การลดต้นทุนของกระบวนการผลิต
ในโรงงานผลิตรองเท้าสตรี

นาย ชุติพงศ์ บุณยประสิทธิ์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรมหาบัณฑิต
สาขาวิชาการจัดการทางวิศวกรรม ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต
คณะวิศวกรรมศาสตร์ จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2545

ISBN 974-17-1527-7

MANUFACTURING PROCESS COST REDUCTION IN A LADY SHOE FACTORY

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A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Engineering in Engineering Management
The Regional Centre for Manufacturing Systems Engineering
Faculty of Engineering
Chulalongkorn University
Academic Year 2002

ISBN 974-17-1527-7

Thesis Title	MANUFACTURING PROCESS COST REDUCTION IN A LADY SHOE FACTORY
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Field of Study	Engineering Management
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ชุติพงศ์ บุณยประสิทธิ์ : การลดต้นทุนของกระบวนการผลิตในโรงงานผลิตรองเท้าสตรี (MANUFACTURING PROCESS COST REDUCTION IN A LADY SHOE FACTORY) อ. ที่ปรึกษา : ผศ. สุทัศน์ รัตนเกื้อกังวาน, 219 หน้า, ISBN 974-17-1527-7

การศึกษานี้มีวัตถุประสงค์เพื่อค้นคว้าหาวิธีการลดต้นทุนการผลิตในโรงงานตัวอย่างและสร้างระบบวิธีคิดต้นทุนมาตรฐานขึ้นเพื่อวัดผลของการลดต้นทุนการผลิตแบบกระบวนการโดยเปรียบเทียบต้นทุนการผลิตต่างๆในช่วงก่อน และหลังการปรับปรุง

ปัญหาในตัวอย่างของโรงงานผลิตรองเท้าสตรีถูกแบ่งแยกเป็น สามกลุ่มหลัก คือ ปัญหาการรวบรวมและเก็บข้อมูล ปัญหาการคิดต้นทุนในกระบวนการผลิต และปัญหาการสูญเสียในกระบวนการผลิต ซึ่งปัญหาเหล่านี้แก้ไขได้โดยจัดทำวิธีการรวบรวม และเอกสารที่จำเป็น ในการเก็บข้อมูล เพื่อคิดต้นทุนในกระบวนการผลิต จากข้อมูลเหล่านี้สามารถคำนวณต้นทุนในกระบวนการผลิตในแต่ละแผนกได้ ต้นทุนเหล่านี้ได้แก่ ต้นทุนวัตถุดิบทางตรง ต้นทุนแรงงานทางตรง และค่าโสหุ้ยของโรงงานของผลิตภัณฑ์ทั้งแบบรองเท้าส้นเตี้ย และส้นสูง โดยยึดหลักจากหน่วยเสมือน (Equivalent Unit) ของผลิตภัณฑ์ที่อยู่ในแต่ละแผนก

การวิเคราะห์การสูญเสียในกระบวนการผลิตจะพิจารณาจากสาเหตุของปัญหาที่ทำให้เกิดการสูญเสีย โดยใช้ผังก้างปลา แบ่งแยกปัญหาการสูญเสียในกระบวนการผลิตเป็น สองประเภทคือ ด้านคุณภาพ และด้านปริมาณ โดยสรุปการสูญเสียเกี่ยวกับคนงานสามารถลดได้โดยจัดให้มีการฝึกอบรม และให้ความรู้สำหรับคนงานที่เข้ามาใหม่ จัดทำคำบรรยายเพื่อให้คนงานเข้าใจ และรู้หน้าที่ของตนเองอย่างเป็นระบบ และรางวัลต่างๆ เพื่อให้คนงานตั้งใจทำงาน การสูญเสียเนื่องจากปัญหาวัตถุดิบมาจากปัจจัยภายนอกจึงไม่สามารถควบคุมได้ การสูญเสียเนื่องจากวิธีการผลิต สามารถลดได้โดย จัดทำตารางเวลาในการผลิตต่างๆให้เป็นระบบ และฝึกให้คนงานสามารถทำงานได้หลายตำแหน่งจะได้มีการทดแทนตำแหน่งต่างๆได้ในยามที่จำเป็น ตลอดจนใช้เอกสารต่างๆที่จัดทำขึ้นเพื่อเป็นข้อมูลในการควบคุมการผลิต และการจัดเก็บสินค้าอย่างมีประสิทธิภาพ

ผลการศึกษาในการลดต้นทุนชี้ให้เห็นว่า ต้นทุนในกระบวนการผลิตรวมต่อหน่วยในการผลิตรองเท้าส้นเตี้ย ลดลงจาก 161.43 บาท เป็น 157.09 บาท และต้นทุนในกระบวนการผลิตรวมต่อหน่วยในการผลิตรองเท้าส้นสูง ลดลงจาก 169.45 เป็น 164.35 บาท

ภาควิชา ศูนย์ระดับภูมิภาคทางวิศวกรรมระบบการผลิต ลายมือชื่อนิสิต……..…………………………

สาขาวิชา การจัดการทางวิศวกรรม

ปีการศึกษา 2545 ลายมือชื่ออาจารย์ที่ปรึกษา…….……..……..

4471603621 : MAJOR ENGINEERING MANAGEMENT

KEY WORD: MANUFACTURING PROCESS COSTING / COST REDUCTION / MATERIAL COST / LABOR COST / OVERHEAD COST

CHUTIPONG PUNYAPRASIDDHI : MANUFACTURING PROCESS COST REDUCTION IN A LADY SHOE FACTORY. THESIS ADVISOR : ASSIST. PROF. SUTHAS RATANAKUAKANGWAN, 219 pp. ISBN 974-17-1527-7

The objective of this research is to find the approaches to reduce the manufacturing costs in the lady shoe factory and create the standard costing method to measure the results of manufacturing process cost reduction by comparing the manufacturing costs before and after improvements.

The problems in the lady shoe factory are categorized into three main groups: data collection and documentation, manufacturing process costing, and loss in manufacturing process. To solve these problems, the effective data collection methods and documents that are necessary for the manufacturing cost analysis are created. The manufacturing costs are calculated in term of the direct material costs, direct labor costs, factory overhead costs for each product type (short and long heel shoes) based on the equivalent units in each manufacturing process.

Fish bone diagrams in two main terms: quality and quantity term of problem was used to analyzed losses in manufacturing processes. Losses based on the worker problem are reduced by introducing the training and orientation program, creating job description documents, and setting the motivation systems. Losses based on the material problem cannot be reduced because they are the uncontrollable losses for the sample factory. Losses due to the problem in method are reduced by using multi-skilled labors, creating production time schedule, and using documents to help controlling inventories and productions.

Results of these cost reductions indicate that the total manufacturing costs per unit of producing short heel shoes are reduced from 161.43 Baht to 157.09 Baht and the total manufacturing costs per unit of producing long heel shoes are reduced from 169.45 Baht to 164.35 Baht.

The Regional Centre for Manufacturing Systems Engineering Student's signature.........................

Field of study Engineering Management Advisor's signature.........................

Academic year 2002

Acknowledgements

This thesis would not be accomplished successfully without the encouragement and guidance of Asst. Prof. Suthas Ratanakuakangwan, my Thesis Advisor, who kindly dedicated his time to contribute and suggest me throughout the research.

I am pleased to demonstrate my thankfulness to Prof. Dr. Sirichan Thongprasert and Asso. Prof. Dr. Chuvej Chansa-ngavej for useful criticism and creative suggestion given to this Thesis, while serving as the examination committees.

A very special acknowledgement is presented to Miss Prapirat Sirisrisornchai, the owner of the lady shoe factory who provided the helpful assistance about the information in shoes manufacturing processes and beneficial comments for the problems in her factory.

My acknowledgement would not be completed without recording my gratefulness to my parents for their great love, endurance and continuing encouragement to me.

Chutipong Punyaprasiddhi

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Abbreviation List

BI	Beginning Inventory
Bt	Baht
CAD	Computer Aided Design
DL	Direct Labor
DM	Direct Material
EI	Ending Inventory
FOH	Factory Overhead Cost
IDL	Indirect Labor
IDM	Indirect Material
J.D.	Job Description
M/C	Machine
OJT	On-the Job Training
R/M	Raw Material

CHAPTER 1

INTRODUCTION

1.1 Background of Shoes Industry

The demand for shoes and shoe parts has slackened until now with vast oversupply of shoes. This has intensified price competition whereby producers cannot raise selling prices while production costs have climbed up, leading to a profit drop.

Under high competitive market and economic crisis, many shoes companies tried to reduce and control the manufacturing costs to produce the products with the lowest cost. At the same time, the company had to keep standard and quality of the product superior to the competitors or at least equal to them.

The executives should know the actual manufacturing costs for the processes in the factory to help them to set up the appropriate manufacturing plans and find the problems or losses points in the manufacturing processes to solve and fix them effectively. Calculating the process costing system is a mean to help them know the actual manufacturing costs they need to spend and how to control those costs.

It is also vital that Thai shoes manufacturers develop their products in order to appeal to more foreign markets. Product design in Thai industry has not yet been sufficiently developed. Research and development will be needed to upgrade production technology and reduce costs in Thai shoes factories.

Therefore, the appropriate costing system and cost reduction are necessary to the lady shoes factory to reduce losses and increase efficiencies in manufacturing processes, gain more profits, and can survive from the severely competitiveness in the shoes market.

1.2 Rationale of the Study

To push up these shoes producers for operating their processes effectively, the research of cost system and cost reduction in a shoes manufacturing is essential for the producer that wants to produce the products with lower costs and know the actual costs in each process to make the good decisions for planning in productions.

By the way, if the shoes producers improve their cost system and production processes to reduce manufacturing costs, they can gain more profits to their business. The shoes industry may boom and require intensive labors so many workers are employed. It also helps to solve the unemployment problem.

1.3 Statement of Problems

1. Data collection and documentation problem. There is no effective documentation system for collecting data in the processes.
2. Manufacturing costing problem. The lady shoes factory does not have the manufacturing costing system to calculate the actual manufacturing costs in processes.
3. Losses in the manufacturing process problem. These losses are influenced by the worker (man), material, or method, which are applied in the processes.

1.4 Objectives

The objectives of this research were:

1. To construct a cost system of lady shoes factory.
2. To analyze and solve the problems to reduce the manufacturing costs for lady shoes factory.

1.5 Scope of the Study

This research was aimed to be conducted within the scope below:

1. The sample lady shoes factory.
2. Cost reduction in the lady shoes factory.

1.6 Research Procedure

The methodology used in this research was as the followings:

1. Surveyed related literatures about costing methods and cost reductions.
2. Studied and collected the information of operating conditions in a shoes manufacturing.
3. Studied and analyzed manufacturing processes of the sample factory.
4. Constructed a costing system and process costing.
5. Analyzed manufacturing losses, found causes, and addressed problems in manufacturing processes.
6. Defined the criteria to solve those problems and reduce manufacturing costs.
7. Compared the results and analyzed the manufacturing costs after improvements in the processes.
8. Summarized the study.
9. Prepared thesis report.
10. Final examination.

1.7 Expected Results

There are 4 expected outputs, which are related to each other. They are shown as follows:

1. The study could be a fundamental literature for further study and development of costing system and cost reduction.
2. The study would help to construct an appropriate costing system for the sample factory.
3. This research could be a guideline to support and develop production in the lady shoes factory.
4. The study should provide various ideas to reduce domestic manufacturing costs, applying with the target factory.

1.8 Literature Survey

As published by other investigators, some applications of relative costing system and cost reduction applied in manufacturing factories are shown below.

Supakit Chantaravisutilert (1999)

This thesis reported the structure of mold manufacturing cost using Activity-Based Costing (ABC) analysis method, comparing with conventional job order costing concept and found out to be the most effective method of calculating the actual cost of a mold. The research used manufacturing information from a plastic manufacturing company, which had its own mold manufacturing department.

Duangdee Angsamaporn (1999)

This thesis proposed a cost system to improve the manufacturing cost system by using an Activity-Based Costing system. The program developed in this work is a tool for collecting information regarding activities and developing a model for the allocation of resources to activities and in turn allocating activities to products to enable cost calculations and reporting by bill of material.

Prachit Hawat (1985)

This thesis presented an appropriate cost accounting system, which will be useful for cost control and decision making. This will result in more efficiency in the production of refractory bricks so that they can compete with those other countries. The study of cost accounting system of refractory brick industry consists of interviewing staffs involving in accounting and production functions and observing the procedures of the existing system. The proposed system resumes the appropriate part of the existing system but some procedures are added, especially, the designing of forms to facilitate the collection of data and report preparation.

Pimprapai Wongtada (1984)

This thesis designed cost accounting system is designed with the intention that it can be used either in small or medium-sized factory. Therefore, the data used in the system designing are collected from the study of one small factory and three other medium-sized factories of similar production method. The proposed costing system is organized in such a way that it will minimize the expenses required in its implementation by trying to utilize the existing information system of the small-sized factory with minimum alteration in the present information gathering procedure.

Walairat Jangharoenjittkul (1998)

This thesis studied costing method to construct a cost system to reduce the cost for biscuit & candy manufacturing. The thesis introduces how a sample factory will reduce raw material losses and direct labor cost. The thesis has focused on how to improved production process, packaging method and studying standard time to manage the manpower. To increase the productivity, on-the-job training as well as manual book has been introduced in order to conduct them to work more efficiency.

Thanakom Tisapramotkul (1999)

The objective of this thesis is to show how to accurately calculate the production cost and reduce unnecessary losses in the production process. This can be done by analyzing each production resource and solving problems by using the following elements; work efficiency when compared to hours of missing work, time used for machinery repair, average time used for machinery repair, work efficiency when compared to standard time, weight of raw material loss during the production process.

Tanate Kowitwattanachai (1999)

Because of the lack of proper cost reduction management in designated utility plants. The costs of producing utilization products are relatively high. Therefore, this research claim how to reduce and control the above costs within the minimum boundary.

Prasert Ngamviseschaikul (2000)

This thesis studied improvements in reflective glass production cost system and loss control. The production processes are studied and analyzed to identify production cost by product category and controlled by estimated cost. Furthermore, the process losses from defects and time loss result in higher production cost. The concepts of loss reduction are applied to resolve the problem.

CHAPTER 2

THEORETICAL BACKGROUND

2.1 Managerial Process

Robbins (1997) mentions about the managerial process that the managers create and maintain an internal environment, commonly called the organization, so that others can work efficiently in it. A manager's job consists of planning, organizing, directing, and controlling the resources of the organization. These resources include people, jobs or positions, technology, facilities and equipment, materials and supplies, information, and money. Managers work in a dynamic environment and must anticipate and adapt to challenges.

The job of every manager involves what is known as the functions of management, i.e., planning, organizing, directing, and controlling. These functions are goal-directed, interrelated and interdependent. Planning involves devising a systematic process for attaining the goals of the organization. It prepares the organization for the future. Organizing involves arranging the necessary resources to carry out the plan. It is the process of creating structure, establishing relationships, and allocating resources to accomplish the goals of the organization. Directing involves the guiding, leading, and overseeing of employees to achieve organizational goals. Controlling involves verifying that actual performance matches the plan. If performance results do not match the plan, corrective action is taken.

Planning is the ongoing process of developing the business's mission and objectives and determining how they will be accomplished. Planning includes both the broadest view of the organization, e.g., its mission, and the narrowest, e.g., a tactic for accomplishing a specific goal.

Organizing is establishing the internal organizational structure of the organization. The focus is on division, coordination, and control of tasks and the flow of information within the organization. It is in these functions that managers distribute authority to job holders.

Directing is influencing people's behavior through motivation, communication, group dynamics, leadership and discipline. The purpose of directing is to channel the behavior of all personnel to accomplish the organization's mission and objectives while simultaneously helping them accomplish their own career objectives.

Controlling is a four-step process of establishing performance standards based on the firm's objectives, measuring and reporting actual performance, comparing the two, and taking corrective or preventive action as necessary.

2.2 Cost Management System

Hilton (1991) addresses the cost management system to be a management planning and control system with the following objectives:

- To measure the cost of the resources consumed in performing the organization’s significant activities.
- To identify and eliminate non-value-added costs. These are the costs of activities that can be eliminated with no deterioration of product quality, performance, or perceived value.
- To determine the efficiency and effectiveness of all major activities performed in the enterprise.
- To identify and evaluate new activities that can improve the future performance of the organization.

Notice the emphasis of a cost management system on the organization's activities. This emphasis, sometimes called activity accounting, is crucial to the goal of producing quality goods and services at the lowest possible cost.

2.3 Manufacturing Costs

Manufacturing costs are classified into the following three categories: direct material, direct labor, and manufacturing overhead. Direct labor and overhead are often called conversion costs, since they are the costs of "converting" raw material into finished products. Direct material and direct labor are often referred to as prime costs. Owler and Brown (1980) presents the manufacturing costs shown as followings.

Direct Material – Raw material that is consumed in the manufacturing process, is physically incorporated in the finished product, and can be traced to products conveniently called direct material. The following groups of materials fall within the definition:

1. All materials are specially purchased for a particular job, order or process.
2. All materials acquired and subsequently requisitioned from the stores for particular production orders.
3. Components purchased or produced, and similarly requisitioned from the finished parts store.
4. Material passing from one operation or process to another, for an example produced, converted or part-manufactured material which is intended for further treatment or operations.
5. Primary packing materials, for examples cartons, wrappings, and cardboard boxes

Direct Labor – The cost of salaries and wages for personnel who work directly on the manufactured product is classified as direct-labor cost. The wages paid to skilled and unskilled workers for this purpose can be allocated specifically to the particular cost accounts concerned.

Manufacturing Overhead – All other costs of manufacturing are classified as manufacturing overhead, which includes three types of costs: indirect material, indirect labor, and other manufacturing costs.

Indirect Material – The cost of materials that are required for the production process but do not become an integral part of the finished product are classified as indirect-material costs. An example is the cost of drill bits used in a metal-fabrication shop. The drill bits wear out and are discarded, but they do not become part of the product. Materials that do become an integral part of the finished product but are insignificant in cost are also often classified as indirect material. Materials such as glue or paint may be so inexpensive that it is not worth tracing their costs to specific products as indirect materials.

Indirect Labor – The costs of personnel who do not work directly on the product, but whose services are necessary for the manufacturing process, are classified as indirect labor. Such personnel include production-department supervisors, custodial employees, and security guards.

Other Manufacturing Costs - All other manufacturing costs that are neither material nor labor costs are classified as manufacturing overhead. These costs include depreciation of plant and equipment, property taxes, insurance, and utilities such as electricity, as well as the costs of operating service departments. Service departments are those that do not work directly on manufacturing products but are necessary for the manufacturing process to occur. Examples include equipment-maintenance departments and computer-aided-design (CAD) departments. In some manufacturing firms, departments are referred to as work centers. Other manufacturing overhead costs include overtime premiums and the cost of idle time.

An overtime premium is the extra compensation paid to an employee who works beyond the time normally scheduled.

Idle time is the time that is not spent productively by an employee due to such events as equipment breakdowns or new setups of production runs. Such idle time is an unavoidable feature of most manufacturing processes. The cost of an employee's idle time is classified as overhead so that if may be spread across all production jobs, rather than being associated with a particular production job.

Both overtime premiums and the cost of idle time should be classified as manufacturing overhead, rather than associated with a particular production job, because the particular job on which idle time or overtime may occur tens to be selected at random.

Fixed and Variable Costs

James (1991) demonstrates that one of the most important cost classifications involves the way a cost changes in relation to changes in the activity of the organization. Activity refers to a measure of the organization's output of product or service. In some organizations, the activities that cause costs to be incurred are called cost drivers.

A variable cost changes in total in direct proportion to a change in the level of activity or cost driver. As activity changes, total variable cost increases or decreases proportionately with the activity change, but unit variable cost remains the same.

A fixed cost remains unchanged in total as the level of activity or cost driver varies. As the activity level increases, total fixed cost remains constant but unit fixed cost declines.

2.4 Cost Structures

An organization's cost structure refers to the relative proportion of its variable and fixed costs. As manufacturing firms move toward computer-integrated manufacturing system, their cost structures are shifting toward proportionately greater fixed costs. In such highly automated manufacturing environments, variable costs such as direct labor constitute a much lower proportion of total manufacturing cost than in the past. Fixed costs, such as depreciation of computer and robotic equipment, occupy a much larger proportion of production costs.

2.5 Work-In-Process Costs

The activity associated with material work-in-process is material movement, storage of material, and associated record keeping. Its costs are traced to the material-handling activity. Each product bill of activity would include a material-handling activity based on the part routing.

2.6 Process Costing Systems

Oliver (1999) presents that the process costing systems apply costs to like products that are usually mass produced in continuous fashion through a series of production processes. These processes usually occur in separate departments, although a single department sometimes contains more than one process.

The flow of costs in two process costing situations: one with a single production department and one with two production departments used in sequence.

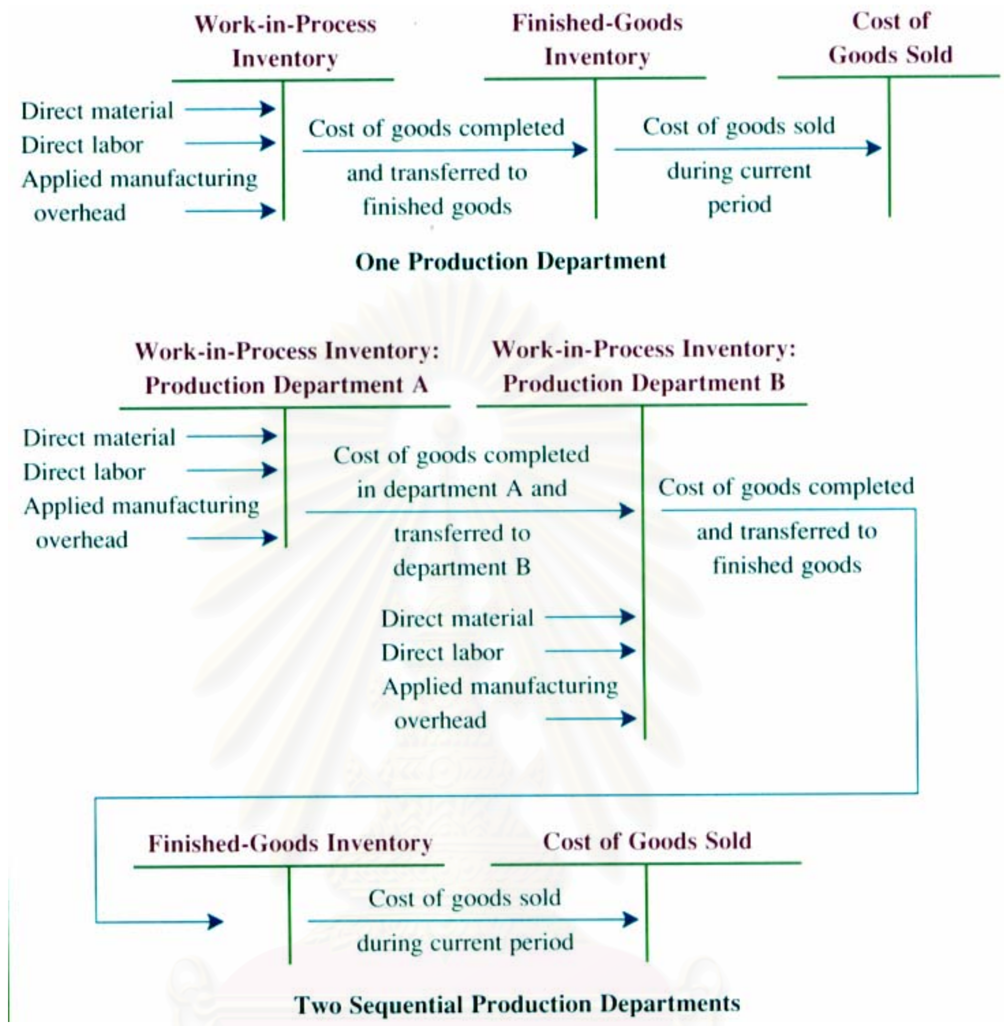


Figure 2-1 Flow of Costs in Process Costing Systems

Direct-material, direct-labor, and manufacturing overhead costs are added to a Work-in-Process Inventory account. As goods are finished, costs are transferred to Finished-Goods Inventory. During the period when goods are sold, the product costs are transferred to Cost of Goods Sold. In the two-department case, when goods are finished in the first production department, costs accumulated in the Work-in-Process Inventory account for production department A are transferred to the Work-in-Process Inventory account for production department B.

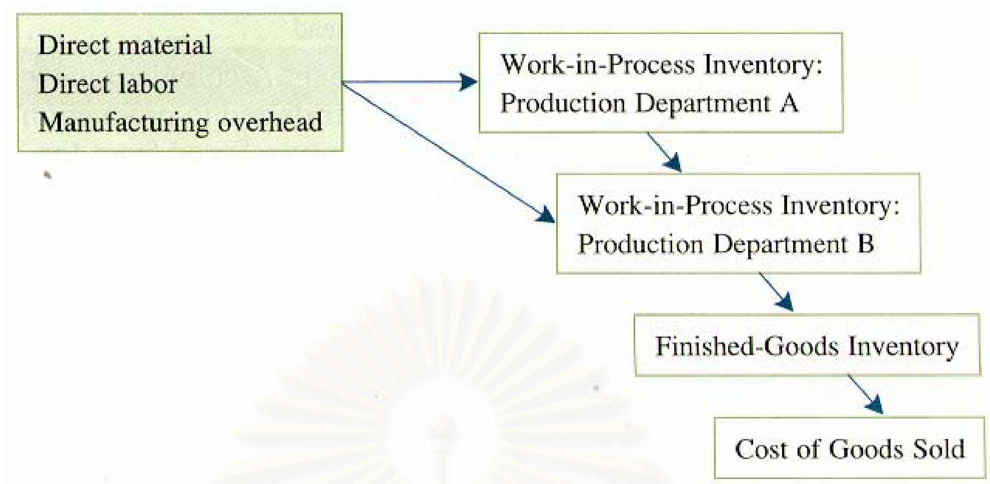


Figure 2-2 Process Costing

In process costing, costs are accumulated by department, rather than by job order or batch. The cost per unit is found by averaging the total costs incurred over the units produced.

Equivalent Units

Material, labor, and overhead costs often are incurred at different rates in a production process. Direct material is usually placed into production at one or more discrete points in the process. In contrast, direct labor and manufacturing overhead, called conversion costs, usually are incurred continuously throughout the process. When an accounting period ends, the partially completed goods that remain in process generally are at different stages of completion with respect to material and conversion activity. The most important feature of process costing is that the costs of direct material and conversion are assigned to equivalent units rather than to physical units.

Illustration of Process Costing

The key document in a typical process-costing system is the departmental production report, prepared for each production department at the end of every accounting period. The department production report summarizes the flow of production quantities through the department, and it shows the amount of production cost transferred out of the department's Work-in-Process Inventory account during the period. The following four steps are used in preparing a departmental production report:

1. Analysis of physical flow of units.
2. Calculation of equivalent units (for direct material and conversion activity).
3. Computation of unit costs (i.e., the cost per equivalent unit for direct material and conversion).
4. Analysis of total costs (determines the cost to be removed from work-in-process and transferred either to the next production department or finished goods).

The process costing approach does not distinguish among individual units of product. Instead, it accumulates costs for a period and divides them by quantities produced during that period to get broad, average unit costs.

2.7 Job Description

Mathis and Jackson (2002) briefly examines that the output from analysis of a job is used to develop a job description. It summarizes job analysis information in a readable format and provides the basis for defensible job-related actions. A job description indicates the tasks, duties, and responsibilities of job. It identifies what is done, why it is done, where it is done, and briefly how it is done.

2.8 Orientation

Dessler (1997) reviews that orientation or training for new employees is the planned introduction of new employees to their jobs, their co-workers, and the organization. Training gives new or present employees the skills they need to perform their jobs. However, orientation should not be a mechanical, one-way process because all employees are different so orientation must incorporate a sensitive awareness of the anxieties, uncertainties, and needs of the new employees. Orientation requires cooperation between individuals in the human resource unit and other managers and supervisors. The overall goal of orientation is to help new employees learn about the organization and their tasks as soon as possible, so that they can begin contributing.

2.9 Implementing Training

The following overview of common training approaches and techniques classifies the appropriate training approaches into several major groups.

1. On-the Job Training (OJT) – The most common type of training at all levels in an organization is on-the-job training. Whether or not the training is planned, people do learn from their job experiences, particularly if these experiences change over time. OJT usually is done by the manager, other employees, or both. A manager or supervisor who trains an employee must be able to teach, and show the employee what to do.

2. Simulation – Simulation is a training approach that uses a training site set up to be identical to the work site. In this setting, trainees can learn under realistic conditions but be away from the pressure of the production schedule.

3. Classroom and Conference Training – Training seminars, courses, and presentations can be used in both skills-related and developmental training. Lectures and discussions are a major part of this training. The numerous management development courses offered by trade associations and educational institutions are examples of conference training.

2.10 Written Communication

Written communications include memos, letters, electronic mail, fax transmissions, notices placed on bulletin boards, or any other device that is transmitted via written words or symbols. The message can be stored for an indefinite period of time. If there are questions concerning the content of the message, it is physically available for later reference. This feature is particularly important for complex and lengthy communications.

2.11 Incentives for Operation Employees

The basic of individual behavior indicates that the people do what they do to satisfy needs. Before, they do anything, they look for the payoff or reward. Therefore, the company should consider rewards as an important force influencing the behavior of employees.

The two main incentive plans for operations employees are piecework plan and standard hour plan

Piecework is the oldest incentive plan and still the most commonly used. It is a system of payment based on the number of items processed by each individual worker in a unit of time, such as items per hour or items per day.

