3 x 15 (L)	180.00	41.76
	3 x 16 (L)	350.00	86.80	3 x 16 (L)	215.00	53.32
	4 x 16 (D)	220.00	72.60	4 x 15 (L)	420.00	129.78
	4 x 16 (L)	335.00	110.55	4 x 16 (L)	120.00	39.60
	4 x 16 (M)	100.00	33.00	4 x 17 (L)	105.00	36.86
	4 x 16 (W)	140.00	46.20	4 x 18 (W)	120.00	44.64
	4 x 18 (L)	225.00	83.70	4 x 18 (L)	128.00	47.62
	1.5 x 25 (L)	475.00	91.68	1.5 x 30 (L)	680.00	162.52
	1.5 x 30 (L)	395.00	94.41			
TC 34/1	3 x 15 (L)	350.00	79.45	3 x 15 (L)	420.00	95.34
	3 x 16 (L)	450.00	108.90	3 x 16 (L)	236.00	57.11
	3.5 x 16 (M)	580.00	163.56	4 x 15 (M)	260.50	78.93
	4 x 15 (UN)	200.00	84.40	4 x 16 (D)	450.00	144.90
	4 x 15 (M)	240.00	72.72	4 x 16 (L)	220.00	70.84
	4 x 16 (W)	820.00	264.04	1.5 x 17 (L)	315.00	40.32
	4 x 16 (D)	150.00	48.30	1.5 x 25 (L)	220.00	41.36
	1.5 x 17 (D)	450.00	57.60	1.5 x 30 (L)	190.00	44.27
	1.5 x 25 (D)	215.00	40.42			
	1.5 x 30 (D)	215.00	50.10			
POLY 75/1	3.5 x 16 (L)	322.00	84.36	4 x 16 (L)	400.00	119.60
	3.5 x 16 (M)	220.00	57.64	4 x 16 (D)	400.00	119.60
	3.5 x 17 (L)	145.00	40.31	4 x 18 (M)	312.00	105.144
	4 x 16 (M)	270.00	80.73	1.5 x 30 (L)	360.00	78.48
	4 x 17 (M)	200.00	59.80	1.75 x 30 (D)	360.00	91.44
	1.5 x 17 (L)	120.00	14.40			
	1.5 x 28 (L)	334.75	72.98			
	1.5 x 30 (M)	238.00	51.88			

Total	13,497.75	3,746.11	Total	10,477.50	2,999.03
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(Note: L = Light Color, M = Middle Color, D = Dark Color, W = White Color, OW = Off-White, and UN = Unbleached Yarn)

Table C-15: Amount of Production in March 2009 and April 2009

	Item	Mar-09		Item	Apr-09	
		(DOZ)	(Kg)		(DOZ)	(Kg)
C 20/1	3.5 x 16 (L)	240.00	75.36	3 x 15 (UN)	120.00	37.20
	3.5 x 17 (D)	230.00	80.04	3.5 x 16 (L)	240.00	75.36
	4 x 15 (UN)	400.00	165.20	3.5 x 17 (L)	135.00	46.98
	4 x 16 (UN)	450.00	198.00	4 x 15 (UN)	385.00	159.01
	4 x 16 (M)	1,205.00	431.39	4 x 16 (UN)	480.00	211.20
	4 x 18 (L)	350.00	140.70	4 x 17 (UN)	460.00	215.28
	1.5 x 25 (L)	560.00	118.16	4 x 18 (W)	208.00	83.62
	1.5 x 30 (D)	520.00	136.24	1.5 x 24 (L)	250.00	52.75
				1.5 x 25 (L)	324.00	68.36
				1.5 x 29 (D)	218.00	51.01
C 60/2	3 x 14 (L)	265.00	57.51	3.5 x 15 (L)	200.00	54.20
	3 x 16 (L)	250.00	62.00	3.5 x 16 (L)	185.00	53.47
	4 x 16 (D)	630.00	207.90	3.5 x 17 (D)	169.00	51.88
	4 x 16 (M)	740.00	244.20	4 x 16 (L)	245.00	80.85
	4 x 18 (L)	185.00	68.82	4 x 17 (L)	148.00	51.95
	1.5 x 25 (L)	450.00	86.85	4 x 18 (W)	124.00	46.13
	1.5 x 30 (L)	350.00	83.65	1.5 x 30 (L)	340.00	81.26
				1.5 x 31 (M)	300.00	71.70
TC 34/1	3 x 15 (W)	235.00	53.35	3 x 16 (UN)	290.00	98.02
	3 x 16 (L)	128.00	30.98	4 x 16 (UN)	380.00	171.00
	3.5 x 16 (M)	240.00	67.68	4 x 16 (L)	250.00	80.50
	3.5 x 17 (L)	280.00	83.72	4 x 17 (UN)	248.00	118.79
	4 x 15 (M)	225.00	68.18	1.5 x 30 (UN)	311.00	101.70
	4 x 16 (L)	368.00	118.50			
	1.5 x 25 (D)	270.00	50.76			
	1.5 x 27 (M)	358.00	73.03			
	1.5 x 30 (D)	311.00	72.46			
POLY 75/1	3.5 x 16 (D)	323.00	84.63	3 x 15 (L)	45.00	9.45
	3.5 x 17 (L)	251.00	69.78	4 x 15 (D)	106.50	29.93
	4 x 16 (M)	385.00	115.12	1.5 x 25 (L)	45.00	7.92

POLY 75/1	4 x 18 (D)	275.00	92.68			
	1.5 x 28 (L)	360.00	73.44			
	1.5 x 30 (M)	315.00	68.67			
Total		11,149.00	3,278.98	Total	6,206.50	2,109.52

(Note: L = Light Color, M = Middle Color, D = Dark Color, W = White Color, OW = Off-White, and UN = Unbleached Yarn)

Table C-16: Amount of Production in May 2009 and June 2009

	Item	May-09		Item	Jun-09	
		(DOZ)	(Kg)		(DOZ)	(Kg)
C 20/1	3 x 15 (UN)	465.00	144.15	3 x 14 (UN)	330.00	95.37
	3.5 x 16 (UN)	580.00	223.30	3 x 16 (L)	150.00	40.50
	3.5 x 17 (D)	244.00	84.91	3 x 16 (D)	168.00	45.36
	4 x 15 (M)	365.00	122.64	3.5 x 15 (M)	127.00	37.47
	4 x 18 (W)	279.00	112.16	3.5 x 16 (M)	280.00	87.92
	4 x 18 (UN)	242.00	119.79	4 x 16 (W)	255.00	91.29
	1.5 x 25 (UN)	445.00	115.26	4 x 18 (W)	214.00	86.03
	1.5 x 29 (UN)	580.00	174.00	4 x 18 (UN)	450.00	222.75
	1.5 x 30 (UN)	242.00	77.68	1.5 x 17 (W)	250.00	36.25
				1.5 x 25 (UN)	780.00	202.02
			1.5 x 31 (D)	300.00	78.60	
C 60/2	3 x 16 (L)	136.00	33.73	3 x 15 (UN)	620.00	183.52
	3 x 16 (D)	284.00	70.43	4 x 16 (M)	230.00	75.90
	3.5 x 16 (D)	177.00	51.15	4 x 16 (W)	200.00	66.00
	3.5 x 16 (L)	196.00	56.64	4 x 16 (L)	180.00	59.40
	4 x 16 (M)	275.00	90.75	1.5 x 25 (UN)	620.00	152.52
	4 x 17 (OW)	235.00	82.49	1.5 x 30 (L)	390.00	93.21
	1.5 x 25 (L)	362.00	69.87			
	1.5 x 30 (L)	422.00	100.86			
TC 34/1	3 x 14 (L)	145.25	30.79	3 x 12 (D)	110.00	20.02
	3 x 16 (L)	191.00	46.22	3 x 16 (L)	210.00	50.82
	3.5 x 16 (M)	175.00	49.35	3.5 x 16 (UN)	360.00	141.84
	3.5 x 17 (L)	194.00	58.01	4 x 15 (UN)	380.00	160.36
	4 x 15 (UN)	530.00	223.66	4 x 16 (D)	245.00	78.89
	4 x 16 (W)	232.00	74.70	1.5 x 17 (D)	110.00	14.08
	1.5 x 25 (UN)	530.00	139.92	1.5 x 25 (L)	210.00	39.48
	1.5 x 30 (UN)	680.00	222.36	1.5 x 30 (L)	245.00	57.09
				1.5 x 32 (UN)	740.00	257.52

POLY 75/1	4 x 16 (M)	358.00	107.04	3.5 x 15 (M)	228.00	55.86
	1.5 x 30 (M)	258.00	56.24	3.5 x 16 (D)	270.00	70.74
	1.5 x 32 (M)	100.00	23.20	3.5 x 17 (L)	172.00	47.82
				4 x 16 (M)	333.50	99.72
				4 x 16 (D)	315.00	94.19
				1.5 x 27 (M)	561.00	106.03
				1.5 x 28 (L)	172.00	35.09
				1.5 x 30 (D)	585.00	127.53
Total	8,922.25	2,761.29	Total	10,790.50	3,111.16	

(**Note:** L = Light Color, M = Middle Color, D = Dark Color, W = White Color, OW = Off-White, and UN = Unbleached Yarn)

BIOGRAPHY

Mr. Paisan Benjasupthavorn has obtained his Bachelor degree in Engineering (Electromechanic Manufacturing Engineering) from Kasetsart University. While he is working for Roong Charoen Knitting, Co., Ltd, he enrolls for Master degree in Engineering Business Management at Regional Center for Manufacturing System Engineering, Chulalongkorn University and University of Warwick.