The standard hour plan is a plan by which a worker is paid a basic hourly rate but is paid an extra percentage of his or her base rate for production exceeding the standard per hour or per day.

2.12 Scheduling and Controlling for Repetitive Manufacturing

Dilworth (1993) mentions that the repetitive manufacturing must deal with repetition of a few familiar jobs since it produces a standard product in relatively high volume. It produces the same product or similar products through the same series of steps. Process planning is very important because so many items will be run through the routing that is developed. A considerable effort should be put into process engineering when the factory is designed.

2.13 Production Control for Repetitive Manufacturing

Repetitive, or continuous manufacturing is characterized by long runs of identical or similar discrete items through the same sequence of processing steps. It faces a simpler production scheduling and control problem than a batch manufacturing factory. The routings are fixed so planning each individual job and preparing individual route sheets are not necessary. The processing steps, routing, and work methods are primarily planned when the production system is designed. The waiting time between operations and the work-in-process inventory are both minimal, so there usually are no queue of different kinds of jobs waiting at the work center, priorities do not have to be determined, and dispatching at each work center is not necessary.

Control of this type of factory is simplest when only one product is produced. There are no other uses of the partially completed items so each stage in the line feeds only the next downstream stage. Assume that the market demand exceeds the capacity of the line so that the constraint on production called a bottleneck. The times required at each operation are different so the longest time process limits the output of the system and throughput rate. If the material is fed into the line faster than this throughput rate of the bottleneck, the result will be an accumulation of work-in-process inventory in front of the bottleneck. This action does not increase the output of the line but it does add tot the cost of partially processed inventory and the need for space to keep it. This situation also requires a longer throughput time to get the average item through the line because some of the items are delayed in the queues.

A small amount of inventory may be intentionally maintained in front of the bottleneck in case, for some reason such as machine breakdown or employees absence. A company in this situation probably would try to increase production at the bottleneck perhaps through methods improvements or installing higher-capacity equipment. The company might also explore ways to subcontract part of the bottleneck operation.

If the company decided to produce product type A and B that use the same production resources, another dimension of complexity analysis is introduced. The company must build an inventory of finished A's to supply customers while the company is producing B's. A question arises regarding how much product A should be produced before shifting to production of B and how much B to make before shifting back to A. Setups are now a factor, and setup time may be a problem that has to be considered.

2.14 Fishbone Diagram

A fishbone diagram displays all contributing factors and their relationships to the outcome to identify areas where data should be collected and analyzed. The major areas of potential causes are shown as the main bones, for examples materials, methods, people, and machines.

This tool is called a fishbone diagram because it looks like the skeleton of a fish. The purpose of the fishbone diagram is to get to the main causes for something. A fishbone diagram can help to figure out why a process works well. The fishbone diagram could also help to explain outcomes like grades; it is a way to look at a process. This tool helps to show a cause effect relationship.

Before constructing the Cause-and-Effect Diagram, it is necessary to analyze the causes. The steps are as follows:

1. Re-examine the problem by asking:
    - What is the problem?
    - Who is affected?
    - When does it occur?
    - Where does it occur?

2. Analyze the causes of a problem

3. List the causes should be grouped by relationships or common factors.

4. Illustrate graphically the causes grouped by relationships by using a Cause-Effect Diagram where:

    - The problem under investigation is described in a box at the head of the diagram.

    - A long spine with an arrow pointing towards the head forms the backbone of the "fish." The direction of the arrow indicates that the items that feed into the spine might cause the problem described in the head.

- A few large bones feed into the spine. These large bones represent the main categories of potential causes of the problem. Again, the arrows represent the direction of the action; the items on the larger bones are thought to cause the problem in the head.

- The smaller bones represent deeper causes of the larger bones they are attached to. Each bone is a link in a Cause-and-Effect chain that leads from the deepest causes to the targeted problem.

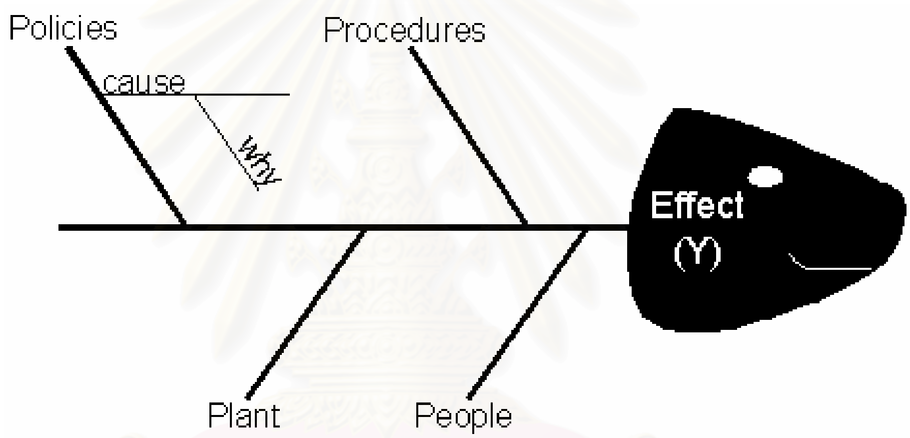


Figure 2-3 Fishbone Diagram

The fishbone has beneficial effects as well. Because people by nature often like to get right to determining what to do about a problem, this can help bring out a more thorough exploration of the issues behind the problem - which will lead to a more robust solution.

2.15 Pareto Diagram

Typically, Pareto analysis is used both to kick off problem solving and to identify root causes of problems. A Pareto diagram puts data in a hierarchical order, which allows the most significant problems to be corrected first. The Pareto analysis technique is used primarily to identify and evaluate nonconformities.

After doing a cause-and-effect analysis, to count the frequency of different causal factors, and to identify problems, Pareto chart should be set up. The steps are shown follows:

1. Gather data on the frequency of the causes and rank the causes from the most to the least important, and calculate the cumulative percentage
2. Draw a horizontal axis (X) that represents the different causes, ordered from the most to least frequent.
3. Draw a vertical axis (Y) with percentages from 0 to 100%.
4. Construct a bar graph based on the percentage of each cause.
5. Construct a bar graph of the cumulative percent.
6. Draw a line from 80% on the Y axis to the line graph, and then drop the line down to the X axis. This line separates the important causes from the trivial ones.

Pareto charts are useful because most problems tend to come from one or two processes or components, rather than from a large number of causes. The hard part is generally collecting the information to be used in the chart. Then categories of information must be set up, along with their incidence. Usually, they are set up in descending order, so that the most common issue or process shows up first. The categories should be specific enough to be actionable.

CHAPTER 3

BACKGROUND AND OPERATIONS OF THE FACTORY

In this chapter, the background and operations of the factory are described and discussed about the background and existing operations before using costing system and cost reduction method to find the problems in manufacturing processes. These are shown sequentially as following.

- History and company background
- Organization
- Products
- Markets and Customers
- Materials
- Production processes
- Machines in production processes
- Factory layout
- Production planning and control
- Inventory
- Losses in process control
- Quality control
- Data Collection and Documentation
- Cost accounting

3.1 History and Company Background

The company was established in 1985 and located at the suburb of Bangkok. During the last ten year, its business got the few profits continually but its starting costs were very high so the company still cannot get profits to cover its starting costs due to operating at low percent of its capacities.

It is a small shoe producer, producing the synthetic leather shoes for lady to export. Its production plan is to produce synthetic leather shoes in the long run to stock by following the conditions that are negotiated with the customers about the features of product such as design, volume, price, and quality.

Nowadays, the company produces approximately 650-750 pairs of shoes a day. Therefore, each month the company produces about 18000 pairs of shoes: 9530 pairs of short heel shoes and 8470 pairs of long heel shoes. The company has a plan to increase its capacity to produce 1000 pairs of shoes a day in the next few years. It operates six days (Monday-Saturday) per week. The normal time period is 8 hours (9.00 a.m.-5.00 p.m.) and the over time period is 4 hours (5.00 p.m.-9.00 p.m.).

The company expects to have no complaint from the customers by controlling the standards of the products and production time.

3.2 Organization

Nowadays, the managing director administers the works in the company through the managers in each department. In production department, the production manager has three supervisors who have worked in shoes manufacturing processes for a long time to help the production manager to suggest and control the workers in each production line.

From the study, in the factory has no clear organization chart and job description of workers for each manufacturing process. Thus, the workers really do not know the tasks that they should be responsible. Actually, the manager and supervisors assign the tasks to the workers only by conversation without any documents so there are many problems and manufacturing losses happened in the manufacturing processes in the factory.

There are about 110 employees in the factory, which consist of 14 indirect labors and 96 direct labors in the manufacturing line.

The organization structure of the company is concluded and shown in the following figure 3-1.

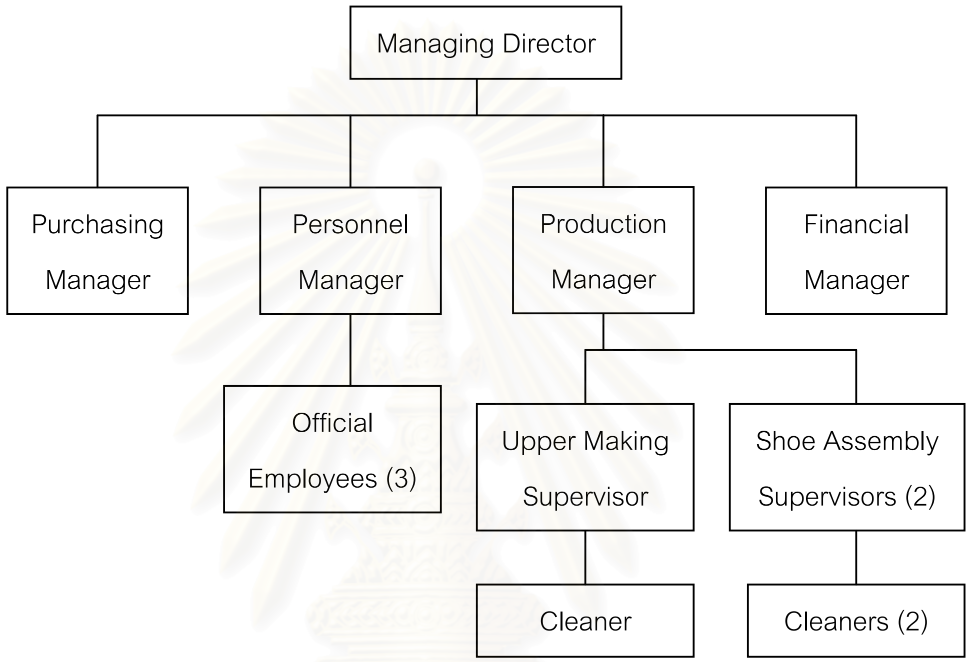


Figure 3-1 The organization structure of the company

Figure 3-1 shows that the corporate strategies and objectives are set by the managing director (MD) and distributed to the major departments in the company to control and follow their jobs to the strategies and methods.

Purchasing department is responsible to contact the suppliers, and purchase the appropriate materials to feed to the production processes.

Personnel department has to manage and control the workers to produce the shoes efficiently. It sets up the regulations for the workers in operating their works.

Production Department plans and controls the production processes to produce shoes in the lowest costs and mistakes, following the quantity and quality of products that are negotiated with the customers. The supervisor in each production process is responsible to control the production process depended on the plans that the manager creates.

Financial department manages budgets to invest, cash flow, expenditures, and revues of the company to show the financial statement in the periods to help MD to decide the strategies and directions of the business effectively.

3.3 Products

The products of the factory are categorized into two main groups: short heel shoes and long heel shoes. The production time of the long heel shoes is longer than the production time of the short heel shoes and the long heel shoes also require the higher skilled-workers to produce them.

Both of product types are produced in the variety of sizes and shapes, depending on the requirements of the customers. The examples of the two main product types are depicted in the Figure 3-2, Figure 3-3, and Figure 3-4.

Figure 3-2 Short Heel Shoe

Figure 3-3 Long Heel Shoe

Figure 3-4 Long Heel Shoe (White Color)

3.4 Markets and Customers

Thai shoe and parts exports have continued to decline. From US$2,170.4 million in 1995, exports were down to US$1,329.8 million in 1996 and to US$1,151.6 million in 1997. For the first 11 months of 1998, earnings in this sector totaled US$833.8 million, a further decline of 20.8 per cent. Earnings in Japanese markets dipped by more than 30 per cent.

America has been the most important overseas market for Thai shoes and parts, receiving almost 40 percent of Thai manufactures in this sector. Another 40 percent have been exported to the European Union, the second most important overseas market for these Thai products.

However, Thai shoes and parts exports were more competitive with exports from Brazil in American markets. Brazil's share declined from the 10.77 percent in 1996 to 9.28 percent in 1997. Shoes and parts exported from Thailand almost automatically became more competitive when the Baht depreciated by nearly 60 percent. From an average exchange rate of Bt25.487 in 1996, the Baht weakened to 40.662 per US dollar in 1997.

Thai producers still need to expand their overseas markets, especially since they stand to lose much in 1999 if China devalues the Yuan. Harnessing their enormous labor market and paying workers relatively little, Chinese producers have considerable advantage in keeping the prices of their manufactures down. The labor market in Thailand has already benefited from rising wages. However, compared with China, these added costs push up the price of Thai products. Thai shoe and parts exports must, therefore, seek new ways to become more competitive in order to avoid losing ground in overseas markets.

For the factory, the shoes are exported to many countries such as USA, England, France, Netherlands, UAE, and Oman. It has many competitors in the shoes market so it causes the severe competition in this market. Most of shoes producers have to reduce the shoe prices to increase their market share for survival.

3.5 Materials

The shoe manufacturing in the factory are divided into two main production processes: upper making and shoe assembly. The materials in both main processes are described below.

The materials in upper making process consist of synthetic leathers (P.U. upper), P.V.C. linings, and pigskin leather linings.

1. Synthetic leathers are used to be the main part of the shoe upper. The surface of the synthetic leathers is an important point to differentiate the good one from the others. If the surface of the synthetic leather is good, the finished shoe probably is beautiful.

2. P.V.C. linings are used to soften the inner side of toe part of the synthetic leathers to be comfortable and healthy when wearing the shoes.

3. Pigskin leather linings are used to soften the inner side of back part of the synthetic leathers to be comfortable and healthy when wearing the shoes.

The materials in shoe assembly process consist of uppers, insoles, outsoles (including heels), and sock linings.

1. Uppers are the wholly components that are used in the upper making process.

Figure 3-5 Examples of Upper Part

2. Insoles are used to be the inner side of the lower part of the shoe. They comprise steels, papers, and facbrics.

- Steels to strengthen and retain the shapes of the insoles.
- Facbrics and paper to soften the inner of the lower part of the shoe.

Figure 3-6 Examples of Insole

3. Outsoles (including heels) are used to be the outer of the lower part of the shoes. They are made from the synthetic rubber that is strong and sticky to strengthen and endure the shoes.

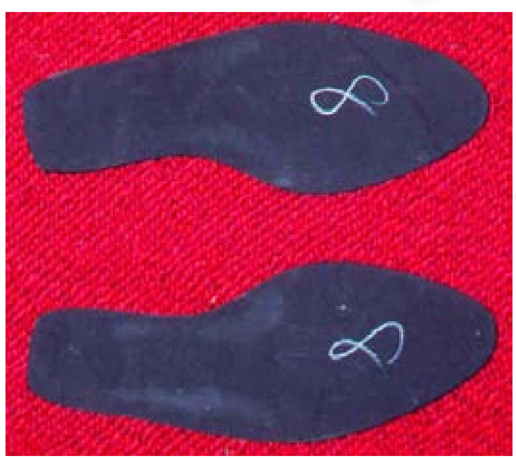


Figure 3-7 Examples of Outsole

Figure 3-8 Examples of Heel

4. Sock linings are used to decorate the inner side of the shoes to be more beautiful.

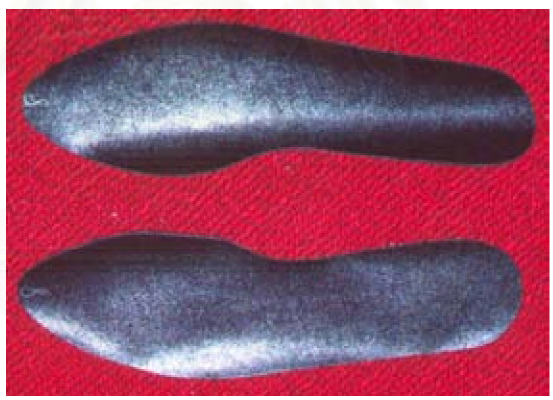


Figure 3-9 Examples of Sock Lining

All of the above materials are used only one item of each kind in the manufacturing processes each finished shoe.

3.6 Production Processes

In general, the shoemaking is divided into main two parts: sole and upper.

1. Sole - A piece of rubber or foam, dried already, is cut out and then trimmed to the required shape and size before finishing.

2. Upper - A piece of material, either fabric, tanned leather, rubber or plastic, is shaped and cut. It is then stitched with other components to form a finished upper and finally fit with the last (a foot-shaped block or form). The examples of the last are shown in Figure 3-10.

Figure 3-10 Examples of Last

After the above two stages, the sole and shoe upper are assembled with adhesive, and further passed through heating process to ensure they stick completely together. The finished shoe is finally cleaned and quality checked before distribution.

In this case, the company actually links the subcontractors to produce and fit the insoles, outsoles, and heels to save its manufacturing cost and time. Therefore, its production line is divided into 2 main processes: upper making and shoe assembly. The lady shoes flow charts of upper making and shoe assembly are shown as follows:

<u>Upper Making</u>

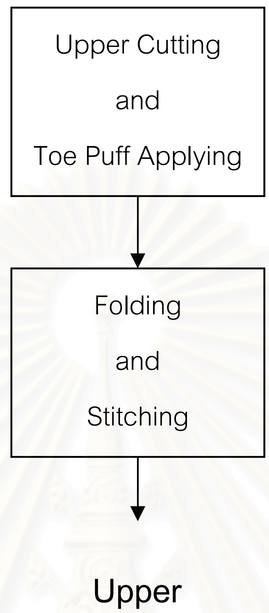


Figure 3-11 Production Flow Chart of Upper Making

Each process of upper making is described in details as following:

1. Upper cutting and toe puff applying

    1.1 Upper cutting – cut the synthetic leather in accordance with a design pattern by using die-cut machines.

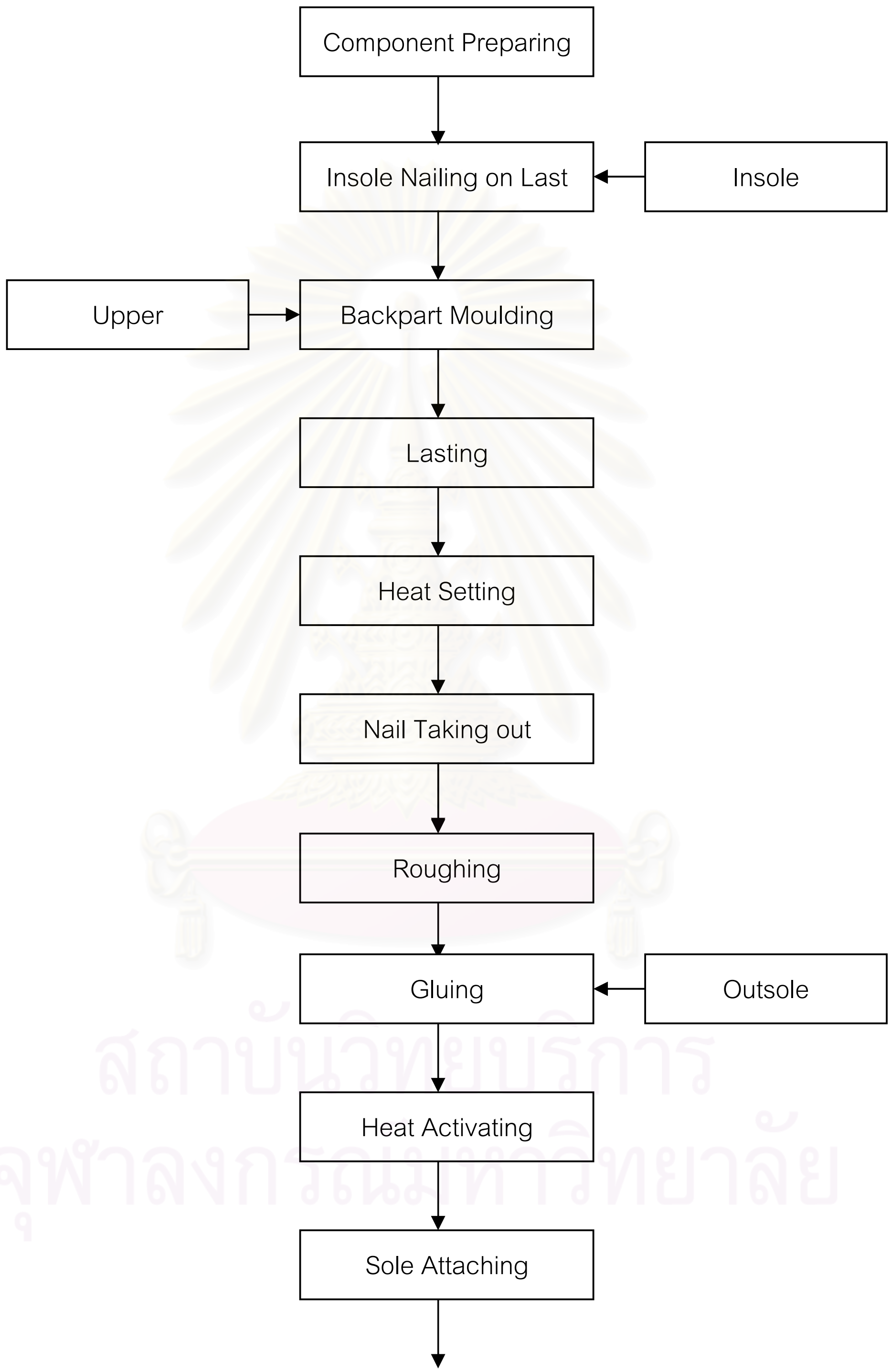
    1.2 Box Toe Applying – strengthen a beam at the front part of a shoe upper.

2. Folding and stitching

    2.1 Folding – fold the synthetic leather at the edges around a shoe upper.

    2.2 Stitching – stitch each part of a shoe upper together.

<u>Shoe Assembly</u>



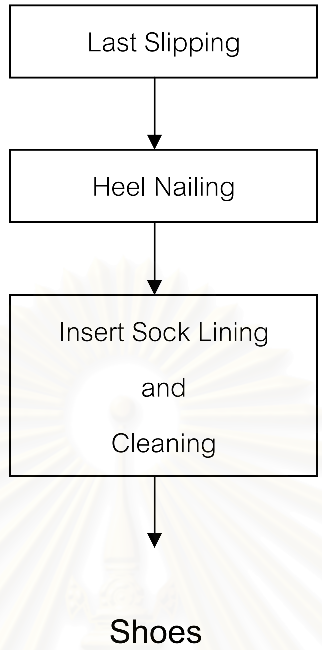


Figure 3-12 Production Flow Chart of Shoe Assembly

Each process of shoe assembly is described in details as following:

1. Component preparing – prepare the components of shoe assembly.
2. Insole nailing on last – nail the insole on a designed last.
3. Back part moulding – mould the back part of a shoe upper by using the machine.
4. Lasting – last the front part of a shoe upper by a machine and keep the edge at the back part by a worker.
5. Heat setting – set the shoe upper and insole through the heat to be effective moulding.
6. Nail taking out – take the nails out from the insole.
7. Roughing – roughen the part of a shoe upper that is under the last for effective gluing.
8. Gluing – glue a shoe (shoe upper and insole) with the outsole.
9. Heat activating – activate the glue by setting the shoe and the outsole through the heat.

10. Sole attaching – attach the shoe and outsole together.

11. Last slipping – slip the last out from the shoe.

12. Heel nailing – nail the heel on the shoe.

13. Inserting sock lining and cleaning

    13.1 Inserting sock lining – insert sock lining for beauty.

    13.2 Cleaning – clean the finished shoe.

3.7 Machines in Production Processes

There are 15 types of machines used in production process. These machines in each production process are shown as following.

In upper cutting and toe puff applying process, there are two types of machines:

1. Travelling head hydraulic cutting machine.
2. Thermoplastic toe puff applying machine.

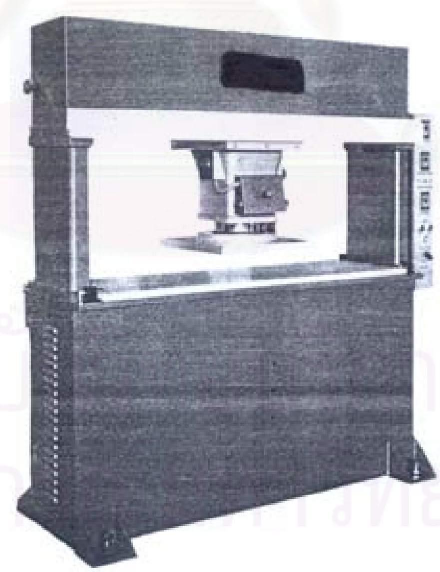


Figure 3-13 Travelling Head Hydraulic Cutting Machine

Figure 3-13 shows the travelling head hydraulic cutting machine used to cut the multiple layer of synthetic leather sheets preparing for making each shoe upper.

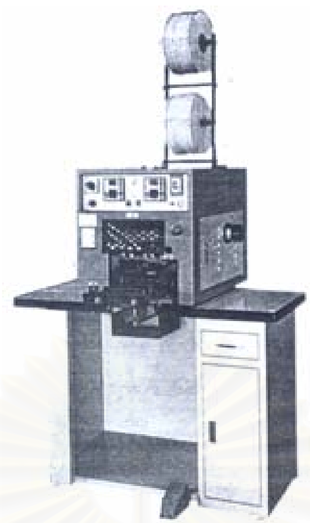


Figure 3-14 Thermoplastic Toe Puff Applying Machine

Figure 3-14 shows the thermoplastic toe puff applying machine used to apply the toe puff with thermoplastic material to reinforce the shoe toe part and make it flexible.

In folding and stitching process, there are two machine types:

1. Edge folding machine.
2. Flat bed single needle sewing machine.

Figure 3-15 Edge Folding Machine

Figure 3-15 illustrates the edge folding machine applied to fold the edges of the synthetic leathers.

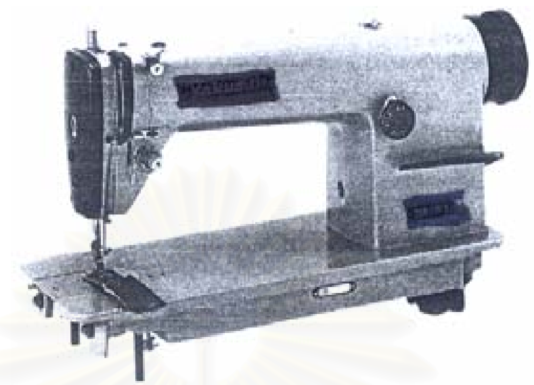


Figure 3-16 Flat Bed Single Needle Sewing Machine

Figure 3-16 demonstrates the flat bed single needle sewing machine used for upper seaming.

In insole nailing on last process, the only one type of machine is the insole stapler.

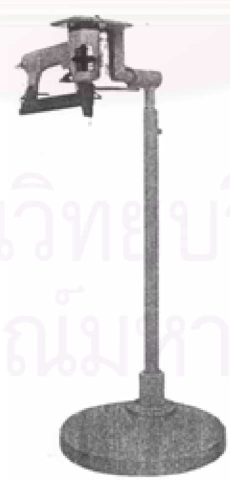


Figure 3-17 Insole Stapler

Figure 3-17 shows the insole stapler used for nailing insole on the bottom of last for better lasting.

In back part moulding process, the only one type of machine is the backpart moulding machine.

Figure 3-18 Backpart Moulding Machine

Figure 3-18 demonstrates the backpart moulding machine used for moulding the backcounter to make it even and shaped before lasting.

In lasting process, there are two machine types:

1. Automatic pulling over toe lasting machine.
2. Hydraulic heel seat lasting machine.

Figure 3-19 Automatic Pulling Over Toe Lasting Machine

Figure 3-19 shows the automatic pulling over toe lasting machine used to last the toe part of the shoe uppers into the insole.

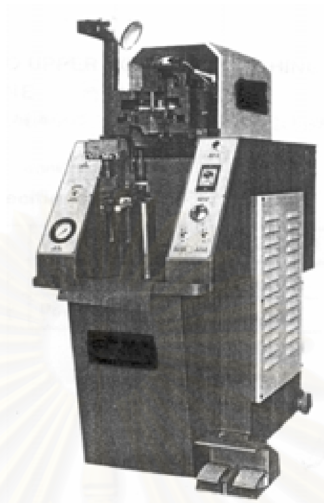


Figure 3-20 Hydraulic Heel Seat Lasting Machine

Figure 3-20 illustrates the hydraulic heel lasting machine used to last the back part of the shoe upper into the insole.

In heat setting process, there is a six tank vacuum vulcanizing machine.

Figure 3-21 Six Tank Vacuum Vulcanizing Machine

Figure 3-21 shows the six tank vacuum vulcanizing machine used to heat the upper of non-vulcanizing shoes for better quality before cementing with the outsole.

In roughing process, there are two machine types:

1. Lasted upper bottom roughing machine.
2. Last upper edge roughing machine.

Figure 3-22 Lasted Upper Bottom Roughing Machine

Figure 3-22 demonstrates the lasted upper bottom roughing machine used for grinding wrinkles after lasting.

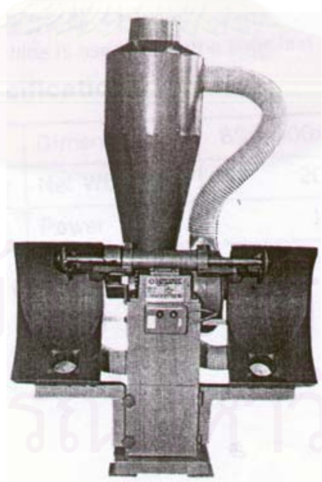


Figure 3-23 Lasted Upper Edge Roughing Machine

Figure 3-23 shows the lasted upper edge roughing machine used to grind the edge part of lasted shoes for better bounding.

In sole attaching process, the only one machine type is the universal sole attaching machine.

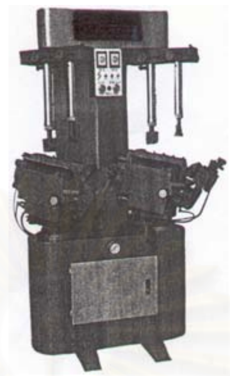


Figure 3-24 Universal Sole Attaching Machine

Figure 3-24 depicts the universal sole attaching machine used to press the lady shoe outsole with lasted uppers. It also can self-adjust the shape of the bottom.

In last slipping process, the only one machine type is hydraulic last slipping machine.

Figure 3-25 Hydraulic Last Slipping Machine

Figure 3-25 shows the hydraulic last slipping machine used to slip the shoe last from the shoes.

In heel nailing process, the only one machine type is the semi-automatic hydraulic heel nailing machine.

Figure 3-26 Semi-Automatic Hydraulic Heel Nailing Machine

Figure 3-26 demonstrates the semi-automatic hydraulic heel nailing machine used to nail the shoe heel for better bounding.

In insert sock lining and cleaning process, the only one machine type is the neoprene glue pasting machine.

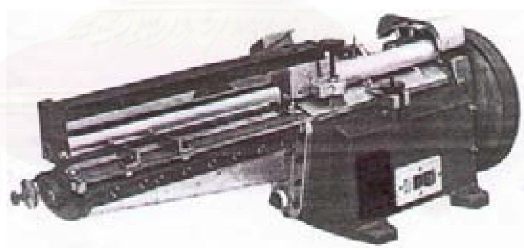


Figure 3-27 Neoprene Glue Pasting Machine

Figure 3-27 shows the neoprene glue machine mainly used for cementing sock linings.

3.8 Factory Layout

The layout of the factory is demonstrated in Figure 3-28.

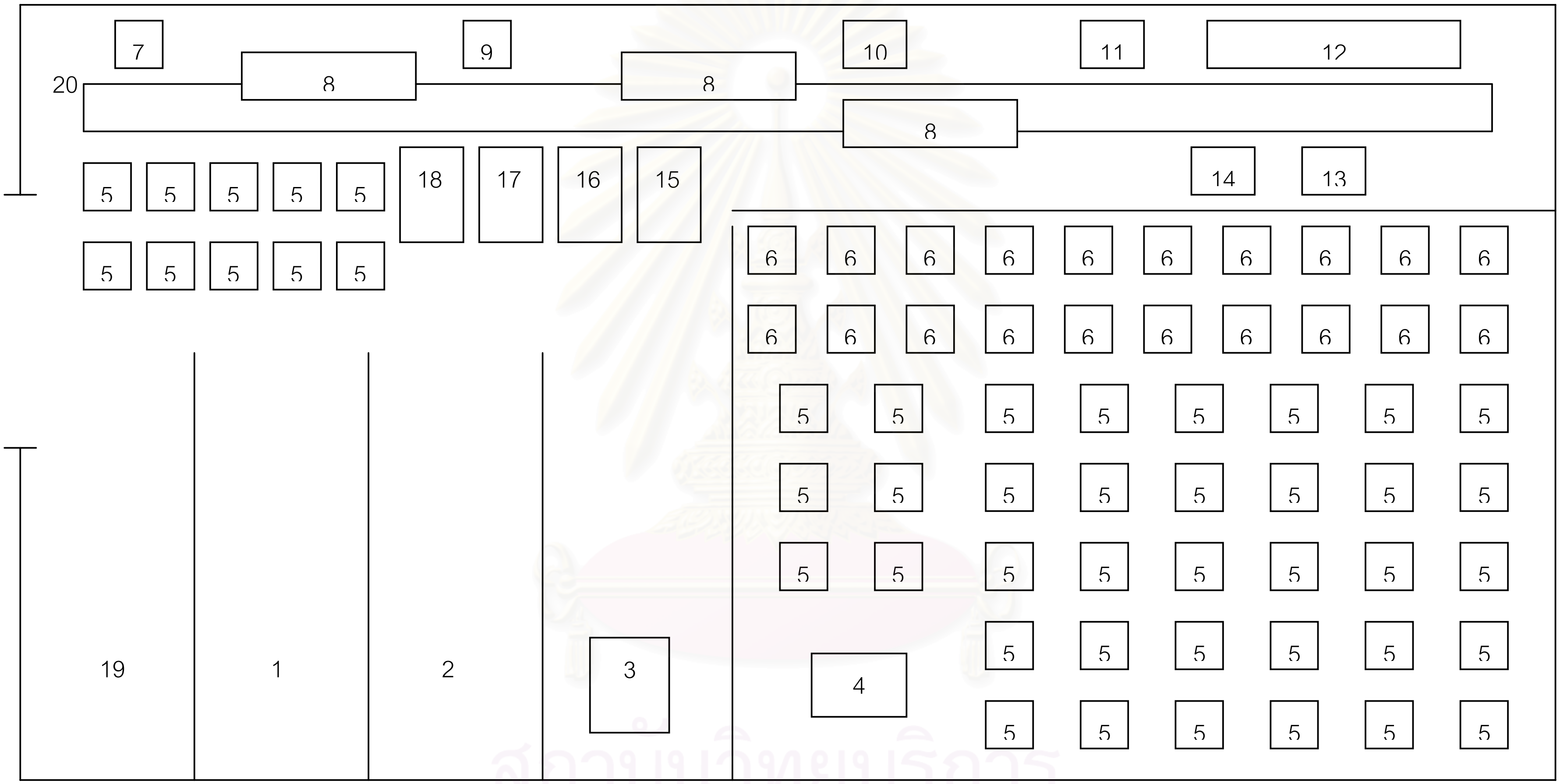


Figure 3-28 Layout of the Sample Factory

From the factory layout in Figure 3-28, the number one to twenty at the points represent the objects in the factory. Each of these numbers is described in the followings.

Number 1 represents the component preparation area.

Number 2 represents the raw material warehouse.

Number 3 represents the cutting area.

Number 4 represents the thermoplastic toe puff applying machine.

Number 5 represents the table.

Number 6 represents the edge folding and flat bed single needle sewing machines.

Number 7 represents the insole stapler.

Number 8 represents the heat oven.

Number 9 represents the backpart moulding machine.

Number 10 represents the automatic pulling over toe lasting machine.

Number 11 represents the hydraulic heel seat lasting machine.

Number 12 represents the six tank vacuum vulcanizing machine.

Number 13 represents the lasted upper bottom roughing machine.

Number 14 represents lasted upper edge roughing machine.

Number 15 represents the universal sole attaching machine.

Number 16 represents the hydraulic last slipping machine.

Number 17 represents the semi-automatic hydraulic heel nailing machine.

Number 18 represents neoprene glue pasting machine.

Number 19 represents the finished shoe storage.

Number 20 represents the belt used for transmitting power.

3.9 Production Planning and Control

The company has no clear production plan. The efficiency of the production plans only depend on the experiences of the production manager who develops and applies the plans with the factory. The production manager just plan roughly what are produced, how many they are produced, and how to manage the workers each day. Therefore, the over time often is fixed at the end of each day that it should use the over time or not and in which process should work in the over time.

From the study, the causes of the ineffective production plan are listed in the followings.

1. The production manager does not realize to the importance of production planning efficiently.
2. There is no personnel who really understand in production plan.
3. It lacks data collection for the information that is necessary in making decision to create the production plan systematically.

Production control in the factory also has no effective method or criteria to cope the problems in its production processes.

From the study, the causes of the ineffective production control are listed in the followings.

1. There is no plan and production schedule so the factory cannot use any criteria to measure and control its operation and do not how to solve the problems happened in the manufacturing processes.
2. There is no information for operating in manufacturing processes such as standard production times, manufacturing costs, volumes of materials used, volumes of materials held in stocks, and appropriate labor times. Thus, there is no standard to control and appraise the yields each day,

3.10 Inventory

Inventory control in the company is managed by the purchasing department. However, materials, which are required in the production processes, are ordered only when the purchasing manager feels that those materials may be insufficient. There is no method to help the manager to know exactly how much the inventory should be hold and when the materials should be ordered.

The company also has no document for material requisitions. Actually, the workers who need to use the materials in production processes can go to pick them without doing any document.

3.11 Loss in Production Process

Losses in production process include the controllable and uncontrollable losses. The main objective is to reduce the controllable losses in production processes at the lowest level to gain productivity and profit. However, the factory never collects and analyzes the causes of losses in production processes. Therefore, it does not know how to control or reduce those losses.

3.12 Quality Control

Quality of product is checked at the end points of upper making process and shoe assembly process by supervisors. At this point, the supervisors record only the amount of incorrect products and then report to the production manager but they do not record why those products are incomplete or how the mistakes occur. Therefore, the production manager cannot know how to reduce the problems and causes that occur in production processes.

3.13 Data Collection and Documentation

In the factory, there is no effective documentation for collecting data in the processes so it is hard to calculate the actual manufacturing costs. The company cannot know the real statements in its factory. Therefore, the company should have a good method to collect information in production processes and make some documents to report the situations to the managers. The important documents that the factory should use to keep data are material bill, labor hour report, overhead bill, maintenance list, production volume report, and work-in-process report.

3.14 Cost Accounting

The factory does not have the manufacturing costing method because the factory does not know the actual costs of products due to ineffective documentation. In particular, the good costing method helps the factory to control the production processes efficiently.

It has only general cost accounting to roughly estimate the production costs per unit only. The example of calculation for shoe manufacturing costs shown below:

Raw materials:

- The cost of a yard of synthetic leather sheet (P.U. upper) is 218 Baht using for 9 pairs of a shoe so the P.U. upper cost is 238 / 9 = 26.44 Baht a pair of a shoe.
- The cost of a yard of lining for front part of shoe (P.V.C. lining) is 97 Baht using for 13 pairs of a shoe so the P.V.C. lining cost is 7.46 Baht a pair of a shoe.
- The cost of 14 feet x 0.4 square-feet lining for back part of shoe (pigskin leather lining) is 5.6 Baht a pair of a shoe.

- The cost of a P.V.C. sock sheet is 87 Baht using for 38 pairs of a shoe so the P.V.C. sock cost is 2.3 Baht per a pair of a shoe.

The total material costs for a pair of a shoe are the sum of P.U. upper, P.V.C. lining, pigskin leather lining, and P.V.C. sock costs: 26.44 + 7.46 + 5.6+ 2.3 = 41.8 Baht plus 4% of total material costs or 1.67 Baht reserved material cost for the errors. Therefore, the total material costs are 37.72 + 1.67 = 43.47 Baht a pair of a shoe.

Subcontractor's products:

- The insole cost is 8.50 Baht per a pair of a shoe.
- The cost of a raw material plate of the outsole is 255 Baht for using 26 pairs of a shoe so the out sole cost is 9.80 Baht per a pair of a shoe.
- The cost of a raw material plate of the heel cost is 140 Baht for using 12 pairs of a shoe so the heel cost is 11.66 Baht per a pair of a shoe.

The total subcontractor's product costs for a pair of a shoe are the sum of insole, outsole, and heel costs: 8.50 + 9.80 + 11.66 = 29.96 Baht plus 3% of total subcontractor's product costs or 0.9 Baht reserved cost for the errors. Therefore, the total subcontractor's product costs are 29.96 + 0.9 = 30.86 Baht a pair of a shoe.

In the factory, there are 96 workers in the production lines and each worker earns 167 Baht per day. The average production volume is about 700 pairs of a shoe. Thus, the total direct labor cost is

(167 x 96) / 700 = 22.9 Baht a pair of a shoe.

The overhead costs are estimated about 20% of materials, subcontractor's product costs, and direct labor costs:

(43.47 + 30.86 + 22.9) x 20% = 19.45 Baht a pair of a shoe.

Therefore, the manufacturing costs per a pair of shoes are the sum of materials, subcontractor's product, labor and overhead cost:

$$43.47 + 30.86 + 22.9 + 19.45 = 116.68 \approx 117 \text{ Baht a pair of a shoe.}$$

From calculations, it shows that the factory estimate only the costs per unit without the standard costing method so the factory cannot know the actual costs.

The factory calculates only the direct material costs per units. It does not calculate the direct labor and factory overhead costs per hour. There is also no calculation of mutual factory overhead allocation to each main production line so the factory does not know the total factory overhead costs in each main production line.

CHAPTER 4

MANUFACTURING COSTING METHOD
FOR THE FACTORY

The company approximately calculates the costs per unit only. It does not have the manufacturing costing method to find current situations and actual costs in production processes. Therefore, in this chapter the manufacturing costing method is set up to make a monthly cost accounting in shoe production processes for the factory.

4.1 Category of Manufacturing Cost

The manufacturing costs in shoe production processes are divided into 3 main groups as follows:

1. Direct Material Cost
2. Direct Labor Cost
3. Factory Overhead Cost

Direct Material Cost

Direct material cost is the cost for materials that are the components of the shoes. These materials are listed below.

1. Synthetic leather
2. Fabric
3. Paper
4. Steel
5. Synthetic rubber

<u>Direct Labor Cost</u>

Direct labor cost is the wage that the company spends for the workers in production line. It includes the wage of workers for both normal time and over time.

<u>Factory Overhead Cost</u>

Factory Overhead Cost is the other expenses in addition to the direct material cost and direct labor cost. It consists of:

1. Indirect material cost
2. Indirect labor cost
3. Security cost
4. Depreciation cost
5. Tax
6. Electric and water supply, and telephone cost
7. Maintenance cost
8. Factory material and other costs

4.2 Data Collection Method

After the factors of manufacturing cost are divided into groups, these factors should be collected to create the effective manufacturing cost accounts. Data collection methods of these factors are described following.

1. Information of direct material cost

    The factory has no requisition system and documents for using materials in stock. Therefore, it is necessary to make a book to record the amount of materials used and then multiply it with the material cost per unit to find the actual direct material costs.

2. Information of direct labor cost

The direct labor costs are collected by recording the worker's time and the wage rate of each worker. Then the company can find the direct labor cost in a period by multiplying the worker's time with the wage rate.

3. Information of factory overhead cost

Data collection methods of factory overhead cost are described in each factor of factory overhead cost below.

3.1 Indirect Material Cost

The indirect materials consist of glue and nails. The used glue is hard to collect so the company should calculate the glue that is used with a shoe by measuring the number of product per glue tube.

3.2 Indirect Labor Cost

This cost comprises the monthly salaries of production manager, and supervisors derived from monthly salary accounts.

3.3 Security cost

This information is collected from the actual wage rate of guards and the real work time in term of hours.

3.4 Depreciation cost

In the factory, the existing account has no calculation of depreciation. Thus, the company should set up this account and calculate the straight-line depreciation to find the depreciation cost per year. Then it should find the average of this cost to divide the depreciation cost per month. This depreciation cost includes:

- Depreciation cost of building.
- Depreciation cost of machines
- Depreciation cost of tools and components

3.5 Tax

This cost is derived from the real tax that the company has to spend every year. The company should also calculate the average of this cost to find this cost per month.

3.6 Electric and water supply, and telephone cost

The information of these factors is derived from the expense accounts about electric and water supply, and telephone cost at the end of every month.

3.7 Maintenance cost

This cost includes the maintenance cost of machines and tools in production processes. The information is collected by recording data from minor expense accounts in the factory about maintenance programs each month.

3.8 Factory material and other costs

These costs consist of tapes, pencil, and boxes derived from recording the lists of factory materials that are used in each day and then collecting these costs to calculate to be the factory material cost of a whole month.

4.3 Documentation

An essential factor that affects to the data collection method is documentation. With good documentation, the required information is collected effectively. The important documents that the factory should use to collect information are material bill, labor hour report, overhead bill, maintenance list, machine hour report, production volume report, and work-in-process report. The forms and examples of these documents are shown as followings.

Material Bill for Upper Making Process

Day/Month/Year	Item	Volume	Receiver	Distributor	Note
1 June 2002	P.U. material	80 yards	Somsak	Wuthichai	
	P.V.C. lining	80 yards			
	Pigskin lining	290 feet^2			

Material Bill for Shoe Assembly Process

Day/Month/Year	Item	Volume	Receiver	Distributor	Note
1 June 2002	Upper	700 pairs	Adisorn	Wuthichai	
	Insole	700 pairs			
	Outsole	700 pairs			
	Heel	700 pairs			

Figure 4-1 Raw Material Bill

Reporter Wuthichai Month June

Item	Total Volume Used	Total Remainder
P.U. material	2085 yards	415 yards
P.V.C. lining	2094 yards	406 yards
Pigskin lining	7544 feet^2	1456 feet^2
Upper	18272 pairs	3528 pairs
Insole	18213 pairs	3587 pairs
Outsole	18083 pairs	3717 pairs
Heel	18083 pairs	3707 pairs

Somchai

(Purchasing Manager)

Figure 4-2 Monthly Material Requisition

Labor Hour List for Upper Making Process

Day/Month/Year	Name	First Period		Second Period		OT Period	
		Start	End	Start	End	Start	End
1 June 2002	Pawinee	8.00	12.00	13.00	17.00	-	-

Labor Hour List for Shoe Assembly Process

Day/Month/Year	Name	First Period		Second Period		OT Period	
		Start	End	Start	End	Start	End
1 June 2002	Pichit	8.00	12.00	13.00	17.00	17.30	21.30

Figure 4-3 Labor Hour List

Reporter Apisit Month June

Name	Total Normal Time (Hour)	Total Over Time (Hour)
Pawinee	200	-
Pichit	200	24

Araya

(Personnel Manager)

Figure 4-4 Monthly Labor Hour Report

Indirect Material Bill for Upper Making Process

Day/Month/Year	Item	Volume	Receiver	Distributor	Note
1 June 2002	Latex String Needle	4 cans 8 tubes 10 needles	Somsak	Wuthichai	

Indirect Material Bill for Shoe Assembly Process

Day/Month/Year	Item	Volume	Receiver	Distributor	Note
1 June 2002	Latex Neoprene Adhesive Primer Staple Nail	25 cans 2 tanks 1 gallon 1 box 2 kilograms	Adisorn	Wuthichai	

Figure 4-5 Indirect Material Bill

Reporter____Wuthichai_____ Month_____June_____

Item	Total Volume Used	Total Remainder
Latex	348 cans	451 cans
String	181 tubes	640 tubes
Needle	195 needles	582 needles
Neoprene Adhesive	46 tanks	253 tanks
Primer	14 gallons	46 gallons
Staple	3 boxes	16 boxes
Nail	37 kilograms	91 kilowgrams

______Somchai______

(Purchasing Manager)

Figure 4-6 Monthly Indirect Material Requisition

Maintenance List

Day/Month/Year	Item	Volume	Note
1 June 2002	Automatic pulling over toe lasting machine	1	In the process of repairing

Figure 4-7 Maintenance List

Reporter Vorawut Month June

Item	Total Volume (Machine)	Total Cost (Baht)
Travelling head hydraulic cutting machine	1	2000
Thermoplastic Toe Puff Applying Machine	1	10000
Flat Bed Single Needle Sewing Machine	4	2400
Insole stapler	1	1000
Automatic pulling over toe lasting machine	1	2000
Total	9	17400

Withaya

(Production Manager)

Figure 4-8 Monthly Maintenance Report

Complete and Defective Upper List for Upper Making Process

(Unit: Pairs)

Day/Month/Year	Item	Complete Product	Defect	Note
1 June 2002	Upper for Short Heel Shoe	722	23	
	Upper for Long Heel Shoe	708	25	

Complete Product and Defect List for Shoe Assembly Process

(Unit: Pairs)

Day/Month/Year	Item	Complete Product	Defect	Note
1 June 2002	Short Heel Shoe	700	25	
	Long Heel Shoe	700	27	

Figure 4-9 Complete Product and Defect List

Reporter Athidej Month June

Item	Total Complete Product (Pairs)	Total Defect (Pairs)
Upper for Short Heel Shoe	9554	372
Upper for Long Heel Shoe	7946	308
Short Heel Shoe	9461	378
Long Heel Shoe	7339	294

Withaya

(Production Manager)

Figure 4-10 Monthly Complete Product and Defect Report

Work-in-Process Report

Reporter Athidej Month June

Process	Short Heel Shoe (pairs)	Long Heel Shoe (pairs)	Note
Upper Making			
1. Upper cutting and box toe applying			
2. Folding and stitching	423	382	
Shoe Assembly			
1. Component Preparing			
2. Insole nailing on last			
3. Back part moulding	375	298	
4. Lasting	154	134	
5. Heat setting			
6. Nail taking out			
7. Roughing			
8. Gluing			
9. Heat activating			
10. Sole attaching			
11. Last slipping			
12. Heel nailing			
13. Insert sock lining and cleaning	226	187	

Withaya

(Production Manager)

Figure 4-11 Monthly Work-in-Process Report

4.4 Shoe Manufacturing Process Costing

Process costing systems record the cost applied to the production of homogeneous goods and to large production runs of similar goods. Some of the entries illustrated in job order costing apply to process costing systems as well. The focus here, however, is on the concept of equivalent unit, which allows computing a unit cost of production input across completed and partially completed batches of output.

Due to the production processes in the factory, these shoe manufacturing costs are calculated in both main production lines: upper making and shoe assembly.

For shoe manufacturing process costing in the factory, calculation is also separated into three categories:

1. Direct Material Costing
2. Direct Labor Costing
3. Factory Over Head Costing

The direct material costs are calculated from the information in the complete and defective product reports, work-in-process reports, and costs per unit of raw materials that are fed into upper making and shoe assembly processes. The main factor for direct material costing is the equivalent unit. The equivalent unit is the amount of a particular input that would be found in a complete unit of output. As a result, if the factory calculates the equivalent unit and direct material cost per unit in each process, it also knows the direct material costs of each process in production lines.

The direct labor costs are calculated from the information in the labor hour reports and wage rates of the workers in manufacturing processes. If the factory records the labor hours of the workers and wage rates, it can calculates the direct labor costs in manufacturing processes.

The factory overhead costs are calculated from the information in indirect material requisitions, salary accounts, maintenance reports, electric and water supply bills, telephone bills, and costs of depreciation, tax, and factory material. The factory overhead costs are divided into two main categories: common and mutual factory overhead costs. The common factory overhead cost is the factory overhead cost that is spent in each manufacturing process separately. The mutual factory overhead cost is the factory overhead cost that is spent for all manufacturing processes in the factory. Actually, the mutual factory overhead cost is allocated into the processes in the factory based on the conversion costs in those processes.

The manufacturing costs that are calculated in term of direct material, direct labor, and factory overhead costs are also allocated into two main product types (short and long heel shoes) based on the equivalent units in manufacturing processes of each product type.

After calculation of manufacturing costs in processes, the manufacturing costs per unit, cost structures, and t-accounts for each product type are computed.

4.4.1 Direct Material Costing

The shoe production processes in the factory operate continually so the factory has work-in-process products in production processes for a period. It indicates that calculation of direct material cost should consider for materials required for both finished products and work-in-process products by calculating equivalent units (E) of work-in-process products. Calculation of equivalent units and direct material costs are demonstrated below.

4.4.1.1 Direct Material Cost in Upper Making Process

The materials in the upper making process comprise:

1. The synthetic leather sheet (P.U. upper)
2. The lining for the toe part of shoe (P.V.C. lining)
3. The lining for the back part of shoe (pigskin leather lining)

In upper making process, there are two sub-processes represented by i processes, i = 1,2. The factory produces two principal product types: short heel and long heel shoe, represented by j types, j = 1,2.

The amount of product type-j is produced in the process-i for a period represented by M_{ij}.

For examples,

M_{11} is the amount of product type-1 that is produced in the process-1.

M_{12} is the amount of product type-2 that is produced in the process-1.

M_{21} is the amount of product type-1 that is produced in the process-2.

M_{22} is the amount of product type-2 that is produced in the process-2.

The accumulative standard production time in the process-i spent to produce product type-j is represented by T_{ij}.

For examples,

T_{11} is the accumulative standard time in the process-1 spent to produce product tyep-1.

T_{12} is the accumulative standard time in the process-1 spent to produce product tyep-2.

T_{21} is the accumulative standard time in the process-2 spent to produce product tyep-1.

T_{22} is the accumulative standard time in the process-2 spent to produce product tyep-2.

Therefore, calculation of equivalent unit for product type-j in upper making (E_{upper}) to find the synthetic leather and linings cost in a period is shown in the following equation.

$$E_{upper-j} = \{ (\sum_{i=1}^{2} M_{ij\ end\ period}\ T_{ij}) + Q_{upper-j}\ T_{upper-j} - (\sum_{i=1}^{2} M_{ij\ starting\ period}\ T_{ij}) \} / T_{upper-j}$$

$M_{ij\ starting\ period}$ is the amount of product type-j in the process-i at the starting period.

$M_{ij\ end\ period}$ is the amount of product type-j in the process-i at the end period.

T_{ij} is the accumulative production time of product type-j in the process-i

$T_{upper-j}$ is the total standard production time in upper making of product type-j in term of second.

$Q_{upper-j}$ is the amount of upper for product type-j in a period.

After calculation of equivalent each product type, the company should calculate the direct material cost for the synthetic leather and linings.

Therefore, calculation of synthetic leather and linings cost to be used in product type-j is demonstrated in the following equations.

P.U. upper cost = $(E_{upper} + L_{upper-j}) \times P_{pu}$

E_{upper} = the equivalent unit of product type-j in upper making line

$L_{upper-j}$ = the amount of total defective uppers for product type-j (unit)

P_{pu} = the price of the synthetic leather per unit (Baht)

P.V.C. lining cost = $(E_{upper} + L_{upper-j}) \times P_{pvc}$

E_{upper} = the equivalent unit of product type-j in upper making line

$L_{upper-j}$ = the amount of total defective uppers for product type-j (unit)

P_{pvc} = the price of the P.V.C lining per unit (Baht)

Pigskin leather lining cost = $(E_{upper} + L_{upper\text{-}j}) \times P_{pigskin}$

E_{upper} = the equivalent unit of product type-j in upper making line

$L_{upper\text{-}j}$ = the amount of total defective uppers for product type-j (unit)

$P_{pigskin}$ = the price of the pigskin leather lining per unit (Baht)

4.4.1.2 Direct Material Cost in Shoe Assembly Process

According to the materials in production process and outsourcing of the factory, there are 3 main direct materials in the shoe assembly line:

1. Upper shoes from the upper making process.
2. Insoles from subcontractors.
3. Outsoles from subcontractors.
4. Sock lining

Both upper and insole are feed to the beginning point of the shoe assembly line so they are calculated the same equivalent unit to find the direct material cost. However, the outsole and sock lining are feed to the end point of the shoe assembly line at the gluing process and insert sock lining process sequentially. They have some different conditions in production processes so it is better to calculate the outsole and sock lining costs separately from upper and insole costs.

<u>Upper and Insole Cost</u>

In shoe assembly process, there are thirteen sub-processes represented by i processes, i = 1,2..,13. The factory produces two principal product types: short heel shoe and long heel shoe, represented by j types, j = 1,2.

Therefore, calculation of equivalent unit for product type-j in shoe assembly line ($E_{assembly}$) to find the synthetic leather and linings cost in a period is shown in the following equation.

$$E_{assembly\text{-}j} = \{ (\sum_{i=1}^{13} M_{ij\ end\ period}\ T_{ij}) + Q_{assembly\text{-}j}\ T_{assembly\text{-}j} - (\sum_{i=1}^{13} M_{ij\ starting\ period}\ T_{ij}) \} / T_{assembly\text{-}j}$$

$M_{ij\ starting\ period}$ is the amount of product type-j in the process-i at the starting period.

$M_{ij\ end\ period}$ is the amount of product type-j in the process-i at the end period.

T_{ij} is the accumulative production time of product type-j in the process-i

$T_{assembly\text{-}j}$ is the total standard production time in shoe assembly line of product type-j in term of second.

$Q_{assembly\text{-}j}$ is the amount of finished product type-j in a period.

After calculation of the equivalent unit of each product type, covering the processes that require upper and insole to be used in the shoe assembly line, the company should calculate the upper and insole cost in this line.

Therefore, calculation of upper and insole cost to be used in product type-j is demonstrated in the following equations.

Upper cost = $(E_{assembly\text{-}j} + L_{assembly\text{-}j}) \times P_{upper}$

$E_{assembly}$ = the equivalent unit in the shoe assembly line

$L_{assembly\text{-}j}$ = the amount of defective product type-j, which occurs only in shoe assembly process of a period.

P_{upper} = the price of the upper per unit (Baht)

Insole cost = $(E_{j\text{-}insole} + L_{assembly\text{-}j}) \times P_{insole}$

$E_{assembly}$ = the equivalent unit in the shoe assembly line

$L_{assembly\text{-}j}$ = the amount of defective product type-j, which occurs only in shoe assembly process of a period.

P_{insole} = the price of the insole per unit (Baht)

<u>Outsole</u>

Outsoles from the subcontractors are used only in some sub-process at the end of the shoe assembly process. Therefore, calculation of equivalent units should consider production in the processes that require outsole only. These processes cover sub-process number 8 to 13 only.

Therefore, calculation of equivalent unit of product type-j to find outsole cost ($E_{outsole-j}$) for a period is shown in the following equation.

$$E_{-outsole-j} = \{ (\sum_{i=8}^{13} M_{ij\ end\ period}\ T_{ij}) + Q_{assembly-j}\ T_{assembly-j} - (\sum_{i=8}^{13} M_{ij\ starting\ period}\ T_{ij}) \} / T_{assembly-j}$$

$E_{-outsole-j}$ is the equivalent unit of work-in-process for product type-j that requires outsole.

$M_{ij\ starting\ period}$ is the amount of product type-j in the process-i at the starting period.

$M_{ij\ end\ period}$ is the amount of product type-j in the process-i at the end period.

$T_{assembly-j}$ is the total standard production time in shoe assembly line of product type-j in term of second.

$Q_{assembly-j}$ is the amount of finished product type-j in a period.

After calculation of the equivalent unit of each product type, covering the processes that require outsole to be used in shoe assembly line, the company should calculate the direct material or outsole cost in this line.

Therefore, calculation of outsole cost to be used in product type-j is demonstrated in the following equation.

Outsole cost = $(E_{-outsole-j} + L_{assembly-j}) \times P_{outsole}$

$E_{-outsole-j}$ = the equivalent unit of work-in-process that requires outsole.

$L_{assembly-j}$ = the amount of defective product type-j, which occurs only in shoe assembly process of a period.

$P_{outsole}$= the price of the outsole per unit (Baht)

Sock Lining

Sock linings are used only in the insert sock lining process at the end of the shoe assembly process. Therefore, calculation of equivalent units should consider production in the last process only.

Therefore, calculation of equivalent unit of product type-j to find sock lining cost (E_{sock-j}) for a period is shown in the following equation.

$$E_{sock-j} = \{ (M_{13j\ end\ period}\ T_{13j}) + Q_{assembly-j}\ T_{assembly-j} - (\Sigma M_{13j\ starting\ period}\ T_{13j}) \} / T_{assembly-j}$$

E_{sock-j} is the equivalent unit of work-in-process that requires sock lining.

$M_{13j\ starting\ period}$ is the amount of product type-j in the last process at the starting period.

$M_{ij\ end\ period}$ is the amount of product type-j in the last process at the end period.

$T_{assembly-j}$ is the total standard production time in shoe assembly line of product type-j in term of second.

$Q_{assembly-j}$ is the amount of finished product type-j in a period.

After calculation of the equivalent unit of each product type, covering the processes that require sock lining to be used in shoe assembly line, the company should calculate the sock lining cost in this production line.

Therefore, calculation of sock lining cost to be used in product type-j is demonstrated in the following equation.

Sock lining cost = $(E_{-sock-j} + L_{assembly-j}) \times P_{sock}$

$E_{-sock-j}$ = the equivalent unit of work-in-process that requires sock lining.

$L_{assembly-j}$ = the amount of defective product type-j, which occurs only in shoe assembly process of a period.

P_{sock}= the price of the sock lining per unit (Baht)

4.4.2 Direct Labor Costing

In production processes, many workers produce the various products so calculation of direct labor cost is based on the production time in each process of each product type and both product types.

4.4.2.1 Direct Labor Cost in Upper Making Process

From calculation of equivalent unit in upper making process,

$E_{upper-j}$ = the equivalent unit in upper making processfor product type-j, j=1,2.

$T_{upper-j}$ = the total standard production time in upper making of product type-j

$C_{labor-upper}$= the total direct labor cost in upper making line

For an example, a product type1

Production volume = E_1

Standard time = T_1

$$\text{Direct labor cost} = (C_{labor-upper} \times E_1 \times T_1) / \{\sum_{J=1}^{2}(E_j \times T_j)\}$$

Therefore, the direct labor cost for producing product type-j

$$= (C_{labor\text{-}upper} \times E_{upper\text{-}j} \times T_{upper\text{-}j}) / \{\sum_{J=1}^{2}(E_{upper\text{-}j} \times T_{upper\text{-}j}) \}$$

4.4.2.2 Direct Labor Cost in Shoe Assembly Process

From calculation of equivalent unit in shoe assembly process,

$E_{assembly\text{-}j}$ = the equivalent unit in shoe assembly processfor product type-j, j=1,2.

$T_{assembly\text{-}j}$ = the total standard production time in shoe assembly of product type-j

$C_{labor\text{-}assembly}$= the total direct labor cost in shoe assembly line

For an example, a product type1

Production volume = E_1

Standard time = T_1

Direct labor cost = $(C_{labor\text{-}assembly} \times E_1 \times T_1) / \{\sum_{J=1}^{2}(E_j \times T_j) \}$

Therefore, the direct labor cost for producing product type-j

$$= (C_{labor\text{-}assembly} \times E_{assembly\text{-}j} \times T_{assembly\text{-}j}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} \times T_{assembly\text{-}j}) \}$$

4.4.3 Factory Overhead Costing

The different types of products have different production time so calculation of factory overhead cost is based on the production time in each process of each product type and both product types.

Calculation of factory overhead cost (FOH) should consider the FOH in upper making line, the FOH in shoe assembly line, and mutual FOH of both production lines.

The mutual factory overhead cost consists of:

1. Indirect labor cost.
2. Security cost
3. Building depreciation cost
4. Land tax
5. Tax
6. Electric supply cost
7. Water supply cost
8. Telephone cost

The mutual FOH should be shared to the FOH of both upper making and shoe assembly line in the appropriate proportion.

4.4.3.1 Factory Overhead Cost in Upper Making Process

The common factory overhead cost in upper making process includes:

1. Indirect material cost for upper making.
2. Indirect labor cost for upper making
3. Depreciation cost of machines and tools in upper making line.
4. Maintenance cost of machines in upper making line
5. Factory material and other costs in upper making line.

The FOH in upper making line also is divided into the FOH of each product type. Calculations of FOH for each product type in upper making are shown below.

From calculation of equivalent unit in upper making process,

$E_{upper\text{-}j}$ = the equivalent unit in upper making processfor product type-j, j =1,2.

$T_{upper\text{-}j}$ = the total standard production time in upper making of product type-j

$C_{FOH\text{-}upper}$= the total direct labor cost in upper making line

For an example, a product type1

Production volume = E_1

Standard time = T_1

FOH cost = $(C_{FOH\text{-}upper} x\ E_1 \times T_1) / \{\sum_{J=1}^{2}(E_j \times T_j)\}$

Therefore, the FOH for producing product type-j

$$= (C_{FOH\text{-}upper} x\ E_{upper\text{-}j} \times T_{upper\text{-}j}) / \{\sum_{J=1}^{2}(E_{upper\text{-}j} \times T_{upper\text{-}j})\}$$

4.4.3.2 Factory Overhead Cost in Shoe Assembly Process

The common factory overhead cost in shoe assembly process includes:

1. Indirect material cost for shoe assembly.
2. Indirect labor cost for shoe assembly
3. Depreciation cost of machines and tools in shoe assembly line.
4. Maintenance cost of machines in shoe assembly line
5. Factory material and other costs in shoe assembly line.

The FOH in shoe assembly line also is divided into the FOH of each product type. Calculations of FOH for each product type in shoe assembly are shown below.

From calculation of equivalent unit in shoe assembly process,

$E_{assembly\text{-}j}$ = the equivalent unit in upper making processfor product type-j, j =1,2.

$T_{assembly\text{-}j}$ = the total standard production time in upper making of product type-j

$C_{FOH\text{-}assembly}$= the total direct labor cost in upper making line

For an example, a product type1

Production volume = E_1

Standard time = T_1

FOH cost = $(C_{FOH\text{-}assembly} \times E_1 \times T_1) / \{\sum_{J=1}^{2}(E_j \times T_j)\}$

Therefore, the FOH cost for producing product type-j

$$= (C_{FOH\text{-}assembly} \times E_{assembly\text{-}j} \times T_{assembly\text{-}j}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} \times T_{assembly\text{-}j})\}$$

From calculation of shoe manufacturing cost for the factory, the essential information is collected to find the actual manufacturing process cost, and cost structure of the factory. The information is depicted below.

4.5 Manufacturing Costing of the Factory in June-August

Calculations of manufacturing costs of the factory are analyzed separately in two main production lines: upper making and shoe assembly.

4.5.1 Manufacturing Costing in Upper Making

Table 4-1 Work-in-Process Volumes in Upper Making Process at the Beginning of June-August

Upper Making Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Upper cutting and box toe applying	0	0
2. Folding and stitching	536	487

Table 4-1 shows work-in-process volumes of each product type in each sub-production process of upper making at the beginning of June-August period.

Table 4-2 Work-in-Process Volumes in Upper Making Process
at the End of June-August

Upper Making Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Upper cutting and box toe applying	0	0
2. Folding and stitching	401	286

Table 4-2 shows work-in-process volumes of each product type in each sub-production process of upper making at the end of June-August period.

Table 4-3 Standard Production Time in Upper Making Process

Upper Making Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Upper cutting and box toe applying	288	326
2. Folding and stitching	1564	1768

Table 4-3 shows the standard production time of producing each product type in each sub-production process of upper making.

Table 4-4 Accumulative Standard Production Time in Upper Making Process

Upper Making Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Upper cutting and box toe applying	288	326
2. Folding and stitching	1852	2004

Table 4-4 shows the accumulative standard production time of producing each product type in each sub-production process of upper making.

The factory has 35 direct labors in upper making process.

Table 4-5 Direct Labor Time and Cost of Upper Making in June-August

Upper Making Process	Normal Time Labor		Over Time Labor		Total	
	Cost	Hour	Cost	Hour	Cost	Hour
1. Upper cutting and box toe applying	50100	2400	0	0	50100	2400
2. Folding and stitching	388275	18600	0	0	388275	18600
Total	438375	21000	0	0	438375	21000

Table 4-5 shows direct labor times and costs of each sub-production process in upper making for normal time and over time labors in June-August.

<u>Indirect Labor Cost in June-August</u>

The upper making supervisor's salary in 3 months	=	24000	Baht
The cleaner's salary in 3 months	=	15000	Baht

Therefore, the total indirect labor cost is

24000 + 15000 = 39000 Baht

Table 4-6 Factory Overhead Costs of Upper Making in June-August

Factory Over Head Costs in June-August	Sum
1. Indirect material cost	67701
2. Indirect labor cost	39000
3. Machines and tools depreciation cost	65750
4. Maintenance cost	39625
5. Factory material and other costs	50166
Total	262242

Therefore, the common factory overhead cost for upper making June-August

= 262242 Baht

Table 4-7 Total Complete and Defective Uppers of Each Product Type in June-August

Product Type	Short Heel Shoe	Long Heel Shoe
Complete Upper	29036	25634
Defective Upper	1018	898

Table 4-7 demonstrates the total complete and Defective uppers of each product type in June-August.

The price of P.U. material per unit = 26.44 Baht

The price of P.V.C. lining per unit = 7.46 Baht

The price of pigskin leather lining per unit = 5.6 Baht

From the above information, the shoe manufacturing process costs of upper making in the factory are demonstrated as following.

4.5.1.1 Direct Material Cost in Upper Making

The equivalent units of each product type in June-August are calculated from:

$$E_{upper\text{-}j} = \{ (\sum_{i=1}^{2} M_{ij\ end\ period}\ T_{ij}) + Q_{upper\text{-}j}\ T_{upper\text{-}j} - (\sum_{i=1}^{2} M_{ij\ starting\ period}\ T_{ij}) \} / T_{upper\text{-}j}$$

Calculation of the equivalent unit for the short heel shoe

$\sum M_{I\text{-}short,\ end\ period}\ T_{i\text{-}short}$ = 401x1852 = 742652

$\sum M_{I\text{-}short,\ starting\ period}\ T_{ij}$ = 536x1852 = 992672

$Q_{upper\text{-}short}\ T_{upper\text{-}short}$ = 29036 x 1852 = 53774672

$E_{upper\text{-}short}$ = (742652+53774672-992672)/1852 = 28901

Calculation of the equivalent unit for the long heel shoe

$\sum M_{I\text{-}long,\ end\ period}\ T_{I\text{-}long}$ = 286x2004 = 573144

$\sum M_{I\text{-}long,\ starting\ period}\ T_{I\text{-}long}$ = 487x2004 = 975948

$Q_{upper\text{-}long}\ T_{upper\text{-}long}$ = 25634 x 2004 = 51370536

$E_{upper\text{-}long}$ = (573144+51370536-975948)/2004= 25433

Table 4-8 Equivalent Unit for Upper Making Process in June-August

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	28901	25433

The direct material costs are calculated from:

Synthetic leather cost = $(E_{upper\text{-}j} + L_{upper\text{-}j}) \times P_{pu}$

For the short heel shoe, the synthetic leather cost is:

(28901+ 1018) x 26.44 = 791058 Baht

For the long heel shoe, the synthetic leather cost is:

(25433+898) x 26.44 = 696192 Baht

P.V.C. lining cost = $(E_{upper\text{-}j} + L_{upper\text{-}j}) \times P_{pvc}$

For the short heel shoe, the P.V.C. lining cost is:

(28901+ 1018) x 7.46 = 223196 Baht

For the long heel shoe, the P.V.C. lining cost is:

(25433+898) x 7.46 = 196429 Baht

Pigskin leather lining cost = $(E_{upper\text{-}j} + L_{upper\text{-}j}) \times P_{pigskin}$

For the short heel shoe, the pigskin leather lining cost is:

(28901x1018) x 5.6 = 167546 Baht

For the long heel shoe, the pigskin leather lining cost is:

(25433+898) x 5.6 = 147454 Baht

4.5.1.2 Direct Labor Cost in Upper Making

The direct labor cost for product type-j is calculated from:

$$(C_{labor} \times E_{upper-j} \times T_{upper-j}) / \{\sum_{J=1}^{2}(E_{upper-j} \times T_{upper-j})\}$$

C_{labor} = total direct labor cost = 438375 Baht

$\sum(E_{upper-j} \times T_{upper-j})$ = $(E_{upper-short} \times T_{upper-short}) + (E_{upper-long} \times T_{upper-long})$

= (28901 x 1852)+ (25433 x 2004)

= 53524652 + 50967732 = 104492384

The direct labor cost for total short heel shoes is

$$(C_{labor} x E_{upper-short} x T_{upper-short})/\{\sum_{J=1}^{2}(E_{upper-j} x T_{upper-j})\} = (438375x28901x1852)/104492384$$

= 224551 Baht

The direct labor cost for total long heel shoes is

$$(C_{labor} \times E_{upper-long} x T_{upper-long})/\{\sum_{j=1}^{2}(E_{upper-j} \times T_{upper-j})\} = (438375x25433x2004)/11184616$$

= 213824 Baht

4.5.1.3 Common Factory Overhead Cost in Upper Making

The factory overhead cost for product type-j is calculated from:

$$(C_{overhead} \times E_{upper-j} \times T_{upper-j}) / \{\sum_{J=1}^{2}(E_{upper-j} \times T_{upper-j})\}$$

$C_{overhead}$ = total common factory overhead cost = 262242 Baht

$\sum(E_{upper-j} \times T_{upper-j})$ = $(E_{upper-short} \times T_{upper-short}) + (E_{upper-long} \times T_{upper-long})$

= (28901 x 1852)+ (25433 x 2004)

= 53524652 + 50967732 = 104492384

The factory overhead cost for short heel shoe is

$$(C_{overhead} x E_{upper-short} x T_{upper-short})/\{\sum_{J=1}^{2}(E_{upper-j} x T_{upperj})\}=(262242x28901x1852)/104492384$$

$$= 134330 \quad \text{Baht}$$

The factory overhead cost for long heel shoe is

$$(C_{overhead}\, x E_{upper-long} x T_{upper-long})/\{\sum_{j=1}^{2}(E_{upper-j} x T_{upper-j})\}=(262242x25433x2004)/104492384$$

$$= 127912 \quad \text{Baht}$$

4.5.2 Manufacturing Costing in Shoe Assembly

Table 4-9 Work-in-Process Volumes in Shoe Assembly Process

at the Beginning of June-August

Shoe Assembly Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Component preparing	0	0
2. Insole nailing on last	0	0
3. Back part moulding	412	351
4. Lasting	244	186
5. Heat setting	0	0
6. Nail taking out	0	0
7. Roughing	0	0
8. Gluing	0	0
9. Heat activating	0	0
10. Sole attaching	0	0
11. Last slipping	0	0
12. Heel nailing	0	0
13. Insert sock lining and cleaning	687	626

Table 4-9 shows work-in-process volumes of each product type in each sub-production process of shoe assembly at the beginning of June-August period.

Table 4-10 Work-in-Process Volumes in Shoe Assembly Process at the End of June-August

Shoe Assembly Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Component preparing	0	0
2. Insole nailing on last	0	0
3. Back part moulding	334	311
4. Lasting	0	0
5. Heat setting	0	0
6. Nail taking out	0	0
7. Roughing	177	154
8. Gluing	0	0
9. Heat activating	0	0
10. Sole attaching	0	0
11. Last slipping	0	0
12. Heel nailing	0	0
13. Insert sock lining and cleaning	438	370

Table 4-10 shows work-in-process volumes of each product type in each sub-production process of shoe assembly at the end of June-August period.

Table 4-11 Standard Production Time in Shoe Assembly Process

Shoe Assembly Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Component preparing	288	326
2. Insole nailing on last	83	94
3. Back part moulding	83	94
4. Lasting	741	838
5. Heat setting	180	180
6. Nail taking out	330	373
7. Roughing	247	280
8. Gluing	371	420
9. Heat activating	60	60
10. Sole attaching	142	466
11. Last slipping	83	94
12. Heel nailing	124	141
13. Insert sock lining and cleaning	576	651

Table 4-11 shows the standard production time of producing each product type in each sub-production process of shoe assembly process.

Table 4-12 Accumulative Standard Production Time in Shoe Assembly Process

Shoe Assembly Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Component preparing	288	326
2. Insole nailing on last	371	420
3. Back part moulding	454	514
4. Lasting	1195	1352
5. Heat setting	1375	1532
6. Nail taking out	1705	1905
7. Roughing	1952	2185
8. Gluing	2323	2605
9. Heat activating	2383	2665
10. Sole attaching	2525	3131
11. Last slipping	2608	3225
12. Heel nailing	2732	3366
13. Insert sock lining and cleaning	3308	4017

Table 4-12 shown the accumulative standard production time of producing each product type in each sub-production process of shoe assembly process.

The factory has 61 direct labors in shoe assembly process. The total direct labor costs and times in each process of these direct labors are demonstrated in Table 4-13.

Table 4-13 Direct Labor Time and Cost of Shoe Assembly in June-August

Shoe Assembly Process	Normal Time Labor		Over Time Labor		Total	
	Cost	Hour	Cost	Hour	Cost	Hour
1. Component preparing	37575	1800	9000	288	46575	2088
2. Insole nailing on last	25050	1200	6000	192	31050	1392
3. Back part moulding	25050	1200	6000	192	31050	1392
4. Lasting	212925	10200	51000	1632	263925	11832
5. Heat setting	-	-	-	-	-	-
6. Nail taking out	75150	3600	18000	576	93150	4176
7. Roughing	75150	3600	18000	576	93150	4176
8. Gluing	75150	3600	18000	576	93150	4176
9. Heat activating	-	-	-	-	-	-
10. Sole attaching	75150	3600	18000	576	93150	4176
11. Last slipping	12525	600	3000	96	15525	696
12. Heel nailing	25050	1200	6000	192	31050	1392
13. Insert sock lining and cleaning	125250	6000	30000	960	155250	161250
Total	764025	36600	183000	5856	947025	42456

Table 4-13 shows direct labor times and costs of each production process in shoe assembly line for normal time and over time labors in June-August. In heat setting and heat activating processes, the products are moved through the machines by belting only. Thus, there is no worker and direct labor cost in these processes.

<u>Indirect Labor Cost in June-August</u>

The shoe assembly supervisor's salary		=	48000	Baht
Two cleaner's salaries	15000 x 2	=	30000	Baht

Therefore, the total indirect labor cost is48000 + 30000 = 78000 Baht

Table 4-14 Factory Overhead Costs in June-August

Factory Over Head Costs in June-August	Sum
1. Indirect material cost	98305
2. Indirect labor cost	78000
3. Machines and tools depreciation cost	193385
4. Maintenance cost	81800
5. Factory material and other costs	100928
Total	552418

From these costs, the total factory overhead cost in June-August

= 552418 Baht

Table 4-15 Total Complete and Defective Shoe of Each Product Type in June-August

Product Type	Short Heel Shoe	Long Heel Shoe
Complete Volume	27425	23965
Defective Volume	1090	956

Table 4-15 demonstrates the total complete and defective shoes of each product type in June-August.

The price of upper per unit = 39.5 Baht

The price of insole per unit = 8.5 Baht

The price of outsole (including heel) per unit = 21.46 Baht

The price of P.V.C. sock per unit = 2.3 Baht

From the above information, the shoe manufacturing process costs of shoe assembly in the factory are demonstrated as following.

4.5.2.1 Direct Material Cost in Shoe Assembly

The equivalent units and direct material costs of each product type in June-August are calculated from:

<u>Upper and Insole</u>

$$E_{assembly\text{-}j} = \{ (\sum_{i=1}^{13} M_{ij\ end\ period}\ T_{ij}) + Q_{assembly\text{-}j}\ T_{assembly\text{-}j} - (\sum_{i=1}^{13} M_{ij\ starting\ period}\ T_{ij}) \} / T_{assembly\text{-}j}$$

Calculation of the equivalent unit for the short heel shoe

$\sum M_{ishort,\ end\ period}\ T_{ishort}$ = (334x454)+(177x1952)+(438x3308)

= 151636+345504+1448904

= 1946044

$\sum M_{ishort\ starting\ period}\ T_{ishort}$ = (412x454)+(244x1195)+(687x3308)

= 188410+291580+2272596

= 2752586

$Q_{assembly\text{-}short}\ T_{assembly\text{-}short}$ = 27425 x 3308 = 90721900

$E_{assembly\text{-}short}$ = (1946044+90721900-2752586)/3308= 27181

Calculation of the equivalent unit for the long heel shoe

$\sum M_{ilong\ end\ period}\ T_{ilong}$ = (311x514)+(154x2185)+(370x4017)

= 159854+336490+1486290

= 1982634

$\Sigma M_{ilong\ starting\ \ period}\ T_{ilong}$ = (351x514)+(186x1352)+(626x4017)

= 180414+251472+2514642

= 2946528

$Q_{assembly\text{-}long}\ T_{assembly\text{-}long}$ = 23965 x 4017 = 96267405

$E_{assembly\text{-}long}$ = (1982634+96267405-2946528)/4017= 23725

Table 4-16 Equivalent Unit of Upper and Insole for Shoe Assembly Process in June-August

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	27181	23725

Upper cost = $(E_{assembly\text{-}j} + L_{assembly\text{-}j}) \times P_{upper}$

For the short heel shoe, the upper cost is:

(27181+ 1090) x 39.5 = 1116705 Baht

For the long heel shoe, the upper cost is:

(23725+ 956) x 39.5 = 974900 Baht

Insole cost = $(E_{assembly\text{-}j} + L_{assembly\text{-}j}) \times P_{insole}$

For the short heel shoe, the insole cost is:

(27181+ 1090) x 8.5 = 240304 Baht

For the long heel shoe, the insole cost is:

(23725+ 956) x 8.5 = 209789 Baht

Outsole

$$E_{outsole\text{-}j} = \{ (\sum_{i=8}^{13} M_{ij\ end\ period}\ T_{ij}) + Q_{assembly\text{-}j}\ T_{assembly\text{-}j} - (\sum_{i=8}^{13} M_{ij\ starting\ period}\ T_{ij}) \} / T_{assembly\text{-}j}$$

Calculation of the equivalent unit for the short heel shoe

$\Sigma M_{ishort,\ end\ period}\ T_{ishort}$ = 438x3308 = 1448904

$\Sigma M_{ishort\ starting\ period}\ T_{ishort}$ = 687x3308 = 2272596

$Q_{assembly\text{-}short}\ T_{assembly\text{-}short}$ = 27425x3308 = 90721900

$E_{outsole\text{-}short}$ = (1448904+90721900-2272596)/3308= 27176

Calculation of the equivalent unit for the long heel shoe

$\Sigma M_{ilong\ end\ period}\ T_{ilong}$ = 370x4017 = 1486290

$\Sigma M_{ilong\ starting\ period}\ T_{ilong}$ = 626x4017 = 2514642

$Q_{assembly\text{-}long}\ T_{assembly\text{-}long}$ = 23965 x 4017 = 96267405

$E_{outsole\text{-}long}$ = (1486290+96267405-2514642)/4017= 23709

Table 4-17 Equivalent Unit of Outsole for Shoe Assembly in June-August

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	27176	23709

Outsole cost = $(E_{outsole\text{-}j} + L_{assembly\text{-}j}) \times P_{uotsole}$

For the short heel shoe, the outsole cost is:

(27176+ 1090) x 21.46 = 606588 Baht

For the long heel shoe, the outsole cost is:

(23709+ 956) x 21.46 = 529311 Baht

<u>Sock Lining</u>

$$E_{sock\text{-}j} = \{ (M_{13j\ end\ period}\ T_{13j}) + Q_{assembly\text{-}j}\ T_{assembly\text{-}j} - (M_{13j\ starting\ period}\ T_{13j}) \} / T_{assembly\text{-}j}$$

Calculation of the equivalent unit for the short heel shoe

$M_{13short\ end\ period}\ T_{13short}$ = 438x3308 = 1448904

$M_{13short\ starting\ period}\ T_{13short}$ = 687x3308 = 2272596

$Q_{assembly\text{-}short}\ T_{assembly\text{-}short}$ = 27425x3308 = 90721900

$E_{sock\text{-}short}$ = (1448904+90721900-2272596)/3308= 27176

Calculation of the equivalent unit for the long heel shoe

$M_{13long\ end\ period}\ T_{13long}$ = 370x4017 = 1486290

$M_{13long\ starting\ period}\ T_{13long}$ = 626x4017 = 2514642

$Q_{assembly\text{-}long}\ T_{assembly\text{-}long}$ = 23965 x 4017 = 96267405

$E_{sock\text{-}long}$ = (1486290+96267405-2514642)/4017= 23709

Table 4-18 Equivalent Unit of Sock Lining for Shoe Assembly in June-August

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	27176	23709

Sock lining cost = $(E_{sock\text{-}j} + L_{assembly\text{-}j}) \times P_{sock}$

For the short heel shoe, the sock lining cost is:

(27176+ 1090) x 2.3 = 65012 Baht

For the long heel shoe, the sock lining cost is:

(23709+ 956) x 2.3 = 56730 Baht

4.5.2.2 Direct Labor Cost in Shoe Assembly

The direct labor cost for product type-j is calculated from:

$$(C_{labor\text{-}assembly} \times E_{assembly\text{-}j} \times T_{assebmly\text{-}j}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} \times T_{assembly\text{-}j})\}$$

$C_{labor\text{-}assembly}$ = total direct labor cost = 947025 Baht

$\{\sum(E_{assembly\text{-}j} \times T_{assembly\text{-}j})$ = $(E_{assembly\text{-}short} \times T_{assebmly\text{-}short}) + (E_{assembly\text{-}long} \times T_{assebmly\text{-}long})$

= (27181x3308) + (23725x4017)

= 89914748 + 95303325 = 185218073

The direct labor cost for total short heel shoes is

$$(C_{labor} \times E_{assembly\text{-}short} \times T_{assembly\text{-}short})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} \times T_{assembly\text{-}j})\}$$

=(947025x27181x3308)/185218073

= 459737 Baht

The direct labor cost for total long heel shoes is

$$(C_{labor} x E_{assembly\text{-}long} x T_{assembly\text{-}long})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j}))\}$$

$= (947025x23725x4017) / 185218073$

$= 487288$ Baht

4.5.2.3 Common Factory Overhead Cost in Shoe Assembly

The factory overhead cost for product type-j is calculated from:

$$(C_{overhead\text{-}assembly} \times E_{assembly\text{-}j} \times T_{assebmly\text{-}j}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} \times T_{assembly\text{-}j})\}$$

$C_{overhead\text{-}assembly}$ = total common factory overhead cost=552418 Baht

$\{\sum(E_{assembly\text{-}j} \times T_{assembly\text{-}j})$ = $(E_{assembly\text{-}short} \times T_{assebmly\text{-}short}) + (E_{assembly\text{-}long} \times T_{assebmly\text{-}long})$

= (27181x3308) + (23725x4017)

= 89914748 + 95303325 = 185218073

The common factory overhead cost for short heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}short} x T_{assembly\text{-}short})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j})\}$$

$= (552418 x27181x3308) / 185218073$

$= 268174$ Baht

The common factory overhead cost for long heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}long} x T_{assembly\text{-}long})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j})\}$$

$= (552418 x23725x4017) / 185218073$

$= 284244$ Baht

4.5.3 Mutual FOH and Conversion Cost

Table 4-19 Mutual Factory Overhead Costs in June-August

Mutual Factory Over Head Costs	Sum
1. Production manager salary	75000
2. Security cost	33000
3. Building depreciation cost	72500
4. Rent	66000
5. Tax	20297
6. Electric supply cost	88503
7. Water supply cost	5592
8. Telephone cost	19704
Total	380596

From these costs, the total mutual FOH in June-August

= 380596 Baht

The conversion costs (direct labor cost and factory overhead cost) of upper making and shoe assembly process are calculated below.

4.5.3.1 Conversion Cost in Upper Making Process

In the upper making process, the total direct labor cost is 438375 Baht and the common factory overhead cost is 262242 Baht. Therefore, the conversion cost of upper making is:

438375 + 262242 = 700617 Baht

4.5.3.2 Conversion Cost in Shoe Assembly Process

In the shoe assembly process, the total direct labor cost is 992625 Baht and the common factory overhead cost is 552418 Baht. Therefore, the conversion cost of shoe assembly is:

947025 + 552418 = 1499443 Baht

Thus, the total conversion cost of both main processes is

700617 + 1499443 = 2200060 Baht

4.5.3.3 Mutual Factory Overhead Cost Allocation

The total mutual FOH in June-August is 380596 Baht. This cost is allocated to add to the common FOH costs of the upper making and shoe assembly processes in the proper proportion.

The mutual FOH that is allocated to the upper making process is:

380596 x (700617 / 2200060) = 121202 Baht

Therefore, the total FOH of upper making is:

262242 + 121202 = 383444 Baht

The mutual FOH that is allocated to the shoe assembly process is:

380596 x (1499443 / 2200060)= 259394 Baht

Therefore, the total FOH of shoe assembly is:

552418 + 259394 = 811812 Baht

4.5.3.4 Direct Labor and Factory Overhead Cost per Hour

Upper Making Process

In June-August period, the total direct labor costs are 438375 Baht and the total direct labor times are 21000 Hours. Therefore, calculation of the direct labor cost per hour is:

438375 / 21000 = 20.88 Baht / Hour.

In June-August period, the total FOH costs are 380983 Baht and the total direct labor times are 21000 Hours. Therefore, calculation of the FOH cost per hour is:

383444 / 21000 = 18.26 Baht / Hour.

Shoe Assembly Process

In June-August period, the total direct labor costs are 992625 Baht and the total direct labor times are 41456 Hours. Therefore, calculation of the direct labor cost per hour is:

947025 / 42456 = 22.31 Baht / Hour.

In June-August period, the total FOH costs are 814273 Baht and the total direct labor times are 21000 Hours. Therefore, calculation of the FOH cost per hour is:

811812 / 42456 = 19.12 Baht / Hour.

4.5.3.5 Total Factory Overhead Cost for Each Product Type

The total factory overhead costs in upper making and shoe assembly process of each product type are calculated below.

Upper Making Process

$C_{overhead\text{-}upper}$ = total factory overhead cost = 383444 Baht

$\sum(E_{upper\text{-}j} \times T_{upper\text{-}j})$ = $(E_{upper\text{-}short} \times T_{upper\text{-}short}) + (E_{upper\text{-}long} \times T_{upper\text{-}long})$

= (28901 x 1852)+ (25433 x 2004)

= 53524652 + 50967732 = 104492384

The total factory overhead cost for short heel shoes is

$$(C_{overhead\text{-}upper} x E_{upper\text{-}short} x T_{upper\text{-}short}) / \{\sum_{J=1}^{2} (E_{upper\text{-}j} x T_{upper\text{-}j}) \}$$

=(383444x28901x1852)/104492384

= 196413 Baht

The total factory overhead cost for long heel shoes is

$$(C_{overhead\text{-}upper} x E_{upper\text{-}long} x T_{upper\text{-}long}) / \{\sum_{J=1}^{2} (E_{upper\text{-}j} x T_{upper\text{-}j}) \}$$

= (383444x25433 x 2004) / 104492384

= 187031 Baht

Shoe Assembly Process

$C_{overhead\text{-}assembly}$ = total factory overhead cost = 811812 Baht

$\sum(E_{assembly\text{-}j} x T_{assembly\text{-}j})$ = $(E_{assembly\text{-}short}$ x $T_{assembly\text{-}short})$+ $(E_{assembly\text{-}long}$x $T_{assembly\text{-}long})$

= (27181x3308) + (23725x4017)

= 89914748 + 95303325 = 185218073

The total factory overhead cost for short heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}short} x T_{assembly\text{-}short})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j}) \}$$

= (811812x28901 x 1852) / 104492384

= 394097 Baht

The total factory overhead cost for long heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}long} x T_{assembly\text{-}long})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j}) \}$$

= (811812x25433 x 2004) / 104492384

= 417715 Baht

4.5.4 Details of Manufacturing Costs in June-August

The details of manufacturing costs consist of:

- Total cost and cost per unit of direct material.
- Total cost and cost per unit of direct labor and FOH.
- Cost Structure

4.5.4.1 Details of Manufacturing Costs for Upper Making

Total Costs and Cost per Unit of Direct Material

From calculation of direct material costs of upper making in page 77, the total costs of synthetic leather, P.V.C. lining, pigskin lining are shown in Table 4-20.

Table 4-20 Direct Material Cost of Upper Making in June-August

Product Type	Direct Material Cost (Baht)			
	Synthetic Leather	P.V.C Lining	Pigskin Lining	Total
Short Heel	791058	223196	167546	1181800
Long Heel	696192	196429	147454	1040075
Total	1487250	419625	315000	2221875

The direct material cost per unit = Direct Material Cost / Equivalent Unit

The equivalent unit of short heel shoes = 28901 Baht.

The equivalent unit of long heel shoes = 25433 Baht

Therefore, the direct material costs per unit of synthetic leather, P.V.C. lining, and pigskin lining in upper making process are shown in Table 4-21.

Table 4-21 Direct Material Cost per Unit of Upper Making in June-August

Product Type	Direct Material Cost per Unit (Baht)			
	Synthetic Leather	P.V.C Lining	Pigskin Lining	Total
Short Heel	27.37	7.72	5.80	40.89
Long Heel	27.37	7.72	5.80	40.89

Total Costs and Cost per Unit of Direct Labor and FOH

From Table 4-5 and calculation of direct labor costs of upper making in page 78, the total direct labor costs of each product type are shown in Table 4-22.

From calculation of mutual FOH allocation in page 92 and total FOH of upper making in page 94, the total FOH of each product type are shown in Table 4-22.

Table 4-22 Direct Labor Cost and FOH of Upper Making in June-August

Product Type	Direct Labor Cost (Baht)	Factory Overhead Cost (Baht)
Short Heel	224551	196413
Long Heel	213824	187031
Total	438375	383444

The direct labor cost per unit = Direct Labor Cost / Equivalent Unit

The factory overhead cost per unit = Factory Overhead Cost / Equivalent Unit

The equivalent unit of short heel shoes = 28901 Baht.

The equivalent unit of long heel shoes = 25433 Baht

Therefore, the direct labor costs per unit and factory overhead costs per unit in upper making process are shown in Table 4-23.

Table 4-23 Direct Labor Cost and FOH per Unit of Upper Making in June-August

Product Type	Direct Labor Cost per Unit (Baht)	Factory Overhead Cost per Unit (Baht)
Short Heel	7.70	6.80
Long Heel	8.41	7.35

Cost Structure of Upper Making

From the costs per unit of direct material in Table 4-21 and the costs per unit of direct labor and factory overhead in Table 4-23, the cost structures of upper making for the short shoe and long heel shoe are illustrated in the Table 4-24 and Table 4-25.

Table 4-24 Cost Structure for Upper Making of Short Heel Shoe in June-August

Item	Cost per Unit (Baht per Unit)	%
Direct Material	40.89	73.82
Direct Labor	7.70	13.90
Factory Overhead	6.80	12.28
Total	55.39	100

Table 4-25 Cost Structure for Upper Making of Long Heel Shoe in June-August

Item	Cost per Unit (Baht per Unit)	%
Direct Material	40.89	72.18
Direct Labor	8.41	14.85
Factory Overhead	7.35	12.97
Total	56.65	100

4.5.4.2 Details of Manufacturing Costs for Shoe Assembly

Total Costs and Cost per Unit of Direct Material

From calculation of direct material costs of shoe assembly in page 86-89, the total costs of upper, insole, outsole, and sock lining in shoe assembly are demonstrated in Table 4-26.

Table 4-26 Direct Material Cost of Shoe Assembly in June-August

Product Type	Direct Material Cost (Baht)				
	Upper	Insole	Outsole	Sock lining	Total
Short Heel	1116705	240304	606588	65012	2028609
Long Heel	974900	209789	529311	56730	1770730
Total	2091605	450093	1135899	121742	3799339

The direct material cost per unit = Direct Material Cost / Equivalent Unit

The equivalent unit of short heel shoes for upper and insole = 27181 Baht.

The equivalent unit of long heel shoes for upper and insole = 23725 Baht

The equivalent unit of short heel shoes for outsole and sock lining = 27176 Baht

The equivalent unit of short heel shoes for outsole and sock lining = 23709 Baht

Therefore, the direct material costs per unit of upper insole, outsole, and sock lining in shoe assembly are shown in Table 4-27.

Table 4-27 Direct Material Cost per Unit of Shoe Assembly in June-August

Product Type	Direct Material Cost per Unit (Baht)				
	Upper	Insole	Outsole	Sock lining	Total
Short Heel	41.08	8.84	22.32	2.39	74.63
Long Heel	41.09	8.84	22.33	2.39	74.65

<u>Total Costs and Cost per Unit of Direct Labor and FOH</u>

From Table 4-13 and calculation for direct labor costs of shoe assembly in page 89-90, the total direct labor costs of each product type are shown in Table 4-28.

From calculation of mutual FOH allocation in page 92 and total FOH of shoe assembly in page 95, the total factory overhead costs of each product type are shown in Table 4-28.

Table 4-28 Direct Labor and Factory Overhead Cost of Shoe Assembly in June-August

Product Type	Direct Labor Cost (Baht)	Factory Overhead Cost (Baht)
Short Heel	459737	394097
Long Heel	487288	417715
Total	947025	811812

The direct labor cost per unit = Direct Labor Cost / Equivalent Unit

The factory overhead cost per unit = Factory Overhead Cost / Equivalent Unit

The equivalent unit of short heel shoes = 27181 Baht.

The equivalent unit of long heel shoes = 23725 Baht

Therefore, the direct labor costs per unit and factory overhead costs per unit in shoe assembly process are shown in Table 4-29.

Table 4-29 Direct Labor and Factory Overhead Cost per Unit of Shoe Assembly In June-August

Product Type	Direct Labor Cost per Unit (Baht)	Factory Overhead Cost per Unit (Baht)
Short Heel	16.91	14.50
Long Heel	20.54	17.61

<u>Cost Structure of Shoe Assembly</u>

From the costs per unit of direct material in Table 4-27 and the costs per unit of direct labor and factory overhead in Table 4-29, the cost structures of shoe assembly for the short shoe and long heel shoe are illustrated in the Table 4-30 and Table 4-31.

Table 4-30 Cost Structure of Short Heel Shoes for Shoe Assembly in June-August

Item	Cost per Unit (Baht per Unit)	%
Direct Material	74.63	70.38
Direct Labor	16.91	15.95
Factory Overhead	14.50	13.67
Total	106.04	100

Table 4-31 Cost Structure of Long Heel Shoes for Shoe Assembly in June-August

Item	Cost per Unit (Baht per Unit)	%
Direct Material	74.65	66.18
Direct Labor	20.54	18.21
Factory Overhead	17.61	15.61
Total	112.80	100

CHAPTER 5

MANUFACTURING COST REDUCTION

According to the chapter 4, the manufacturing cost is divided into 3 main groups: direct material cost, direct labor cost, and factory over head cost. Therefore, the aim of manufacturing cost reduction is to reduce these three main costs.

Due to the study in cost structure of the factory, it shows that the direct material cost is the most proportion of the total manufacturing cost. The second is the factory over head cost and the third is the direct labor cost. Thus, the analysis of manufacturing cost reduction should be emphasized on the direct material cost, factory overhead cost, and direct labor cost, sequentially from the most important cost to the least important cost.

It is necessary to study the works in manufacturing processes and situations in the factory that may cause the additional costs for loss in manufacturing process or the unnecessary costs. It is better to find the causes of the losses in manufacturing process and then analyze the methods to eliminate these losses because if the losses in manufacturing process decrease, the productivity increases and the cost per unit also decreases.

Cost reduction analysis should be considered about the losses in manufacturing processes that are the controllable or uncontrollable loss. If it is the controllable loss, the methods of manufacturing cost reduction exist. However, the company cannot reduce the manufacturing costs influenced from the uncontrollable losses. Thus, it is unnecessary to study of cost reduction for the uncontrollable losses.

The loss reductions in manufacturing processes are analyzed on the causes of each loss as following.

5.1 Loss in Manufacturing Process

Loses in manufacturing process may be influenced by the worker (man), material, or method. Those loses would be under control or not. In this research, we divide the loss analysis into 2 terms: quality and quantity (time) by using fishbone diagrams.

5.1.1 Loss Based on Quality

Problems and causes from the worker (man)

- Different ability to work
- Low skills
- Inefficient machine controlling
- Mindless working

Problems and causes from the material

- Low quality

Problems and causes from the method

- Bad communication

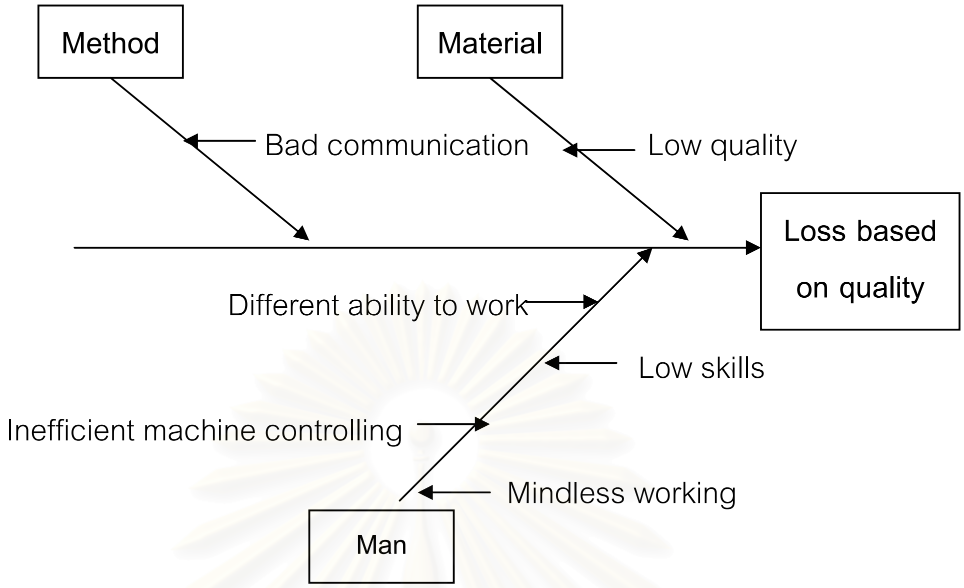


Figure 5-1 Fishbone Diagram of Loss Based on Quality

5.1.1.1 Problems and Causes from the worker based on Quality

<u>Different ability to work</u>

The experience and work-time of each worker are different so the knowledge and practice of the worker are not comparable in abilities. In manufacturing processes, the products are produced on the assembly line in each process by the different worker, who has the different knowledge and ability so the quality of the product is not consistent. For an example, the worker who does not have any experience and skill of his work spend the operating time more than the worker who have the experience and skill of his work. Therefore, this problem causes loses in manufacturing system.

Low skills

The quality of products is low because the workers have the low skills for their works in each process of assembly line. The examples that the workers make a mistake on the product such as bad upper folding, stitching, and outsole gluing.

Inefficient machine controlling

The workers control the machines inefficiently due to lack of technology manual. Additionally, some machines are hard to be used. Therefore, the processes that need the machine to assemble the shoes often have the errors such as wrong pattern lasting and assembling.

Mindless working

Some workers do not realize the importance of low cost working because the effect on high manufacturing costs do not influence to their routines so the workers do not pay attention to their jobs. Therefore, it causes the loss in manufacturing processes. The examples of these problems are:

1. The worker does not take all nails out from the finished shoes.
2. The worker makes a mistake on materials such as scraping by pens and nails on the synthetic leather.
3. The worker packs the finished goods in a box inefficiently such as wrong volume of product in a box, different size of right/left side shoes, and packing both right side shoes or both left side shoes.

5.1.1.2 Problems and Causes from the material based on quality

<u>Low quality</u>

The quality of materials is lower than the specifications that are addressed in the negotiation with the supplier. For an example, low quality steel insole cannot stand the weight of a shoe's user.

5.1.1.3 Problems and Causes from the method based on Quality

<u>Bad communication</u>

The executives and supervisors order the workers by conversation only without any document so it is the bad downward communication. As a result, sometimes the workers confuse and operate their jobs that are not compatible with the order.

5.1.2 Loss Based on Quantity

Problems and causes from the worker (man)

- Misunderstand working
- Intractable working

Problems and causes from the material

- Lack of material

Problems and causes from the method

- Bad production plan
- Bad inventory control
- Bad material order

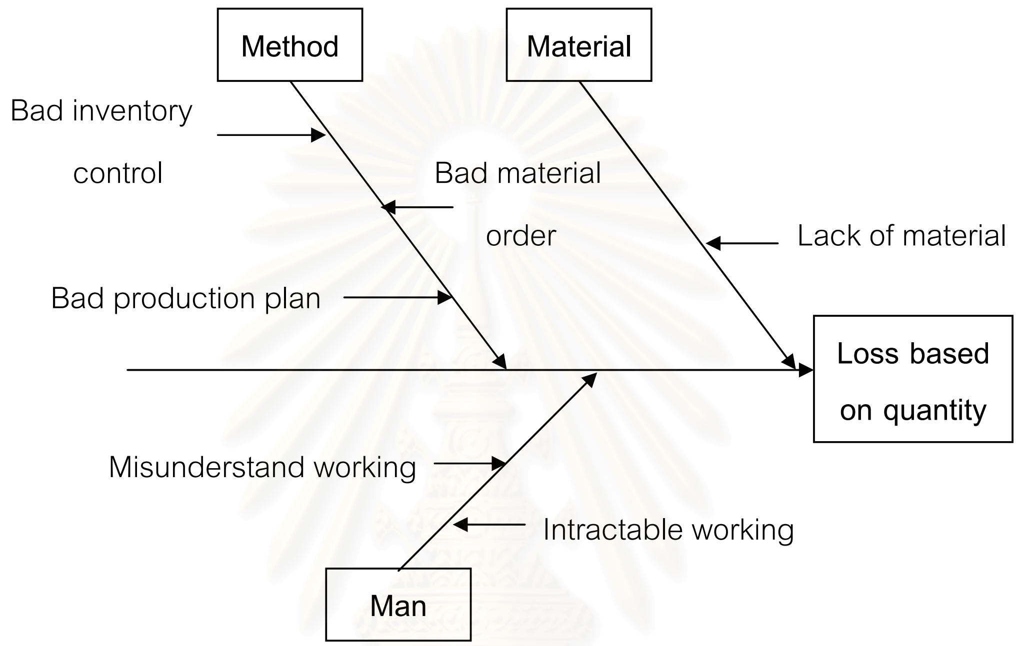


Figure 5-2 Fishbone Diagram of Loss Based on Quantity

5.1.2.1 Problems and Causes from the worker (man) based on quantity

<u>Misunderstand working</u>

The workers misunderstand the orders by operating the products in wrong volume. For an example, the worker cuts the synthetic leather over-required 200 pairs of a shoe of number 7 so the goods lack 200 pairs of a shoe of number 7½ size. Therefore, the factory needs to order more synthetic leather for 200 pairs of a shoe of number 7½ size.

Intractable working

The workers do not work in accordance with the orders. For an example, the die cut machine cuts the 6 synthetic leather sheets in 1 time but the worker control the machine to cut 10 synthetic leather sheets in 1 time so the lower layers of the synthetic leather sheet are not torn. Therefore, this problem causes the loss in the manufacturing process.

5.1.2.2 Problems and Causes from the material based on quantity

Lack of material

The factory lacks the raw material to supply its manufacturing processes on occasions. The causes of this problem are shown in followings:

1. The factory of the supplier cannot produce the materials to supply the factory promptly.
2. The factory of the supplier needs to wait and get many orders before starting mass production to produce the materials in lowest costs.

5.1.2.3 Problems and Causes from the method based on quantity

Bad production plan

In manufacturing processes, the products have to be flowed in assembly lines to avoid loses in the process. However, a bad manufacturing plan causes the bottleneck problems in the manufacturing processes. Arrangement and management of the workers in each process are improper. The products cannot flow in the assembly line and the workers in some processes do not have work to do. These waste time and loss should be got out. In the factory, the bottleneck problem often happens in the following processes:

1. After lasting the front part of shoe upper by machines, which is a fast process, the shoe upper is sent for lasting the back part of shoe upper by workers. The workers need to spend a long time for lasting the back part of shoe upper so the production flows stop at this process.

2. After last slipping process, the shoe is sent to insert sock lining. However, the workers cannot insert sock lining in the limited time. Therefore, the next process is probably delayed.

Bad inventory control

Occasionally, the materials in the warehouse are not enough to produce the products for the volume that are defined in the job order. Additionally, with the market in short supply for that material, the factory needs to break off manufacturing processes.

Bad material order

The factory order the materials insufficiently because the actual losses in manufacturing processes are much more than the expected losses. For an example, the factory receives an order to produce 10,000 pairs of a shoe. A yard of the synthetic leather sheet is cut to be the material for 9 pairs of a shoe. Therefore, the factory requires 1,111 yards of the synthetic leather sheet plus 1% of total sheets or 11 yards of reserved synthetic leather sheets for the errors so the factory needs 1,111 + 11 = 1,122 yards of synthetic leather sheets. Therefore, the factory orders the synthetic leather approximately 1.130 yards to produce 10,170 pairs of a shoe. However, the actual losses for cutting synthetic leather in manufacturing process are about 300 pairs of a shoe so the factory lacks 130 pairs of a shoe. As a result, the factory needs to order more synthetic leather to produce 130 pairs of a shoe.

5.1.3 Defect and T-Account in June-August

The percentages of defects in upper making and shoe assembly processes are calculated below.

5.1.3.1 Percentage of Defect for Short Heel Shoe in Upper Making Process

Percentage of Defect = (Defect / Production Volume) x100

Table 5-1 Percentage of Defect in Upper Making Process in June-August

Product Type	Equivalent Unit	Defect (Unit)	Total Production Volume (Unit)	Percentage of Defect (%)
Short Heel	28901	1018	29919	3.40
Long Heel	25433	898	26331	3.41
Total	54334	1916	56250	3.41

The problems of these Defective uppers are influenced from the resources in manufacturing processes such man, material, and method. These problems of defect are considered and analyzed for the causes of only problems that influence in mistake of producing products because the other problems such as lack of material, bad inventory control, and bad material order cause the only loss time and additional costs in manufacturing processes. In upper making process, the percentages and volumes of defect of short heel shoe are shown in Table 5-2 and Table 5-3, the percentages and volumes of defect of short heel shoe are shown in Table 5-4 and Table 5-5.

The defects are divided into 9 groups based on the causes of loss. The causes of loss are analyzed on the mistakes of the products that indicate why the mistakes occur.

If the quality of product is not consistent in each product group, the incomplete products are categorized into the different ability to work problem.

If there are mistakes on the products such as bad upper folding, stitching, and outsole gluing, these products are categorized into the low skill-working problem.

If there are the errors from pattern lasting and assembling by machines, these incomplete products are categorized into the inefficient machine-controlling problem.

If the mistakes on the products are having the rests of nail in the finished shoes and scraping on the synthetic leather by pens or nails, these incomplete products are categorized into the mindless working problem.

If the quality of material that is used in the manufacturing process is low, the low quality products are categorized into the low quality material problem.

If the products are not compatible with the order, these products are categorized into the bad communication problem.

If the products are produced in wrong volumes, these wrong volumes are categorized into the misunderstand-working problem.

If the synthetic leather sheet is torn well by the die cut machine, the products are categorized into the intractable working problem.

If the bottleneck problem occurs in the manufacturing process, the products that are hold at the bottleneck are categorized into the bad production plan problem.

Table 5-2 Defect Costs of Upper for Short Heel Short in June-August

Defect Cost = Defect x Cost per unit

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	136	7533
2	Low skill working	Man	203	11244
3	Inefficient machine controlling	Man	64	3545
4	Mindless working	Man	181	10026
5	Misunderstand working	Man	140	7755
6	Intractable working	Man	91	5040
7	Low quality material	Material	66	3656
8	Bad communication	Method	55	3046
9	Bad production plan	Method	82	4542
	Total		1018	56387

From Table 4-24, the upper cost per unit for short heel shoe is 55.39 Baht.

Table 5-3 Percentage of Defective Upper Costs for Short Heel Shoe in June-August

	Causes of Problem	Defect Cost	Percentage of Defect	Accumulative Percentage
1	Low skill working	11244	19.94	19.94
2	Mindless working	10026	17.78	37.72
3	Misunderstand working	7755	13.75	51.47
4	Different ability to work	7533	13.36	64.83
5	Intractable working	5040	8.94	73.77
6	Bad production plan	4542	8.06	81.83
7	Low quality material	3656	6.48	88.31
8	Inefficient machine controlling	3545	6.29	94.60
9	Bad communication	3046	5.40	100
	Total	56387	100	

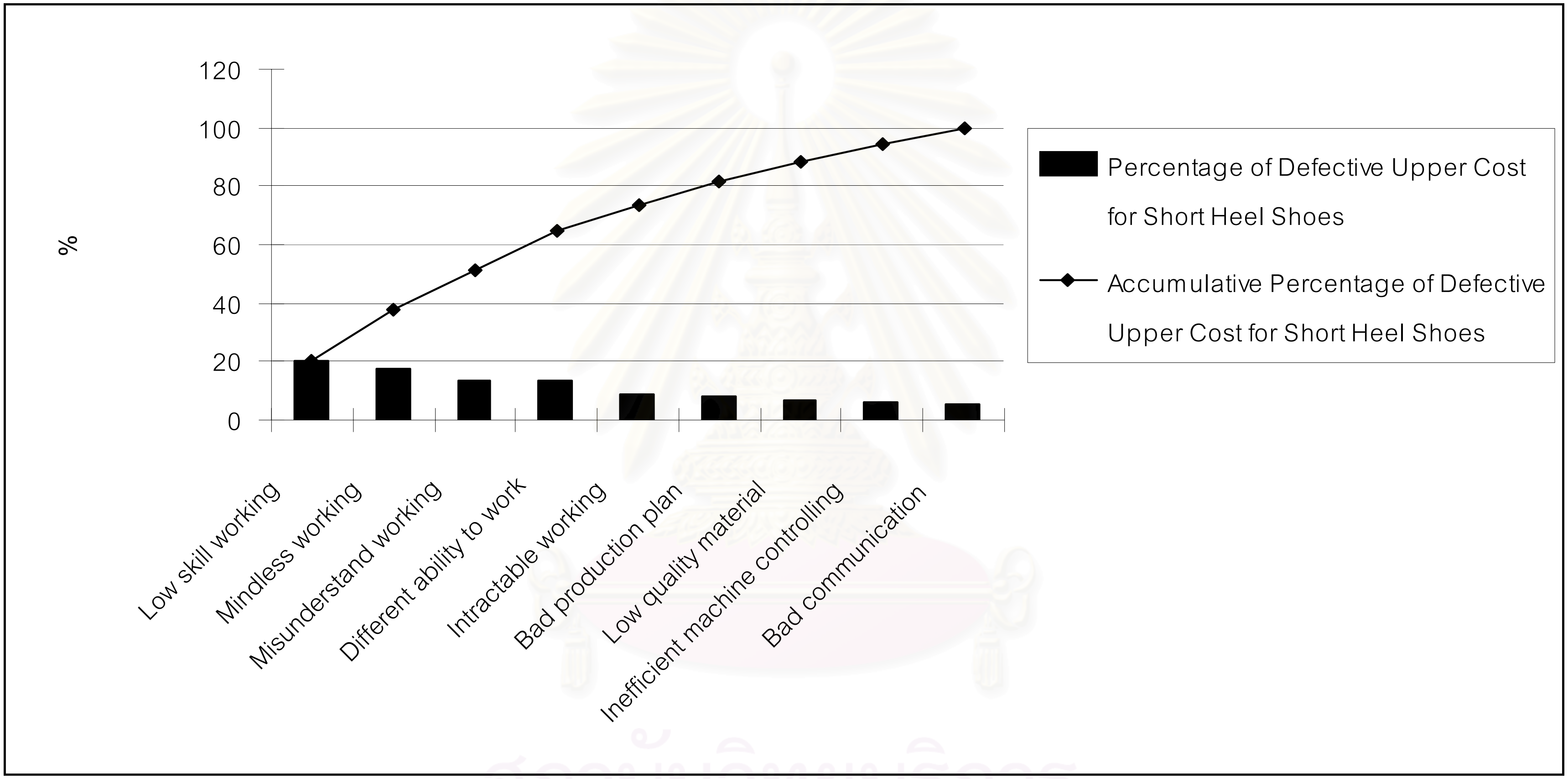


Figure 5-3 Pareto Diagram of Defective Uppers for Short Heel Shoes in June-August

Table 5-4 Defect Costs of Upper of Long Heel Shoe in June-August

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	103	5835
2	Low skill working	Man	181	10254
3	Inefficient machine controlling	Man	52	2946
4	Mindless working	Man	159	9007
5	Misunderstand working	Man	120	6798
6	Intractable working	Man	88	4985
7	Low quality material	Material	48	2719
8	Bad communication	Method	55	3116
9	Bad production plan	Method	92	5212
	Total		898	50872

From Table 4-25, the upper cost per unit for long heel shoe is 56.65 Baht.

Table 5-5 Percentage of Defective Upper Costs of Long Heel Shoe in June-August

	Causes of Problem	Defect Cost	Percentage of Defect	Accumulative Percentage
1	Low skill working	10254	20.16	20.16
2	Mindless working	9007	17.71	37.87
3	Misunderstand working	6798	13.36	51.23
4	Different ability to work	5835	11.47	62.70
5	Bad production plan	5212	10.24	72.94
6	Intractable working	4985	9.80	82.74
7	Bad communication	3116	6.13	88.87
8	Inefficient machine controlling	2946	5.79	94.66
9	Low quality material	2719	5.34	100
	Total	50872	100	

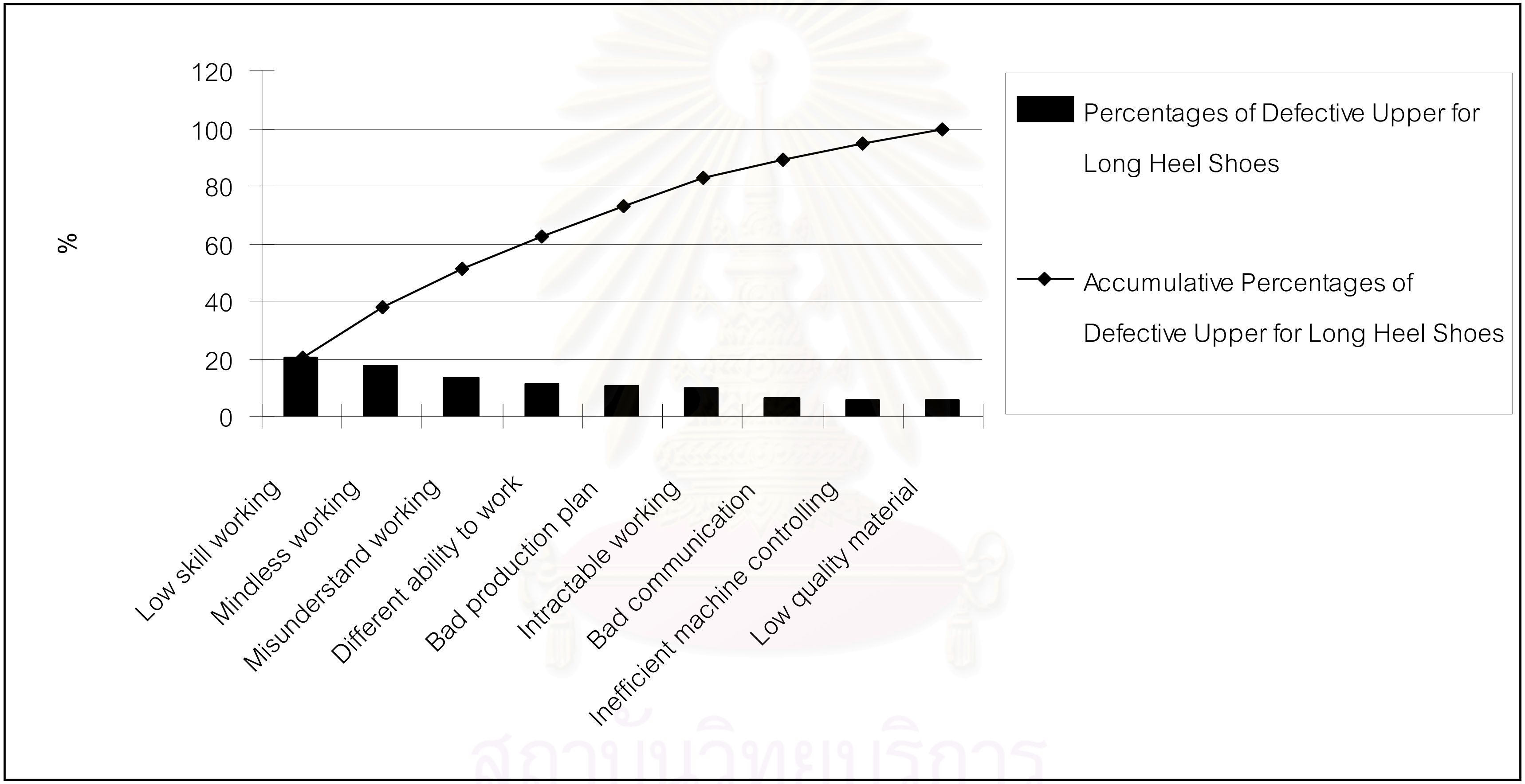


Figure 5-4 Pareto Diagram of Defective Uppers for Long Heel Shoes in June-August.

5.1.3.2 T-Account of Upper Making in June-August

The T-account for upper making of short heel shoe in June-August is shown in Table 5-6.

Table 5-6 T-Account for Upper Making of Short Heel Shoe in June-August

1 June 2002 – 31 August 2002 Upper Making for Short Heel Shoe			
BI		Transfer Cost	
DM Cost	21917	Total Cost	1551917
DL Cost	4127		
FOH Cost	3645		
Production		EI	
DM Cost	1181762	DM Cost	16397
DL Cost	222538	DL Cost	3088
FOH Cost	196527	FOH Cost	2727
		Balance	56387
Total Cost	1630516	Total Cost	1630516

BI means the beginning inventory of both materials and work-in-processes in the beginning period.

EI means the ending inventory of both materials and work-in-processes in the end period.

Production means the products that are produced during the beginning period and end period.

DM Cost	means the direct material costs for raw materials, work-in-processes, finished products (information from purchasing department).
DL Cost	means the direct labor costs in producing for work-in-processes and finished products (information from personnel department).
FOH Cost	means the factory overhead costs in producing for work-in-processes and finished products (information from financial department).
Cost/Unit*Units	means the manufacturing costs in producing for the complete products (information from financial department).
Balance	means the manufacturing losses that occur and influence the total costs of the both sides in T-account, which are not equal with each other. These manufacturing losses are shown at the balance item (information from production department).

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 4-1 and cost per unit in Table 4-24.

DM, DL, and FOH costs of EI are calculated from the work-in-process inventory in Table 4-2 and cost per unit in Table 4-24.

DM, DL, and FOH costs of production are calculated from equivalent units of uppers that are produced in Table 4-8.

The balance or defect cost in upper making process is calculated in Table 5-2.

The T-account for upper making of long heel shoe in June-August is shown in Table 5-7.

Table 5-7 T-Account for Upper Making of Long Heel Shoe in June-August

1 June 2002 – 31 August 2002 Upper Making for Long Heel Shoe			
BI		Transfer Cost	
DM Cost	19913	Total Cost	1401294
DL Cost	4096		
FOH Cost	3579		
Production		EI	
DM Cost	1039955	DM Cost	11695
DL Cost	213892	DL Cost	2405
FOH Cost	186933	FOH Cost	2102
		Balance	50872
Total Cost	1468368	Total Cost	1468368

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 4-1 and cost per unit in Table 4-25.

DM, DL, and FOH costs of EI are calculated from the work-in-process inventory in Table 4-2 and cost per unit in Table 4-25.

DM, DL, and FOH costs of production are calculated from products that are produced in Table 4-8.

The balance or defect cost in upper making process is calculated in Table 5-4.

5.1.3.3 Percentage of Defect in Shoe Assembly Process

Percentage of Defect = (Defect / Production Volume) x100

Table 5-8 Percentage of Defect in Shoe Assembly Process in June-August

Product Type	Equivalent Unit	Defect (Unit)	Total Production Volume (Unit)	Percentage of Defect (%)
Short Heel	27181	1090	28271	3.86
Long Heel	23725	956	24681	3.87
Total	50906	2046	52952	3.86

In shoe assembly process, the total defects are 2046 units. These defects are also influenced from the mistake of resources in producing shoes such as worker, material, and method.

Therefore, the number of defects in shoe assembly process is considered and analyzed on their causes of each problem. In shoe assembly process, the defects and percentages for each manufacturing problem of short heel shoe are calculated in each its cause shown in Table 5-9 and Table 5-10. The defects and percentages of long heel shoe are shown in Table 5-11 and 5-12. The Pareto diagram of defects for short and long heel shoe are shown in Figure 5-4 and Figure 5-5.

Table 5-9 Defect costs of shoe of Short Heel Shoe in June-August

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	127	13467
2	Low skill working	Man	163	17284
3	Inefficient machine controlling	Man	138	14634
4	Mindless working	Man	194	20572
5	Misunderstand working	Man	100	10604
6	Intractable working	Man	85	9013
7	Low quality material	Material	38	4030
8	Bad communication	Method	65	6893
9	Bad production plan	Method	180	19087
	Total		1090	115584

From Table 4-30, the short heel shoe cost per unit is 106.04 Baht.

Table 5-10 Percentage of Defect Cost of Short Heel Shoe in June-August

	Causes of Problem	Defect Cost	Percentage of Defect	Accumulative Percentage
1	Mindless working	20572	17.80	17.80
2	Bad production plan	19087	16.51	34.31
3	Low skill working	17284	14.96	49.27
4	Inefficient machine controlling	14634	12.66	61.93
5	Different ability to work	13467	11.65	73.58
6	Misunderstand working	10604	9.17	82.75
7	Intractable working	9013	7.80	90.55
8	Bad communication	6893	5.96	96.51
9	Low quality material	4030	3.49	100
	Total	115584	100	

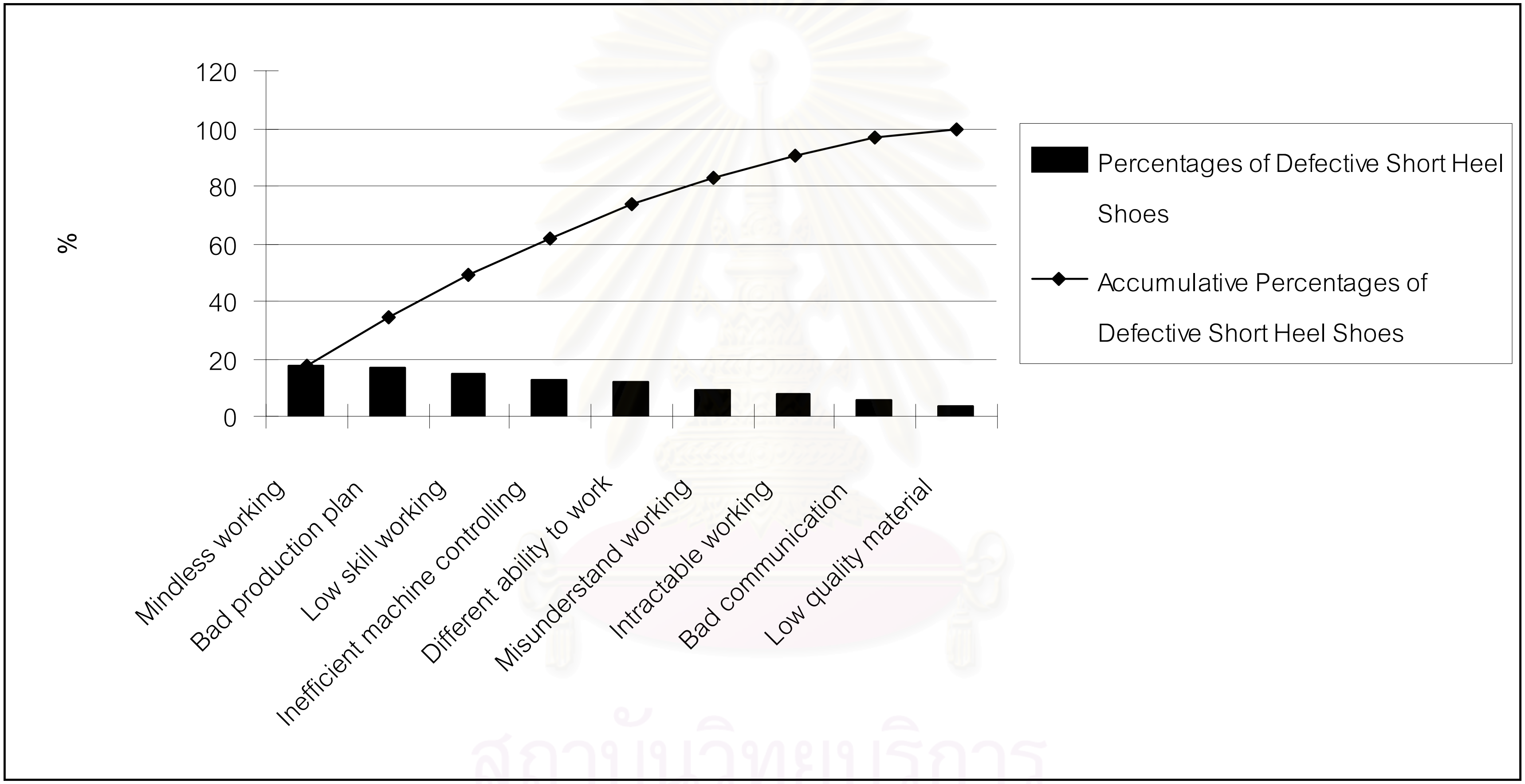


Figure 5-5 Pareto Diagram of Defective Short Heel Shoes in June-August

Table 5-11 Defect Costs of Shoe of Long Heel Shoe in June-August

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	118	13310
2	Low skill working	Man	154	17371
3	Inefficient machine controlling	Man	131	14777
4	Mindless working	Man	177	19966
5	Misunderstand working	Man	85	9588
6	Intractable working	Man	56	6317
7	Low quality material	Material	20	2256
8	Bad communication	Method	65	7332
9	Bad production plan	Method	150	16920
	Total		956	107837

From Table 4-30, the long heel shoe cost per unit is 112.80 Baht.

Table 5-12 Percentage of Defect Cost of Long Heel Shoe in June-August

	Causes of Problem	Defect Cost	Percentage of Defect	Accumulative Percentage
1	Mindless working	19966	18.52	18.52
2	Low skill working	17371	16.11	34.63
3	Bad production plan	16920	15.69	50.32
4	Inefficient machine controlling	14777	13.70	64.02
5	Different ability to work	13310	12.34	76.36
6	Misunderstand working	9588	8.89	85.25
7	Bad communication	7332	6.80	92.05
8	Intractable working	6317	5.86	97.91
9	Low quality material	2256	2.09	100
	Total	107837	100	

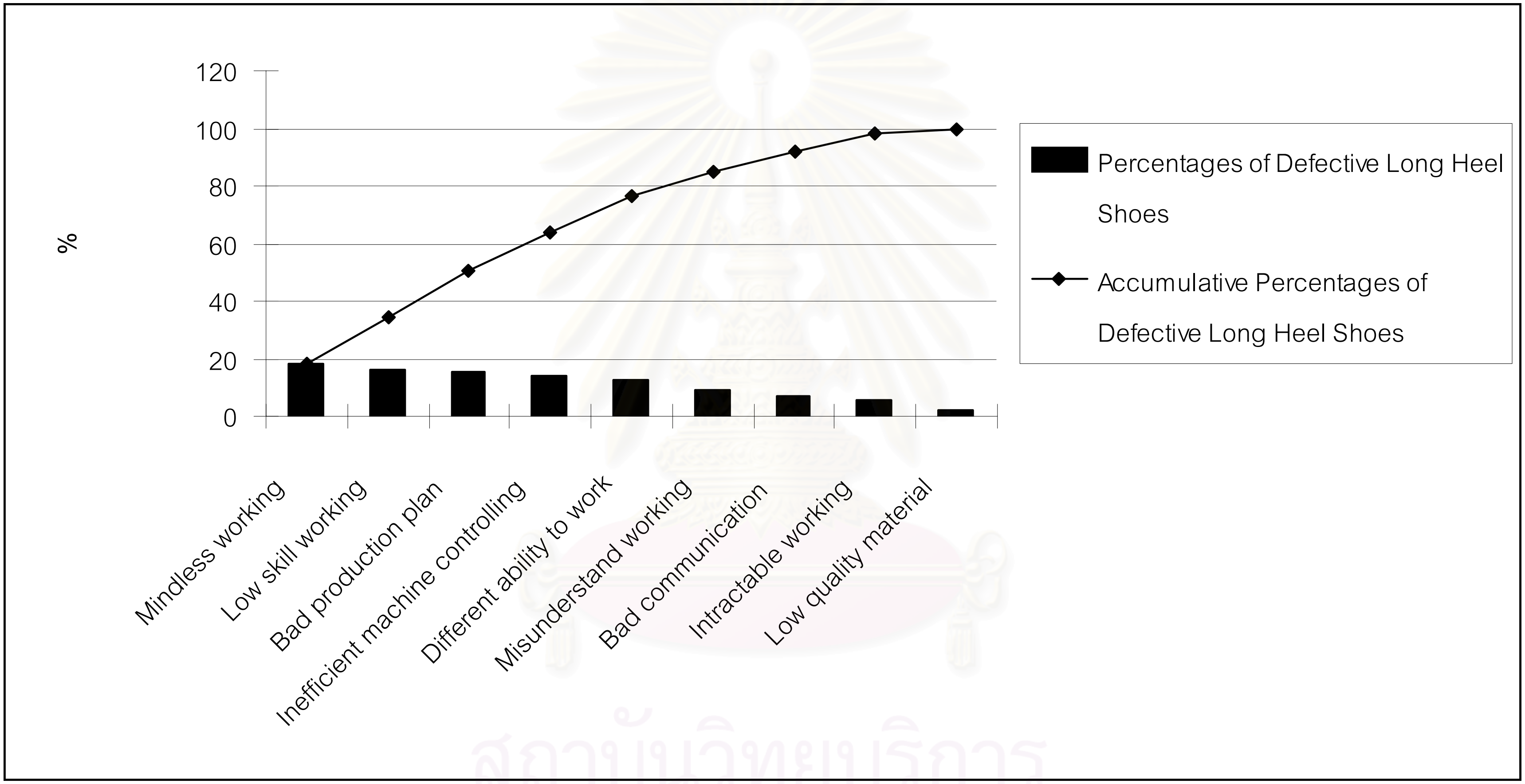


Figure 5-6 Pareto Diagram of Defective Long Heel Shoes in June-August

5.1.3.4 T-Account of Shoe Assembly in June-August

The T-account for shoe assembly and in June-August is demonstrated in Table 5-13 and 5-14.

Table 5-13 T-Account for Shoe Assembly Process of Short Heel Shoe in June-August

1 June 2002 – 31 August 2002 Shoe Assembly for Short Heel Shoe			
BI		Transfer Cost	
DM Cost	100228	Total Cost	2808469
DL Cost	22710		
FOH Cost	19474		
Production		EI	
DM Cost	2028518	DM Cost	70824
DL Cost	459631	DL Cost	16048
FOH Cost	394125	FOH Cost	13761
		Balance	115584
Total Cost	3024686	Total Cost	3024686

From calculation in T-account, it shows that the manufacturing costs change from the beginning period to the end period and the total costs in both sides must be equal with each other. The costs in the left side mean the costs that flow in the manufacturing system and the costs in the right side mean the costs that flow out from the manufacturing system.

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 4-9 and cost per unit in Table 4-30.

DM, DL, and FOH costs of EI are calculated from the work-in-process inventory in Table 4-10 and cost per unit in Table 4-30.

DM, DL, and FOH costs of production are calculated from short heel shoe that are produced in Table 4-16.

The balance or defect cost in shoe assembly process is calculated in Table 5-9.

Table 5-14 T-Account for Shoe Assembly Process of Long Heel Shoe in June-August

1 June 2002 – 31 August 2002 Shoe Assembly for Long Heel Shoe					
BI			Transfer Cost		
	DM Cost	86818		Total Cost	2605341
	DL Cost	23888			
	FOH Cost	20480			
Production			EI		
	DM Cost	1771071		DM Cost	62333
	DL Cost	487312		DL Cost	17151
	FOH Cost	417797		FOH Cost	14704
				Balance	107837
	Total Cost	2807366		Total Cost	2807366

From calculation in T-account, it shows that the manufacturing costs change from the beginning period to the end period and the total costs in both sides must be equal with each other. The costs in the left side mean the costs that flow in the manufacturing system and the costs in the right side mean the costs that flow out from the manufacturing system.

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 4-9 and cost per unit in Table 4-31.

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 4-10 and cost per unit in Table 4-31.

DM, DL, and FOH costs of production are calculated from products that are produced in Table 4-16.

The balance or defect cost in shoe assembly process is calculated in Table 5-11.

5.2 Loss Reduction in Manufacturing Process

Loss reduction in manufacturing process is to consider about the causes of each loss and analyze to eliminate or reduce these losses to the minimize level as possible.

5.2.1 Loss Reduction Based on Quality

Loss reduction based on quality is considered about the causes and losses based on quality and analyze to find the methods to reduce these losses in term of quality.

5.2.1.1 Loss Reduction from the worker based on quality

Loss reduction related on the worker

- Losses from different ability to work and low skills of the work are reduced by introducing for training and testing programs.
- Loss from inefficient machine controlling is reduced by creating job descriptions in the key processes.
- Loss from mindless working is reduced by setting up motivation system in the company.

The details of these loss reductions are described below.

<u>Training and Orientation Program</u>

Loss reductions from different ability to work and low skill of the workers are complemented by setting up the training and orientation program to provide the fundamental information in manufacturing processes including methods of working, products, and existing environments. The executives in the company should emphasize on training the new workers and workers that are shifted to the new position to maintain the effective works in manufacturing processes. Orientation of workers in the real situations is also important for the new workers and the workers that are shifted to the new position because the real situations help the workers to be familiar with their works and improve their ability quickly.

The factory has to introduce the training courses of each process in production line for the new workers. The supervisors in the production lines are responsible to complete these tasks. The training courses are divided into two levels:

1. General courses.
2. High skill courses.

The general courses are set up for all new workers in every process to know basically how to operate their works in each process. These courses are complemented by the supervisors in both upper making and shoe assembly processes, spending about 3 hours each course.

The high skill courses are set up for the new workers that operate in the processes that require high skills and experiences of the workers. These processes include folding and stitching in upper making process and backpart moulding and lasting in shoe assembly process. These courses also are complemented by the supervisors in both upper making and shoe assembly processes, spending about 3-5 days each course. Actually, the trainees in these courses need to train with the real materials in the existing environments to learn the real conditions in their works.

Motivation System

The objective of motivation is to develop the work forms by providing rewards or repaying to the workers in the company. Motivation system is an essential method to change the work forms, especially the attitudes of the workers about the losses in the manufacturing processes.

The company should change the existing work forms that have a lot of losses in manufacturing processes to the new work forms that reduce the losses in manufacturing processes. The company should also differentiate the workers who realize on the values of producing the products with the loss at the minimize level from the workers who do not realize on the values of producing the products without losses in manufacturing processes by providing the different rewards or repaying

Generally, the company has to offer the monthly bonus to the workers who totally follow the rules of the company. The motivation system for the workers in the factory is described below.

The factory provides the monthly bonus 100 Baht for the workers who totally follow the rules, increasing 100 Baht in the next continuous month and maximum at 600 Baht. If these workers do not follow the rules in any month, they need to restart the monthly bonus at 100 Baht again.

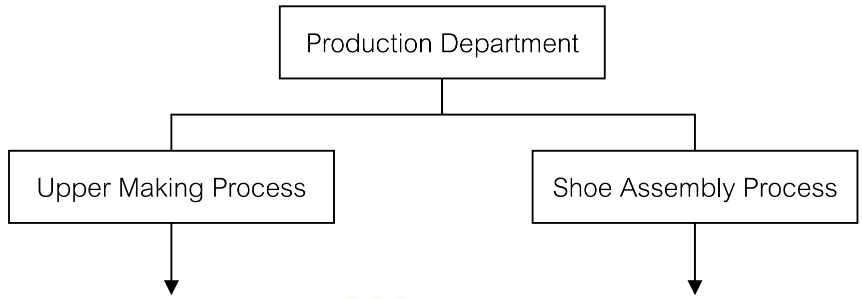
The factory also charges 50 Baht from the workers who are cautioned 3 times for mistakes on the products in their works to reduce loss products in manufacturing processes.

Job Description

The company should determine clearly the methods of working for the workers in the key processes to help the workers in those processes totally understand their jobs and how to complete their jobs well by using job description documents.

Job description consists of descriptions about works in each process, emphasizing on the details in the factory directly related to the manufacturing processes. The information of job descriptions is collected from each worker in the real operation and the general methods of shoe production.

The job description documents of shoe manufacturing in the factory that are created for each manufacturing process in the production department are separated into two main production lines: upper making and shoe assembly as demonstrated in Figure 5-7.



Job Description Documents

- Upper cutting and toe puff applying
- Stitching and folding
- Component preparing

Job Description Documents

- Insole nailing
- Back part moulding
- Lasting
- Heat setting
- Nail taking out
- Roughing
- Gluing
- Heat activating
- Sole attaching
- Last slipping
- Heel nailing
- Insert sock lining.

Figure 5-7 Chart of creating job description documents.

Figure 5-7 shows the chart of creating job description documents for the production department in two main production lines: upper making and shoe assembly processes.

The examples of description documents in the production department for each process of both main shoe production lines are demonstrated below.

Job Description Document

Department	Production (Upper Making)
Subject	Upper Cutting and Toe Puff Applying
Position	Upper Cutting Worker

Upper Cutting

1. Bring the synthetic leather sheet (P.U. material) approximately 6 layers on the 2 square-wah table.
2. Put the pattern of upper shoe on the P.U. material to plot and draw 18-20 pairs of upper shoe each synthetic leather sheet.
3. Use the travelling head hydraulic cutting machine to cut the layers of P.U. material following the drawn patterns, which are coincident with both size and side of the patterns.

(The lining sheets also are cut following the same processes above)

Toe Puff Applying

4. Put the chemical sheet on the back part of upper shoe to be better shaped.
5. Bring the upper shoes pass the thermoplastic toe puff applying machine to cover the upper shoes with plastic for better setting.
6. Prepare the upper, back part lining, and toe part lining 10 pairs each set for the stitching and folding process.

Major Description

- Cut the uppers and linings and puff the toe part of upper.

Minor Description

- Clean the square-wah table and thermoplastic toe puff applying machine

Job Description Document

Department	Production (Upper Making)
Subject	Stitching and Folding
Position	Stitching Worker

<u>Stitching and Folding</u>

1. Glue the back part lining and toe part lining stick together.
2. Glue on the inner side of synthetic leather upper edge
3. Lay the tape on the synthetic leather upper edge to protect ripping when it passes lasting machines.
4. Overlap the upper and lining to fold their inner edge by using the edge folding machine.
5. Stitch the upper and lining together by using the flat bed single needle sewing machine.
6. Check the quality and quantity of the upper shoes.
7. Fix the tags on the upper shoes to show who produce them, when they are produced, and how many they are produced.
8. Put these upper shoes to keep at the component preparation area.

<u>Major Description</u>

- Stitch and fold the uppers and linings together.

<u>Minor Description</u>

- Clean the flat bed single needle sewing machine and edge folding machine.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Component Preparing
Position	Preparing Worker

Component Preparing

1. Prepare uppers (including chemical sheets), insoles, outsoles, heels, sock linings, and lasts about 100 pairs each set.
2. Move 100 pairs of uppers, insoles, and lasts to the insole nailing area each round.
3. Move 100 pairs of outsoles to the gluing area each round.
4. Move 100 pairs of heels to the heel nailing area each round.
5. Move 100 pairs of sock linings to the insert sock lining area each round.

Major Description

- Prepare and inspect the components from the upper making process to feed them in the shoe assembly process.

Minor Description

- Check the upper volumes and sizes to be consistent with the orders.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Insole Nailing
Position	Insole Nailing Worker

<u>Insole Nailing</u>

1. Put the last upside down.
2. Put the insole on the bottom of the last to be compatible both toe part and back part of the insole with the last.
3. Use insole stapler drives the nails to attach insole and last together by treading the machine 1 time per nail shot.
   - At back part, right side 2 shots and left side 2 shots.
   - At toe part, right side 2 shots, left side 2 shots, and middle 1 shot.
4. Put the insole and last on the belt used for transmitting power.

<u>Major Description</u>

- Nail the insole and last together by using the insole stapler.

<u>Minor Description</u>

- Prepare the nails and clean the insole staper.

Job Description Document

Department Production (Shoe Assembly)

Subject Back Part Moulding

Position Back Part Moulding Worker

Back Part Moulding

1. Dip the chemical sheet in benzene to dissolve to be glue.
2. Put the dissolved chemical sheet on the back part of the upper.
3. Smooth the upper by using the pincer to get rid of the wrinkles on the back part of upper.
4. Put the lining on the back part of upper.
5. Smooth the upper again.
6. Put the upper on the belt used for transmitting power to pass heat oven.
7. Bring the upper from heat oven to mould the back part of upper by using the backpart moulding machine. (The machine holds the upper on the designed pattern about 10 seconds and then the machine springs the upper back.)

Major Description

- Mould the back part of the upper.

Minor Description

- Prepare the benzene tank and clean the backpart moulding machine and heat oven No.1.

Job Description Document

Department Production (Shoe Assembly)

Subject Lasting

Position Lasting Worker

Toe Lasting

1. Glue the edge of insole, last, and upper.
2. Put the same side and size of the last, upper, and insole on the belt used for transmitting power to pass heat oven.
3. Take the upper from the belt used for transmitting power to cover the insole and last.
4. Put the upper, insole, and last on the automatic pulling over toe lasting machine.
5. Press button 1, the pincers of the machine catch the middle toe part of upper and insole.
6. Press button 2, the pincers of the machine catch the right and left side of the toe part of upper and insole.
7. Press button 3, the pincers of the machine catch the right and left side of center part of upper and insole.
8. Adjust the position of the edge of upper and last by controlling the pump handle of the machine.
9. Press button 4, the machine gathers and presses the upper and insole at the glued part.
10. Put the upper and insole on the belt used for transmitting power.

Job Description Document

Department Production (Shoe Assembly)

Subject Lasting (continue)

Position Lasting Worker

Heel Seat Lasting

11. Put the last upside down.
12. Use the pincer pull the middle edge of upper to stick with the edge of insole both inner and outer side.
13. Put the upper and insole on the base of hydraulic heel seat lasting machine.
14. Press the button, the machine gather and press the edge of the back part of upper to stick with the insole.

Major Description

- Last the upper and insole together.

Minor Description

- Prepare the pincer and glue (Latex) cans.
- Clean the automatic pulling over toe lasting machine, hydraulic heel seat lasting machine, and heat oven No. 2.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Heat Setting
Position	Heat Setting Worker

Heat Setting

1. Arrange the uppers and insoles to put them in the six tank vacuum vulcanizing machine.
2. Put 5 pairs of uppers and insoles each shelf of the machine.
3. Press the start button, the machine heat the uppers and insoles, spending approximately 3 minutes
4. Bring the uppers and insoles out from the machine.

Major Description

- Put the uppers and insoles in the six tank vacuum vulcanizing machine.

Minor Description

- Clean the six tank vacuum vulcanizing machine.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Nail Taking Out
Position	Nail Taking Out Worker

Nail Taking Out

1. Take all staples out from the insole (9 shots)
   - 4 shots at the back part of insole.
   - 5 shots at the toe part of insole.

Major Description

- Take all staples out from the insole.

Minor Description

- Clean the belt used for transmitting power.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Roughing
Position	Roughing Worker

Bottom Roughing

1. Press the start button; the lasted upper bottom roughing machine start to spin.
2. Rough the bottom of upper and insole by putting the bottom part of upper and insole on the machine. The machine scrubs the upper and insole to get rid of the wrinkles of the upper.

Edge Roughing

3. Put the last upside down.
4. Press the start button; lasted upper edge roughing machine start to spin.
5. Bring the edge of upper into contact the machine to scrubs the edge of upper to be better gluing.

Major Description

- Rough the upper and insole to get rid of the wrinkles and to be better gluing.

Minor Description

- Clean the lasted upper bottom roughing machine and lasted upper edge roughing machine

Job Description Document

Department	Production (Shoe Assembly)
Subject	Gluing
Position	Gluing Worker

Gluing

1. Glue the whole bottom area, specially the edge of upper that is under the insole and last.
2. Glue the outsole.
3. Prepare the same side and size of lasts, uppers, insoles and outsoles to be attached together.
4. Put the sets of lasts, uppers, insoles and outsoles on the belt used for transmitting power to pass heat oven.

Major Description

- Glue the insole (including the last and upper) and outsole to prepare attaching together.

Minor Description

- Prepare the glue (Neoprene Adhesive) tank.

Job Description Document

Department Production (Shoe Assembly)

Subject Heat Activating

Position Heat Activating Worker

Heat Activating

1. Pass the lasts, uppers, insoles, and outsoles in the heat oven to activate the glue to be better attaching, spending about 1 minute.

Major Description

- Put the lasts, uppers, insoles, and outsoles pass the heat oven to the activate the glue.

Minor Description

- Clean the heat oven No.3.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Sole Attaching
Position	Sole Attaching Worker

Sole Attaching

1. Bring the last, upper, insole, and outsole from the belt used for transmitting power.
2. Put the upper, insole, and last upside down by left hand.
3. Hold the middle side of outsole by right hand.
4. Attach the upper, insole, last, and outsole together.
5. Press the edge to ensure the 2 parts stick together.
6. Put the shoe on the universal sole attaching machine.
7. Press the button; the machine presses the outsole with the last by using pressure of gas.
8. Bring the shoe out from the machine.

Major Description

- Attach the insole and outsole together.

Minor Description

- Clean the universal sole attaching machine.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Last Slipping
Position	Last Slipping Worker

Last Slipping

1. Put the last upside down.
2. Put back part of last on the hydraulic last slipping machine.
3. Press the button; the machine hooks and pushes the shoes out from the last.
4. Put the shoe on the belt used for transmitting power.

Major Description

- Slip the last out from the shoe.

Minor Description

- Clean the hydraulic last slipping machine.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Heel Nailing
Position	Heel Nailing Worker

Heel Nailing

1. Glue the bottom of shoe at heel area.
2. Glue the same side and size of heel.
3. Attach the heel with the shoe.
4. Put nails in the 4 holes of semi-automatic hydraulic heel nailing machine.
5. Put the shoe upside down to cover the base of the machine.
6. Press button 1; the machine holds the shoe by its pincers.
7. Press button 2 to drive the nails on the heel.
8. Put the shoe on the belt used for transmitting power.

Major Description

- Nail the heel and shoe together.

Minor Description

- Prepare the glue (Neoprene Adhesive) tank.
- Clean the semi-automatic hydraulic heel nailing machine.

Job Description Document

Department	Production (Shoe Assembly)
Subject	Insert Sock Lining
Position	Insert Sock Lining Worker

Insert Sock Lining

1. Prepare a set of sock lining and shoe in the same size and side.
2. Glue the sock lining by passing the neoprene glue pasting machine to cover the bottom side of sock lining with glue.
3. Put the same size and side of sock lining and shoe on the belt used for transmitting power.
4. Put the sock lining and shoe from the belt used for transmitting power.
5. Glue the inner side of insole by using the brush.
6. Attach the sock lining on the inner side of insole.
7. Press the sock lining with the insole to ensure that it sticks together.
8. Clean the shoes and wipe the exceeding glue out.

Major Description

- Insert sock lining in the shoe.

Minor Description

- Prepare the glue (Neoprene Adhesive) tank.
- Clean the neoprene glue pasting machine.

5.2.1.2 Loss Reduction from the Material Based on Quality

Loss reduction related on the worker

- Loss from low quality materials is reduced by purchasing the standard materials.

<u>Purchasing the standard material</u>

According to the materials of the factory, the synthetic leather for upper making, insole, and outsole are derived from the regular suppliers so the factory cannot control the quality of these materials. Therefore, this loss is an uncontrollable loss in the manufacturing process of the factory.

However, the company may reduce this loss by find and negotiate with the new suppliers that provide the higher standard materials than the existing materials are.

5.2.1.3 Loss Reduction from the Method Based on Quality

Loss reduction related on the method

- Loss from bad communication is reduced by using documents in commanding the jobs.

<u>Documentation</u>

For the bad communication problem in operating works, including both upward and downward communication, documentation helps the managers and workers to communicate and remember about tasks clearly.

An important document that helps the managers and works to have a clear vision about their tasks is job list. For an example, the workers clearly know the sizes and product types that they produce each day. The job order is shown Table 5-15.

Table 5-15 The Example of Daily Job Order in
Upper Cutting and Toe Puff Applying Process

Day / Month / Year	Task	Detail
1 June 2002	Upper Cutting and Toe Puff Applying (Black Color / Upper of Short Heel Shoe)	<u>First Round</u> Size 6 -- 20 pairs Size 6 ½ -- 20 pairs Size 7 -- 30 pairs Size 7 ½ -- 30 pairs Size 8 -- 55 pairs Size 8 ½ -- 60 pairs Size 9 -- 55 pairs Size 9 ½ -- 40 pairs Size 10 -- 40 pairs <u>Second Round</u> Size 6 -- 20 pairs Size 6 ½ -- 20 pairs Size 7 -- 30 pairs Size 7 ½ -- 30 pairs Size 8 -- 55 pairs Size 8 ½ -- 60 pairs Size 9 -- 55 pairs Size 9 ½ -- 40 pairs Size 10 -- 40 pairs

Table 5-15 illustrates the example of job order and its details each day.

5.2.2 Loss Reduction Based on Quantity

Loss reduction based on quantity is considered about the causes and losses based on quantity and analyze to find the methods to reduce these losses in term of quantity.

5.2.2.1 Loss Reduction from the Worker Based on Quantity

Loss reduction related on the worker

- Loss from misunderstand working of workers is reduced by creating job descriptions in the key processes .
- Loss from intractable working of workers is reduced by setting up the motivation system in the company.

The details of job description for each process are shown at the appendix.

5.2.2.2 Loss Reduction from the Material Based on Quantity

Loss reduction related on the material

- Loss from lack of materials due to the delays of suppliers is an uncontrollable loss. Therefore, the company cannot find the materials in that period or reduce this loss in manufacturing processes.

5.2.2.3 Loss Reduction from the Method Based on Quantity

Loss reduction related on the method

- Loss from bad Production plan is reduced by using multi-skill labors and creating production time schedule for producing shoes.
- Losses from bad inventory control and bad material order are reduced by using documents to record the amounts and uses of materials.

Multi-Skilled Labor

The existing production plan of the factory is the only idea of the production manager based on his experiences. Therefore, the factory has no formal method to plan the production processes so it has many problems in term of quantity of the products such as production delay or bottleneck process.

The company must train some workers to work in multiple processes. For an example, the workers who work in the short-time process such as lasting the front part of shoe upper process should have the skills to help the workers in the long-time process such as lasting the back part of shoe upper to reduce the loss time or bottleneck problem in the manufacturing process.

The approach to reduce the manufacturing loss time by hiring the part-time workers to help in the long-time process is not effective because those workers need to be trained for a period before starting their works in the manufacturing process. It causes the additional costs and times to complete this approach.

Thus, training the workers in the short-time process to help workers in the long-time process is an effective plan due to no need to spend additional costs to hire part-time workers and to train the new workers for the new processes frequently.

The supervisors must set up the special courses for some workers who are in the short processes to train the works in the long processes, spending about 3 hours. Therefore, these workers who can work in 2-3 manufacturing processes help the other workers who are in the long processes when the production plan is not appropriate to avoid the bottleneck problem in the manufacturing processes.

Production Time Schedule

The effective production plan is necessary, especially ordering the jobs in manufacturing processes and drawing the production time schedules. The production manager should command the jobs based on their priorities and draw the production time schedules to help in operating the manufacturing process to be associated with other processes. It also helps to reduce breaking works off and situations that the workers in the process need to wait the products from the prior process. For an example in upper making process, the materials from suppliers delay about one week so the factory has to order materials before production date one week. Thus, the factory needs to plan the production processes for the next period.

The manager also knows the trends of production volume and time in production processes so he can control the production volume to meet the requirements and conditions of customer or transportation appropriately.

Therefore, the works in each production process flow continually with the effective production plan by using monthly the production time schedules and multiple skill workers to reduce loss times and bottleneck problems in the manufacturing processes.

An example of the production time schedule for shoe manufacturing processes in November are shown in the Table 5-8.

Table 5-16 The Example of Production Time Schedule in November

(Unit: Volume / Type)

Production Process	1	2	3	4	5	6	7	8	9	10
1. Upper cutting and box toe applying	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
2. Folding and stitching	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
3. Component preparing	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
4. Insole nailing on last	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
5. Back part moulding	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
6. Lasting	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
7. Heat setting	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
8. Nail taking out	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
9. Roughing	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
10. Gluing	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
11. Heat activating	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
12. Sole attaching	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
13. Last slipping	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
14. Heel nailing	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-
15. Insert sock lining and cleaning	700/S	700/S	-	700/S	700/S	700/S	700/S	700/S	700/S	-

Production Process	11	12	13	14	15	16	17	18	19	20
1. Upper cutting and box toe applying	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
2. Folding and stitching	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
3. Component preparing	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
4. Insole nailing on last	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
5. Back part moulding	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
6. Lasting	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
7. Heat setting	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
8. Nail taking out	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
9. Roughing	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
10. Gluing	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
11. Heat activating	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
12. Sole attaching	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
13. Last slipping	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
14. Heel nailing	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L
15. Insert sock lining and cleaning	700/S	700/S	700/S	700/S	700/S	700/S	-	700/S	500/S, 200L	700/L

Production Process	21	22	23	24	25	26	27	28	29	30
1. Upper cutting and box toe applying	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
2. Folding and stitching	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
3. Component preparing	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
4. Insole nailing on last	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
5. Back part moulding	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
6. Lasting	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
7. Heat setting	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
8. Nail taking out	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
9. Roughing	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
10. Gluing	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
11. Heat activating	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
12. Sole attaching	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
13. Last slipping	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
14. Heel nailing	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L
15. Insert sock lining and cleaning	700/L	700/L	700/L	-	700/L	700/L	700/L	700/L	700/L	700/L

S – Short Heel Type, L – Long Heel Type

Wuthichai (Production Planner) Withaya (Production Manager)

Inventory Documents

Documentation about the amounts and uses of materials help the purchasing manager to know the actual level of materials in the stock and its uses in each process so he knows and plans how much inventory should be hold and when the materials should be ordered exactly.

Thus, the company should make the documents to record the amounts of inventory in the stock and its uses. The essential documents for inventory control are the material bills and monthly material requisition reports described already in the chapter 4.

Table 5-17 Problems and Loss Reduction in Term of Quality

Influenced Resource	Problem	Controllable	Uncontrollable	Loss Reduction
Man	Different ability to work	√		Introduce training and testing program
	Low skills	√		Introduce training and testing program
	Inefficient machine controlling	√		Create job description
	Mindless working	√		Set up motivation System
Material	Low quality		√	
Method	Bad communication	√		Create order documents

Table 5-18 Problems and Loss Reduction in Term of Quantity

Influenced Resource	Problem	Controllable	Uncontrollable	Loss Reduction
Man	Misunderstand working	√		Create job description
	Intractable working	√		Set up motivation System
Material	Lack of material		√	
Method	Bad production plan	√		Create production time schedules
	Bad inventory control	√		Use inventory documents
	Bad material order	√		Use inventory documents

The problems and loss reductions of each problem in manufacturing processes are summarized in the table 5-17 in term of quality and table 5-18 in term of quantity.

It shows that the losses of material problems both in term of quality and quantity are the uncontrollable losses so the factory cannot reduce these losses in manufacturing processes. Therefore, this research finds the ways to reduce the losses of worker and method problems in the manufacturing processes explained above.

CHAPTER 6

RESULTS AND COMPARISONS

The results of manufacturing process cost reduction are measured in term of manufacturing costs by calculating the manufacturing costs before and after cost reductions to find the effectiveness of manufacturing cost reductions.

The information of the manufacturing costs is divided into two periods:

1. The manufacturing costs before cost reductions in June-August.
2. The manufacturing costs after cost reductions in October-December.

The manufacturing costs in each period is compared with each other to know how much the manufacturing costs change.

The manufacturing costs before cost reductions are calculated in the chapter 4. Therefore, in this chapter the manufacturing costs after cost reductions are calculated to be compared with the results in June-August. According to the manufacturing process cost reductions, the manufacturing cost and productivity of the factory in October-December change from the results in June-August. The manufacturing process costing in October-December is demonstrated below.

Calculations of manufacturing costs of the factory in October-December also are analyzed separately in two main production lines: upper making and shoe assembly.

6.1 Manufacturing Costing of Upper Making in October-December

Table 6-1 Work-in-Process Volumes in Upper Making Process
at the Beginning of October-December

Upper Making Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Upper cutting and box toe applying	0	0
2. Folding and stitching	424	389

Table 6-1 shows work-in-process volumes of each product type in each sub-production process of upper making at the beginning of October-December period.

Table 6-2 Work-in-Process Volumes in Upper Making Process
at the End of October-December

Upper Making Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Upper cutting and box toe applying	0	0
2. Folding and stitching	441	406

Table 6-2 shows work-in-process volumes of each product type in each sub-production process of upper making at the end of October-December period.

The factory still has 35 direct labors in upper making process.

Table 6-3 Direct Labor Time and Cost of Upper Making in October-December

Upper Making Process	Normal Time Labor		Over Time Labor		Total	
	Cost	Hour	Cost	Hour	Cost	Hour
1. Upper cutting and box toe applying	48764	2336	0	0	48764	2336
2. Folding and stitching	377921	18104	0	0	377921	18104
Total	426685	20440	0	0	426685	20440

Table 6-3 shows direct labor times and costs of each sub-production process in upper making for normal time and over time labors in October-December.

Table 6-4 Common Factory Overhead Costs of Upper Making in October-December

Factory Overhead Costs in October-December	Sum
1. Indirect material cost	54992
2. Indirect labor cost	39000
3. Machines and tools depreciation cost	65750
4. Maintenance cost	28874
5. Factory material and other costs	47991
Total	236607

Therefore, the common factory overhead cost for upper making October-December is 236607 Baht.

Table 6-5 Total Complete and Defective Uppers of Upper Making in October-December

Product Type	Short Heel Shoe	Long Heel Shoe
Complete Upper	29695	26013
Defective Upper	924	807

Table 6-5 demonstrates the total complete and defective uppers of each product type in October-December.

From the above information, the shoe manufacturing process costs of upper making in the factory are demonstrated as following.

6.1.1 Direct Material Cost in Upper Making

The equivalent units of each product type in October-December are demonstrated in Table 6-6.

Table 6-6 Equivalent Unit for Upper Making Process in October-December

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	29712	26030

The direct material costs are calculated from:

Synthetic leather cost = $(E_{upper-j} + L_{upper-j}) \times P_{pu}$

For the short heel shoe, the synthetic leather cost is:

(29712+ 924) x 26.44 = 810016 Baht

For the long heel shoe, the synthetic leather cost is:

(26030+807) x 26.44 = 709570 Baht

P.V.C. lining cost = $(E_{upper-j} + L_{upper-j}) \times P_{pvc}$

For the short heel shoe, the P.V.C. lining cost is:

(29712+ 924) x 7.46 = 228545 Baht

For the long heel shoe, the P.V.C. lining cost is:

(26030+807) x 7.46 = 200204 Baht

Pigskin leather lining cost = $(E_{upper\text{-}j} + L_{upper\text{-}j}) \times P_{pigskin}$

For the short heel shoe, the pigskin leather lining cost is:

(29712+ 924) x 5.6 = 171562 Baht

For the long heel shoe, the pigskin leather lining cost is:

(26030+807) x 5.6 = 150287 Baht

6.1.2 Direct Labor Cost in Upper Making

The direct labor cost for product type-j is calculated from:

$$(C_{labor} \times E_{upper\text{-}j} \times T_{upper\text{-}j}) / \{\sum_{J=1}^{2}(E_{upper\text{-}j} \times T_{upper\text{-}j})\}$$

C_{labor} = total direct labor cost = 426685 Baht

$\sum(E_{upper\text{-}j} \times T_{upper\text{-}j})$ = $(E_{upper\text{-}short} \times T_{upper\text{-}short}) + (E_{upper\text{-}long} \times T_{upper\text{-}long})$

= (29712 x 1852)+ (26030 x 2004)

= 55026624 + 52164120 = 107190744

The direct labor cost for total short heel shoes is

$$(C_{labor} x E_{upper\text{-}short} x T_{upper\text{-}short})/\{\sum_{J=1}^{2}(E_{upper\text{-}j} x T_{upper\text{-}j})\} = (426685x29712x1852)/ 107190744$$

= 219040 Baht

The direct labor cost for total long heel shoes is

$$(C_{labor} \times E_{upper\text{-}long} x T_{upper\text{-}long})/\{\sum_{j=1}^{2}(E_{upper\text{-}j}\ x T_{upper\text{-}j})\}=(426685x26030x2004)/ 107190744$$

= 207645 Baht

6.1.3 Common Factory Overhead Cost in Upper Making

The factory overhead cost for product type-j is calculated from:

$$(C_{overhead} \times E_{upper-j} \times T_{upper-j}) \,/\, \{\sum_{J=1}^{2}(E_{upper-j} \times T_{upper-j})\}$$

$C_{overhead}$ = total common factory overhead cost = 236607 Baht

$\sum(E_{upper-j} \times T_{upper-j})$ = $(E_{upper-short} \times T_{upper-short}) + (E_{upper-long} \times T_{upper-long})$

= (29712 x 1852)+ (26030 x 2004)

= 55026624 + 52164120 = 107190744

The factory overhead cost for short heel shoe is

$$(C_{overhead} x E_{upper-short} x T_{upper-short})/\{\sum_{J=1}^{2}(E_{upper-j} x T_{upperj})\} = (236607x29712x1852)/103334744$$

= 121463 Baht

The factory overhead cost for long heel shoe is

$$(C_{overhead}\ x E_{upper-long} x T_{upper-long})/\{\sum_{j=1}^{2}(E_{upper-j} x T_{upper-j})\} = (236607x26030x2004)/103334744$$

= 115144 Baht

6.2 Manufacturing Costing of Shoe Assembly in October-December

Table 6-7 Work-in-Process Volumes in Shoe Assembly Process at the Beginning of October-December

Shoe Assembly Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Component preparing	212	195
2. Insole nailing on last	0	0
3. Back part moulding	370	316
4. Lasting	0	0
5. Heat setting	0	0
6. Nail taking out	0	0
7. Roughing	0	0
8. Gluing	0	0
9. Heat activating	0	0
10. Sole attaching	0	0
11. Last slipping	0	0
12. Heel nailing	0	0
13. Insert sock lining and cleaning	541	505

Table 6-7 shows work-in-process volumes of each product type in each sub-production process of shoe assembly at the beginning of October-December period.

Table 6-8 Work-in-Process Volumes in Shoe Assembly Process
at the End of October-December

Shoe Assembly Process	Product Type	
	Short Heel Shoe	Long Heel Shoe
1. Component preparing	0	0
2. Insole nailing on last	0	0
3. Back part moulding	230	208
4. Lasting	0	0
5. Heat setting	0	0
6. Nail taking out	0	0
7. Roughing	0	0
8. Gluing	0	0
9. Heat activating	0	0
10. Sole attaching	0	0
11. Last slipping	0	0
12. Heel nailing	0	0
13. Insert sock lining and cleaning	253	221

Table 6-8 shows work-in-process volumes of each product type in each sub-production process of shoe assembly at the end of October-December period.

Table 6-9 Direct Labor Time and Cost of Shoe Assembly in October-December

Shoe Assembly Process	Normal Time Labor		Over Time Labor		Total	
	Cost	Hour	Cost	Hour	Cost	Hour
1. Component preparing	36573	1752	6750	216	43323	1978
2. Insole nailing on last	24382	1168	4500	144	28882	1312
3. Back part moulding	24382	1168	4500	144	28882	1312
4. Lasting	207247	9928	38250	1224	245497	11152
5. Heat setting	-	-	-	-	-	-
6. Nail taking out	73146	3504	13500	432	86646	3936
7. Roughing	73146	3504	13500	432	86646	3936
8. Gluing	73146	3504	13500	432	86646	3936
1. Heat activating	-	-	-	-	-	-
2. Sole attaching	73146	3504	13500	432	86646	3936
3. Last slipping	12191	584	2250	72	14441	656
4. Heel nailing	24382	1168	4500	144	28882	1312
5. Insert sock lining and cleaning	121910	5874	22500	720	144410	6594
Total	743651	35624	137250	4392	880901	40060

Table 6-9 shows direct labor times and costs of each production process in shoe assembly line for normal time and over time labors in October-December.

Table 6-10 Factory Overhead Costs for Shoe Assembly in October-December

Factory Overhead Costs in October-December	Sum
1. Indirect material cost	89403
2. Indirect labor cost	78000
3. Machines and tools depreciation cost	193385
4. Maintenance cost	64654
5. Factory material and other costs	80550
Total	505992

From these costs, the total factory overhead cost in October-December

= 505992 Baht

Table 6-11 Total Complete and Defective Shoe of Shoe Assembly in October-December

Product Type	Short Heel Shoe	Long Heel Shoe
Complete Volume	28201	24494
Defective Volume	956	834

Table 6-11 demonstrates the total complete and defective shoes of each product type in October-December.

From the above information, the shoe manufacturing process costs of shoe assembly in the factory are demonstrated as following.

6.2.1 Direct Material Cost in Shoe Assembly

The equivalent units of each product type in October-December are shown in the Table 6-12.

Table 6-12 Equivalent Unit for Upper and Insole of Shoe Assembly

in October-December

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	27875	24180

Upper and Insole

Upper cost = $(E_{assembly\text{-}j} + L_{assembly\text{-}j}) \times P_{upper}$

For the short heel shoe, the upper cost is:

(27875+ 956) x 39.5 = 1138825 Baht

For the long heel shoe, the upper cost is:

(24180+834) x 39.5 = 988053 Baht

Insole cost = $(E_{assembly\text{-}j} + L_{assembly\text{-}j}) \times P_{insole}$

For the short heel shoe, the insole cost is:

(27875+ 956) x 8.5 = 245064 Baht

For the long heel shoe, the insole cost is:

(24180+834) x 8.5 = 212619 Baht

Outsole

Table 6-13 Equivalent Unit for Outsole of Shoe Assembly

in October-December

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	27313	24210

Table 6-13 shows the equivalent units of the work-in-process products that require outsole in manufacturing processes in October-December.

Outsole cost = $(E_{outsole\text{-}j} + L_{assembly\text{-}j}) \times P_{uotsole}$

For the short heel shoe, the outsole cost is:

(27313+956) x 21.46 = 606653 Baht

For the long heel shoe, the outsole cost is:

(24010+834) x 21.46 = 533152 Baht

<u>Sock Lining</u>

Table 6-14 Equivalent Unit for Sock Lining of Shoe Assembly in October-December

Product Type	Short Heel Shoe	Long Heel Shoe
Equivalent Unit	27313	24010

Table 6-14 shows the equivalent units of the work-in-process products that require sock lining in manufacturing processes in October-December.

Sock lining cost = $(E_{sock\text{-}j} + L_{assembly\text{-}j}) \times P_{sock}$

For the short heel shoe, the sock lining cost is:

(27313+956) x 2.3 = 65019 Baht

For the long heel shoe, the sock lining cost is:

(24010+834) x 2.3 = 57141 Baht

6.2.2 Direct Labor Cost in Shoe Assembly

The direct labor cost for product type-j is calculated from:

$$(C_{labor\text{-}assembly} \times E_{assembly\text{-}j} \times T_{assebmly\text{-}j}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} \times T_{assembly\text{-}j})\}$$

$C_{labor\text{-}assembly}$ = total direct labor cost = 880901 Baht

$\{\sum(E_{assembly\text{-}j} \times T_{assembly\text{-}j})$ = $(E_{assembly\text{-}short} \times T_{assebmly\text{-}short}) + (E_{assembly\text{-}long} \times T_{assebmly\text{-}long})$

= (27875x3308) + (24180x4017)

= 92210500 + 97131060 = 189341560

The direct labor cost for total short heel shoes is

$$(C_{labor} x E_{assembly\text{-}short} x T_{assembly\text{-}short})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j})\}$$

=(880901x27875x3308)/ 189341560

= 429004 Baht

The direct labor cost for total long heel shoes is

$$(C_{labor} x E_{assembly\text{-}long} x T_{assembly\text{-}long})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j}))\}$$

= (880901x24180x4017) / 189341560

= 451897 Baht

6.2.3 Common Factory Overhead Cost in Shoe Assembly

The factory overhead cost for product type-j is calculated from:

$$(C_{overhead\text{-}assembly} \times E_{assembly\text{-}j} \times T_{assebmly\text{-}j}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} \times T_{assembly\text{-}j})\}$$

$C_{overhead\text{-}assembly}$ = total common factory overhead cost=505992 Baht

$\{\sum(E_{assembly\text{-}j} \times T_{assembly\text{-}j})$ = $(E_{assembly\text{-}short} \times T_{assebmly\text{-}short}) + (E_{assembly\text{-}long} \times T_{assebmly\text{-}long})$

= (27875x3308) + (24180x4017)

= 92210500 + 97131060 = 189341560

The common factory overhead cost for short heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}short} x T_{assembly\text{-}short}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j})\}$$

= (505992 x27875x3308) / 189341560

= 246421 Baht

The common factory overhead cost for long heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}long} x T_{assembly\text{-}long}) / \{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j})\}$$

= (505992 x24180x4017) / 189341560

= 259571 Baht

6.3 Mutual FOH and Conversion Cost

Table 6-15 Mutual Factory Overhead Costs of Shoe Assembly in October-December

Mutual Factory Overhead Costs	Sum
1. Production manager salary	75000
2. Security cost	33000
3. Building depreciation cost	72500
4. Rent	66000
5. Tax	20148
6. Electric supply cost	85143
7. Water supply cost	5505
8. Telephone cost	13173
Total	370469

From these costs, the total mutual FOH in October-December

= 370469 Baht

The conversion costs (direct labor cost and factory overhead cost) of upper making and shoe assembly process are calculated below.

6.3.1 Conversion Cost in Upper Making Process

In the upper making process, the total direct labor cost is 426685 Baht and the common factory overhead cost is 231607 Baht. Therefore, the conversion cost of upper making is:

426685 + 236607 = 663292 Baht

6.3.2 Conversion Cost in Shoe Assembly Process

In the shoe assembly process, the total direct labor cost is 880901 Baht and the common factory overhead cost is 517992 Baht. Therefore, the conversion cost of shoe assembly is:

880901 + 505992 = 1386893 Baht

Thus, the total conversion cost of both main processes is

663292 + 1386893 = 2050185 Baht

6.3.3 Mutual Factory Overhead Cost Allocation

The total mutual FOH in October-December is 380596 Baht. This cost is allocated to add to the common FOH costs of the upper making and shoe assembly processes in the proper proportion.

The mutual FOH that is allocated to the upper making process is:

370469 x (663292 / 2050185) = 119857 Baht

Therefore, the total FOH of upper making is:

236607 + 119857 = 356464 Baht

The mutual FOH that is allocated to the shoe assembly process is:

370469 x (1386893 / 2050185)= 250612 Baht

Therefore, the total FOH of shoe assembly is:

505992 + 250612 = 756604 Baht

6.3.4 Direct Labor and Factory Overhead Cost per Hour

Upper Making Process

In October-December period, the total direct labor costs are 426685 Baht and the total direct labor times are 20440 Hours. Therefore, calculation of the direct labor cost per hour is:

426685 / 20440 = 20.88 Baht / Hour.

In October-December period, the total FOH costs are 378171 Baht and the total direct labor times are 20440 Hours. Therefore, calculation of the FOH cost per hour is:

356464 / 20440 = 17.44 Baht / Hour.

<u>Shoe Assembly Process</u>

In October-December period, the total direct labor costs are 880901 Baht and the total direct labor times are 40060 Hours. Therefore, calculation of the direct labor cost per hour is:

880901 / 40060 = 21.99 Baht / Hour.

In October-December period, the total FOH costs are 766897 Baht and the total direct labor times are 40060 Hours. Therefore, calculation of the FOH cost per hour is:

756604 / 40060 = 18.91 Baht / Hour.

6.3.5 Total Factory Overhead Cost for Each Product Type

The total factory overhead costs in upper making and shoe assembly process of each product type are calculated below.

<u>Upper Making Process</u>

$C_{overhead\text{-}upper}$ = total factory overhead cost = 356464 Baht

$\sum(E_{upper\text{-}j} \times T_{upper\text{-}j})$ = $(E_{upper\text{-}short} \times T_{upper\text{-}short}) + (E_{upper\text{-}long} \times T_{upper\text{-}long})$

= (29712 x 1852)+ (26030 x 2004)

= 55026624 + 52164120 = 107190744

The total factory overhead cost for short heel shoe is

$(C_{overhead\text{-}upper} x E_{upper\text{-}short} x T_{upper\text{-}short}) / \{\sum_{J=1}^{2}(E_{upper\text{-}j} x T_{upper\text{-}j})\}$

=(356464x29712x1852)/ 107190744

= 1829922 Baht

The total factory overhead cost for long heel shoe is

$$(C_{overhead\text{-}upper} x E_{upper\text{-}long} x T_{upper\text{-}long})/\{\sum_{J=1}^{2}(E_{upper\text{-}j} x T_{upper\text{-}j}) \}$$

= (356464x26030 x 2004) / 103334744

= 173472 Baht

Shoe Assembly Process

$C_{overhead\text{-}assembly}$ = total factory overhead cost = 756604 Baht

$\sum(E_{assembly\text{-}j} x T_{assembly\text{-}j})$ = $(E_{assembly\text{-}short} \times T_{assembly\text{-}short}) + (E_{assembly\text{-}long} \times T_{assembly\text{-}long})$

= (27875x3308) + (24180x4017)

= 92210500 + 97131060 = 189341560

The total factory overhead cost for short heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}short} x T_{assembly\text{-}short})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j}) \}$$

= (756604x27875 x 1852) / 189341560

= 368471 Baht

The total factory overhead cost for long heel shoe is

$$(C_{overhead\text{-}assembly} x E_{assembly\text{-}long} x T_{assembly\text{-}long})/\{\sum_{J=1}^{2}(E_{assembly\text{-}j} x T_{assembly\text{-}j}) \}$$

= (756604x24180 x 2004) / 189341560

= 388253 Baht

6.4 Details of Manufacturing Costs in October-December

The details of manufacturing costs consist of:

- Total cost and cost per unit of direct material.
- Total cost and cost per unit of direct labor and FOH.
- Cost Structure

6.4.1 Details of Manufacturing Costs for Upper Making

Total Costs and Cost per Unit of Direct Material

From calculation of direct material costs of upper making in page 160-161, the total costs of synthetic leather, P.V.C. lining, pigskin lining are shown in Table 6-16.

Table 6-16 Direct Material Cost of Upper Making in October-December

Product Type	Direct Material Cost (Baht)			
	Synthetic Leather	P.V.C Lining	Pigskin Lining	Total
Short Heel	810016	228545	171562	1210123
Long Heel	709570	200204	150287	1060061
Total	1519586	428749	321849	2270184

The direct material cost per unit = Direct Material Cost / Equivalent Unit

The equivalent unit of short heel shoes = 29712 Baht.

The equivalent unit of long heel shoes = 26030 Baht

Therefore, the direct material costs per unit of synthetic leather, P.V.C. lining, and pigskin lining in upper making process are shown in Table 6-17.

Table 6-17 Direct Material Cost per Unit of Upper Making in October-December

Product Type	Direct Material Cost per Unit (Baht)			
	Synthetic Leather	P.V.C Lining	Pigskin Lining	Total
Short Heel	27.26	7.69	5.77	40.72
Long Heel	27.26	7.69	5.77	40.72

<u>Total Costs and Cost per Unit of Direct Labor and FOH</u>

From Table 6-3 and calculation of direct labor costs of upper making in page 161-162, the total direct labor costs of each product type are shown in Table 6-18.

From calculation of mutual FOH allocation in page 172 and total FOH of upper making in page 173-174, the total FOH of each product type are shown in Table 6-18.

Table 6-18 Direct Labor and FOH costs of Upper Making in October-December

Product Type	Direct Labor Cost (Baht)	Factory Overhead Cost (Baht)
Short Heel	219040	182992
Long Heel	207645	173472
Total	426685	356464

The direct labor cost per unit = Direct Labor Cost / Equivalent Unit

The factory overhead cost per unit = Factory Overhead Cost / Equivalent Unit

The equivalent unit of short heel shoes = 29712 Baht.

The equivalent unit of long heel shoes = 26030 Baht

Therefore, the direct labor costs per unit and factory overhead costs per unit in upper making process are shown in Table 6-19.

Table 6-19 Direct Labor and FOH Costs per Unit of Upper Making in October-December

Product Type	Direct Labor Cost per Unit (Baht)	Factory Overhead Cost per Unit (Baht)
Short Heel	7.37	6.16
Long Heel	7.98	6.66

Cost Structure of Upper Making

From the costs per unit of direct material in Table 6-17 and the costs per unit of direct labor and factory overhead in Table 6-19, the cost structures of upper making for the short shoe and long heel shoe are illustrated in the Table 6-20 and Table 6-21.

Table 6-20 Cost Structure of Short Heel Shoe for Upper Making in October-December

Item	Cost per Unit (Baht per Unit)	%
Direct Material	40.72	75.06
Direct Labor	7.37	13.59
Factory Overhead	6.16	11.35
Total	54.25	100

Table 6-21 Cost Structure of Long Heel Shoe for Upper Making in October-December

Item	Cost per Unit (Baht per Unit)	%
Direct Material	40.72	73.56
Direct Labor	7.98	14.41
Factory Overhead	6.66	12.03
Total	55.36	100

6.4.2 Details of Manufacturing Costs for Shoe Assembly

Total Costs and Cost per Unit of Direct Material

From calculation of direct material costs of shoe assembly in page 167-168, the total costs of upper, insole, outsole, and sock lining in shoe assembly are demonstrated in Table 6-22.

Table 6-22 Direct Material Cost of Shoe Assembly in October-December

Product Type	Direct Material Cost (Baht)				
	Upper	Insole	Outsole	Sock lining	Total
Short Heel	1138825	245064	606653	65019	2055561
Long Heel	988053	212619	533152	57141	1790965
Total	2126878	457683	1139805	122160	3846526

The direct material cost per unit = Direct Material Cost / Equivalent Unit

The equivalent unit of short heel shoes for upper and insole = 27875 Baht.

The equivalent unit of long heel shoes for upper and insole = 24180 Baht

The equivalent unit of short heel shoes for outsole and sock lining = 27313 Baht

The equivalent unit of short heel shoes for outsole and sock lining = 24210 Baht

Therefore, the direct material costs per unit of upper insole, outsole, and sock lining in shoe assembly are shown in Table 6-23.

Table 6-23 Direct Material Cost per Unit of Shoe Assembly in October-December

Product Type	Direct Material Cost per Unit (Baht)				
	Upper	Insole	Outsole	Sock lining	Total
Short Heel	40.85	8.79	22.21	2.38	74.23
Long Heel	40.86	8.79	22.21	2.38	74.24

<u>Total Costs and Cost per Unit of Direct Labor and FOH</u>

From Table 6-9 and calculation for direct labor costs of shoe assembly in page 169, the total direct labor costs of each product type are shown in Table 6-24.

From calculation of mutual FOH allocation in page 172 and total FOH of shoe assembly in page 175, the total factory overhead costs of each product type are shown in Table 6-24.

Table 6-24 Direct Labor and Factory Overhead Cost of Shoe Assembly in October-December

Product Type	Direct Labor Cost (Baht)	Factory Overhead Cost (Baht)
Short Heel	429004	368471
Long Heel	451897	388253
Total	880901	756604

The direct labor cost per unit = Direct Labor Cost / Equivalent Unit

The factory overhead cost per unit = Factory Overhead Cost / Equivalent Unit

The equivalent unit of short heel shoes for upper and insole = 27875 Baht.

The equivalent unit of long heel shoes for upper and insole = 24180 Baht

Therefore, the direct labor costs per unit and factory overhead costs per unit in shoe assembly process are shown in Table 6-25.

Table 6-25 Direct Labor and Factory Overhead Cost per Unit of Shoe Assembly in October-December

Product Type	Direct Labor Cost per Unit (Baht)	Factory Overhead Cost per Unit (Baht)
Short Heel	15.39	13.22
Long Heel	18.69	16.06

<u>Cost Structure of Shoe Assembly</u>

From the costs per unit of direct material in Table 6-23 and the costs per unit of direct labor and factory overhead in Table 6-25, the cost structures of shoe assembly for the short shoe and long heel shoe are illustrated in the Table 6-26 and Table 6-27.

Table 6-26 Cost Structure of Short Heel Shoe for Shoe Assembly in October-December

Item	Cost per Unit (Baht per Unit)	%
Direct Material	74.23	72.18
Direct Labor	15.39	14.96
Factory Overhead	13.22	12.86
Total	102.84	100

Table 6-27 Cost Structure of Long Heel Shoe for Shoe Assembly in October-December

Item	Cost per Unit (Baht per Unit)	%
Direct Material	74.24	68.12
Direct Labor	18.69	17.15
Factory Overhead	16.06	14.73
Total	108.99	100

6.5 Defect and T-Account in October-December

The percentages of defect in upper making and shoe assembly processes are calculated below.

6.5.1 Percentage of Defect in Upper Making Process

Percentage of Defect = (Defect / Production Volume) x100

Table 6-28 Percentage of Defect in Upper Making Process in October-December

Product Type	Equivalent Unit	Defect (Unit)	Total Production Volume (Unit)	Percentage of Defect (%)
Short Heel	29712	924	30636	3.02
Tall Heel	26030	807	26837	3.01
Total	55742	1731	57473	3.01

In upper making process, the total defects are 1731 units. These defects are also influenced from the mistake of resources in producing shoes such as worker, material, and method.

In shoe assembly process, the defects and percentages of short heel shoe are shown in Table 6-29 and Table 6-30. The defects and percentages of long heel shoe are shown in Table 6-31 and Table 6-32.

Table 6-29 Defect Costs of Upper for Short Heel Shoe in October-December

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	131	7106
2	Low skill working	Man	204	11067
3	Inefficient machine controlling	Man	52	2821
4	Mindless working	Man	163	8843
5	Misunderstand working	Man	82	4449
6	Intractable working	Man	95	5154
7	Low quality material	Material	73	3960
8	Bad communication	Method	44	2387
9	Bad production plan	Method	80	4340
	Total		924	50127

From Table 6-20, the upper cost per unit for short heel shoe is 54.25 Baht.

Table 6-30 Percentage of Defect Upper Cost for Short Heel Shoe in October-December

	Causes of Problem	Defect Cost	Percentage of Defect	Accumulative Percentage
1	Low skill working	11067	22.08	22.08
2	Mindless working	8843	17.64	39.72
3	Different ability to work	7106	14.17	53.89
4	Intractable working	5154	10.28	64.17
5	Misunderstand working	4449	8.88	73.05
6	Bad production plan	4340	8.66	81.71
7	Low quality material	3960	7.90	89.61
8	Inefficient machine controlling	2821	5.63	95.24
9	Bad communication	2387	4.76	100
	Total	50127	100	

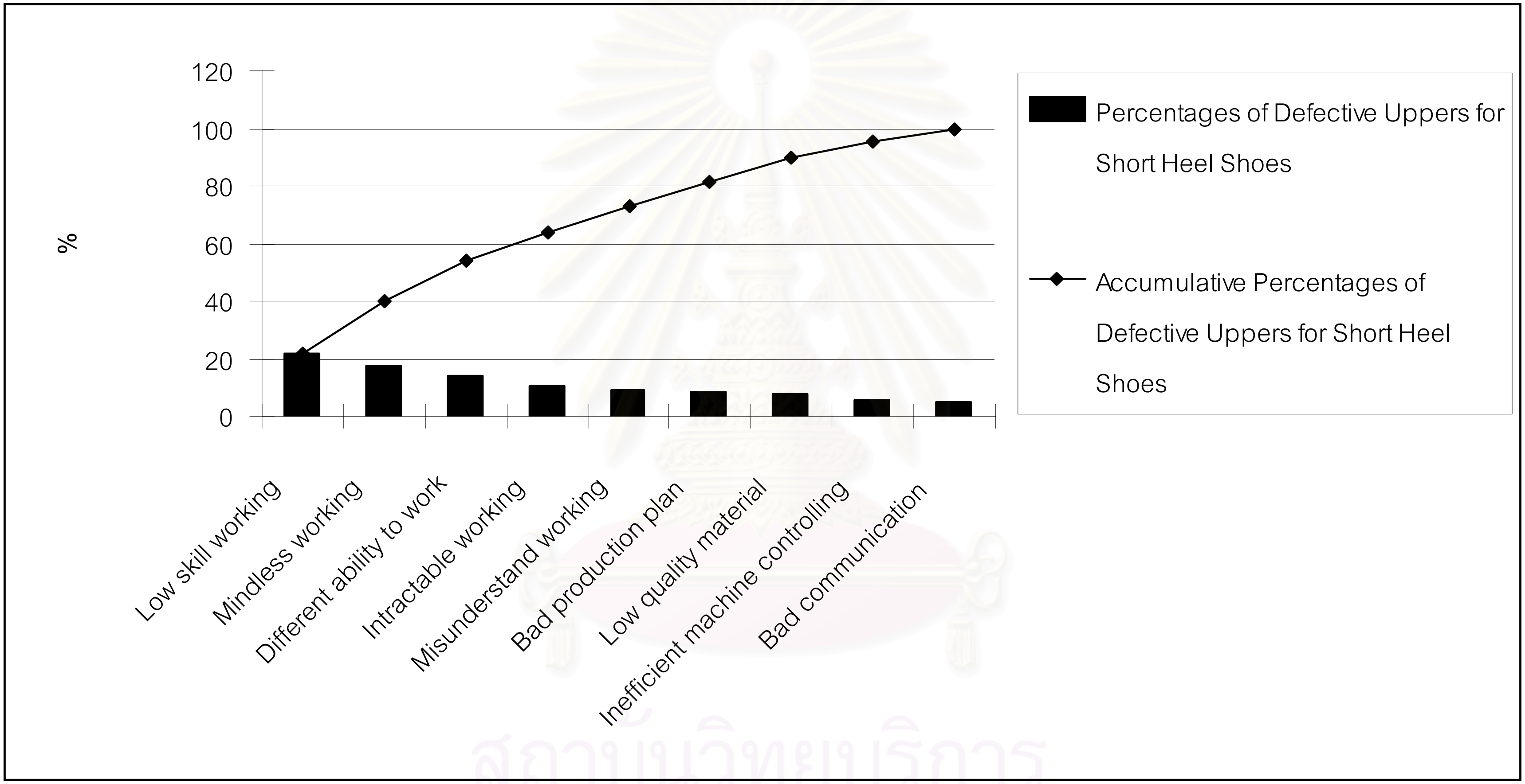


Figure 6-1 Pareto Diagram of Defective Uppers for Short Heel Shoes in October-December

Table 6-31 Defect Costs of Upper for Long Heel Shoe in October-December

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	101	5591
2	Low skill working	Man	177	9799
3	Inefficient machine controlling	Man	44	2436
4	Mindless working	Man	159	8802
5	Misunderstand working	Man	75	4152
6	Intractable working	Man	89	4927
7	Low quality material	Material	66	3654
8	Bad communication	Method	36	1993
9	Bad production plan	Method	60	3322
	Total		807	44676

From Table 6-21, the upper cost per unit for long heel shoe is 55.36 Baht.

Table 6-32 Percentage of Defect Upper Cost for Long Heel Shoe in October-December

	Causes of Problem	Defect Cost	Percentage of Defect	Accumulative Percentage
1	Low skill working	9799	21.93	21.93
2	Mindless working	8802	19.70	41.63
3	Different ability to work	5591	12.51	54.14
4	Intractable working	4927	11.03	65.17
5	Misunderstand working	4152	9.30	74.47
6	Low quality material	3654	8.18	82.65
7	Bad production plan	3322	7.44	90.09
8	Inefficient machine controlling	2436	5.45	95.54
9	Bad communication	1993	4.46	100
	Total	44676	100	

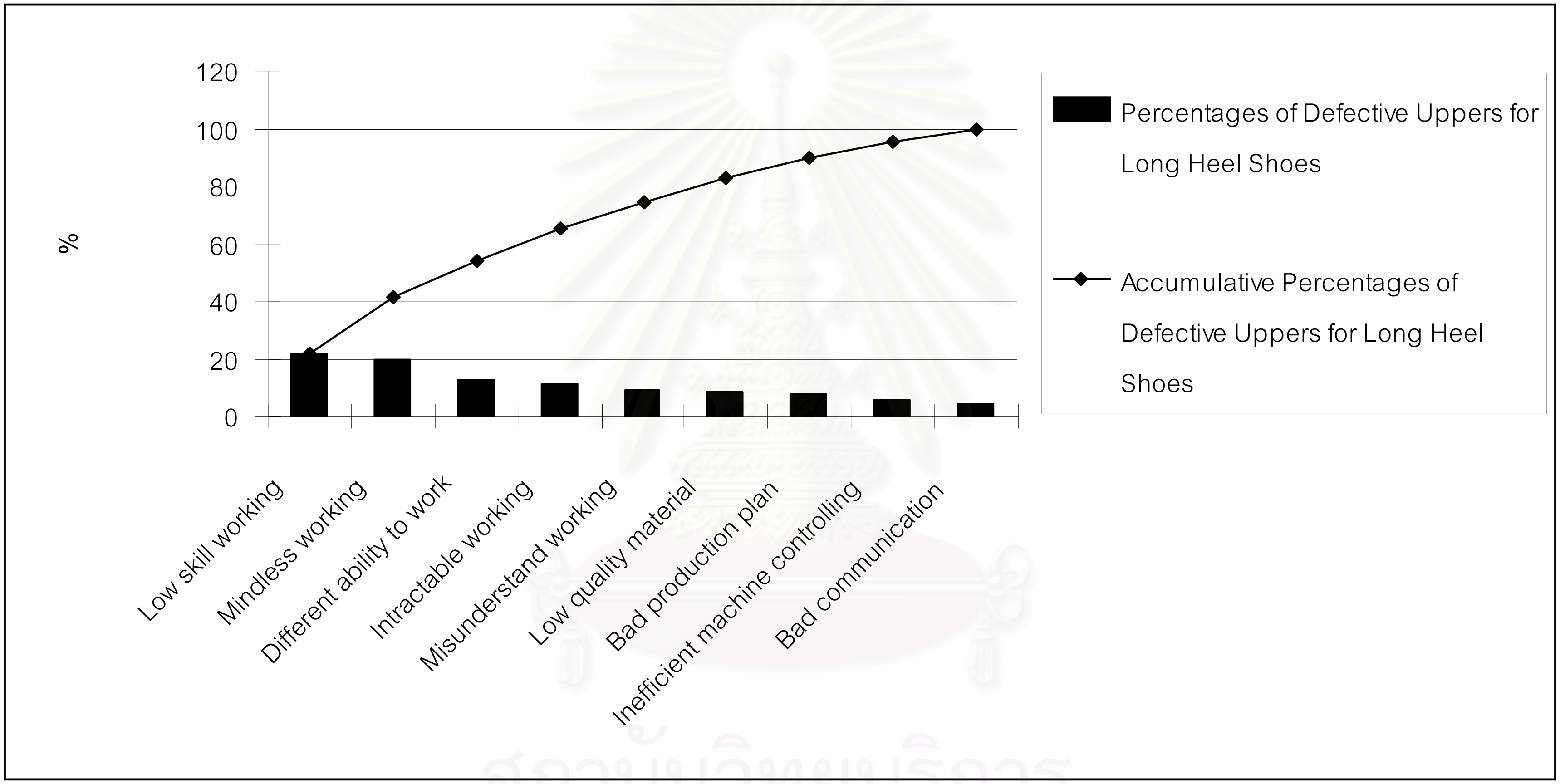


Figure 6-2 Pareto Diagram of Defective Uppers for Long Heel Shoes in October-December

6.5.2 T-Account in Upper Making Process

The T-account of upper making for short heel shoe in October-December is shown in Table 6-33.

Table 6-33 T-Account of Upper Making for Short Heel Shoe in October-December

1 October 2002 – 31 December 2002 Upper Making for Short Heel Shoe			
BI		Transfer Cost	
DM Cost	58393	Total Cost	1601954
DL Cost	3125		
FOH Cost	2612		
Production		EI	
DM Cost	1209873	DM Cost	17958
DL Cost	218977	DL Cost	3250
FOH Cost	183026	FOH Cost	2717
		Balance	50127
Total Cost	1676006	Total Cost	1676006

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 6-1 and costs per unit in Table 6-20.

DM, DL, and FOH costs of EI are calculated from the work-in-process inventory in Table 6-2 and costs per unit in Table 6-20.

DM, DL, and FOH costs of production are calculated from products that are produced in Table 6-6 and costs per unit in Table 6-20.

The balance or defect cost in upper making process is calculated in Table 6-29.

The T-account of upper making for long heel shoe in October-December is shown in Table 6-34.

Table 6-34 T-Account of Upper Making for Long Heel Shoe in October-December

1 October 2002 – 31 December 2002 Upper Making for Long Heel Shoe					
BI			Transfer Cost		
	DM Cost	15840		Total Cost	1395404
	DL Cost	3104			
	FOH Cost	2591			
Production			EI		
	DM Cost	1059942		DM Cost	16532
	DL Cost	207719		DL Cost	3240
	FOH Cost	173360		FOH Cost	2704
				Balance	44676
	Total Cost	1462556		Total Cost	1462556

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 6-1 and costs per unit in Table 6-21.

DM, DL, and FOH costs of EI are calculated from the work-in-process inventory in Table 6-2 and costs per unit in Table 6-21.

DM, DL, and FOH costs of production are calculated from products that are produced in Table 6-6 and costs per unit in Table 6-21.

The balance or defect cost in upper making process is calculated in Table 6-31.

6.5.3 Percentage of Defect in Shoe Assembly Process

Percentage of Defect = (Defect / Production Volume) x100

Table 6-35 Percentage of Defect in Shoe Assembly Process in October-December

Product Type	Equivalent Unit	Defect (Unit)	Total Production Volume (Unit)	Percentage of Defect (%)
Short Heel	27875	956	28831	3.32
Tall Heel	24180	834	25014	3.33
Total	52055	1790	53845	3.32

In shoe assembly process, the total defects are 1790 units. These defects are also influenced from the mistake of resources in producing shoes such as worker, material, and method.

Therefore, the number of defects in shoe assembly process is considered and analyzed on their causes of each problem. The defects and percentages for short heel shoe are shown in Table 6-36 and 6-37. The defects and percentages for long heel shoe are shown in Table 6-38 and 6-39.

Table 6-36 Defect Costs of Shoe for Short Heel Shoe in October-November

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	123	12649
2	Low skill working	Man	141	14500
3	Inefficient machine controlling	Man	128	13164
4	Mindless working	Man	166	17072
5	Misunderstand working	Man	72	7404
6	Intractable working	Man	83	8536
7	Low quality material	Material	77	7919
8	Bad communication	Method	41	4216
9	Bad production plan	Method	125	12855
	Total		956	98315

From Table 6-26, the shoe cost per unit for short heel shoe is 102.84 Baht.

Table 6-37 Percentage of Defect Shoe Costs for Short Heel Shoe in October-December

	Causes of Problem	Defect	Percentage of Defect	Accumulative Percentage
1	Mindless working	17072	17.36	17.36
2	Low skill working	14500	14.75	32.11
3	Inefficient machine controlling	13164	13.39	45.50
4	Bad production plan	12855	13.08	58.58
5	Different ability to work	12649	12.87	71.45
6	Intractable working	8536	8.68	80.13
7	Low quality material	7919	8.05	88.18
8	Misunderstand working	7404	7.53	95.71
9	Bad communication	4216	4.29	100
	Total	98315	100	

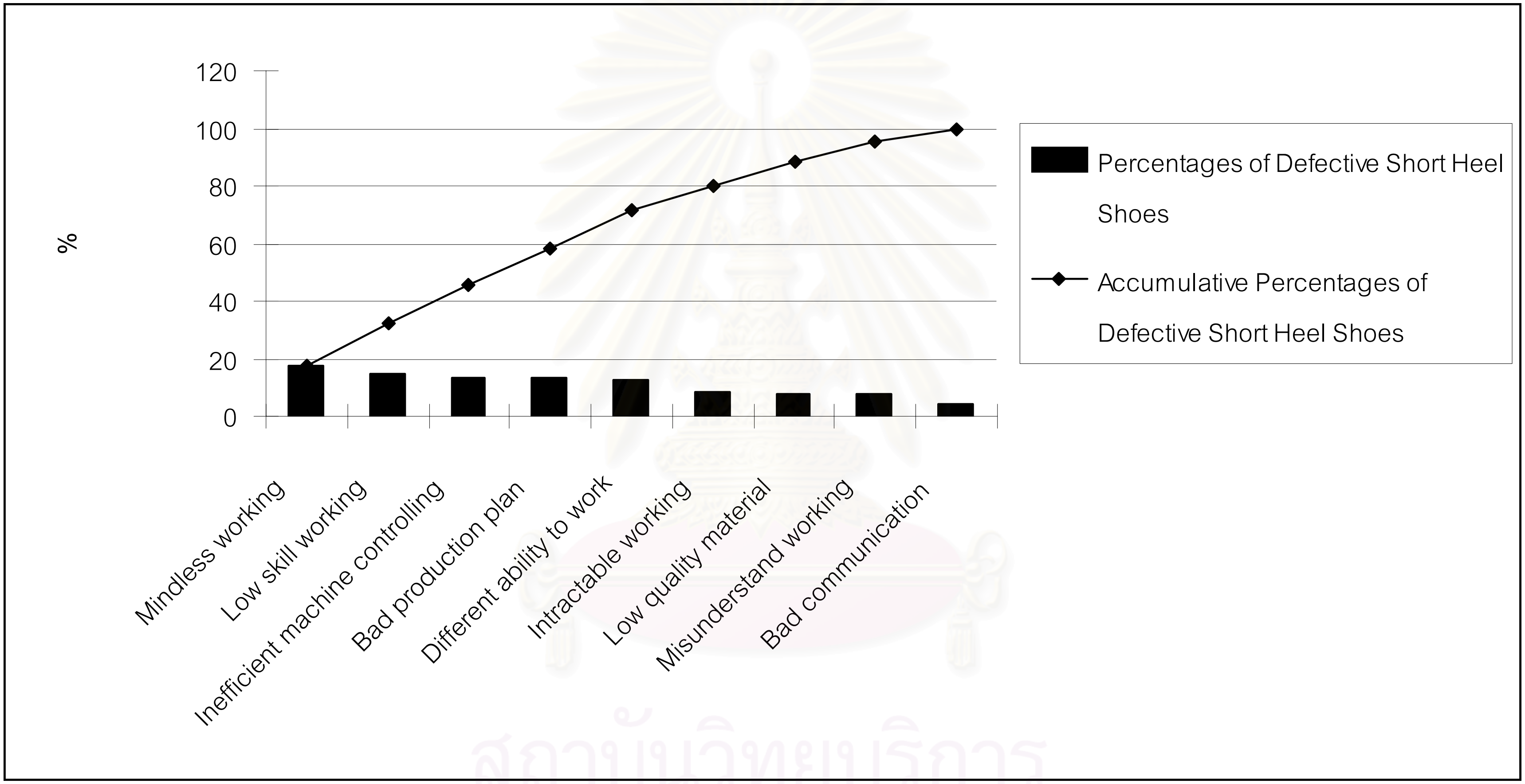


Figure 6-3 Pareto Diagram of Defective Short Heel Shoes in October-December

Table 6-38 Defect Costs of Shoe for Long Heel Shoe in October-November

	Causes of Problem	Resource of Problem	Defect	Defect Cost
1	Different ability to work	Man	103	11226
2	Low skill working	Man	132	14387
3	Inefficient machine controlling	Man	116	12643
4	Mindless working	Man	148	16131
5	Misunderstand working	Man	64	6975
6	Intractable working	Man	81	8828
7	Low quality material	Material	75	8174
8	Bad communication	Method	25	2725
9	Bad production plan	Method	90	9809
	Total		834	90898

From Table 6-27, the cost per unit for long heel shoe is 108.99 Baht.

Table 6-39 Percentage of Defect Shoe Costs for Long Heel Shoe in October-December

	Causes of Problem	Defect	Percentage of Defect	Accumulative Percentage
1	Mindless working	16131	17.75	17.75
2	Low skill working	14387	15.83	33.58
3	Inefficient machine controlling	12643	13.91	47.49
4	Different ability to work	11226	12.35	59.84
5	Bad production plan	9809	10.79	70.63
6	Intractable working	8828	9.71	80.34
7	Low quality material	8174	8.99	89.33
8	Misunderstand working	6975	7.67	97.00
9	Bad communication	2725	3.00	100
	Total	90898	100	

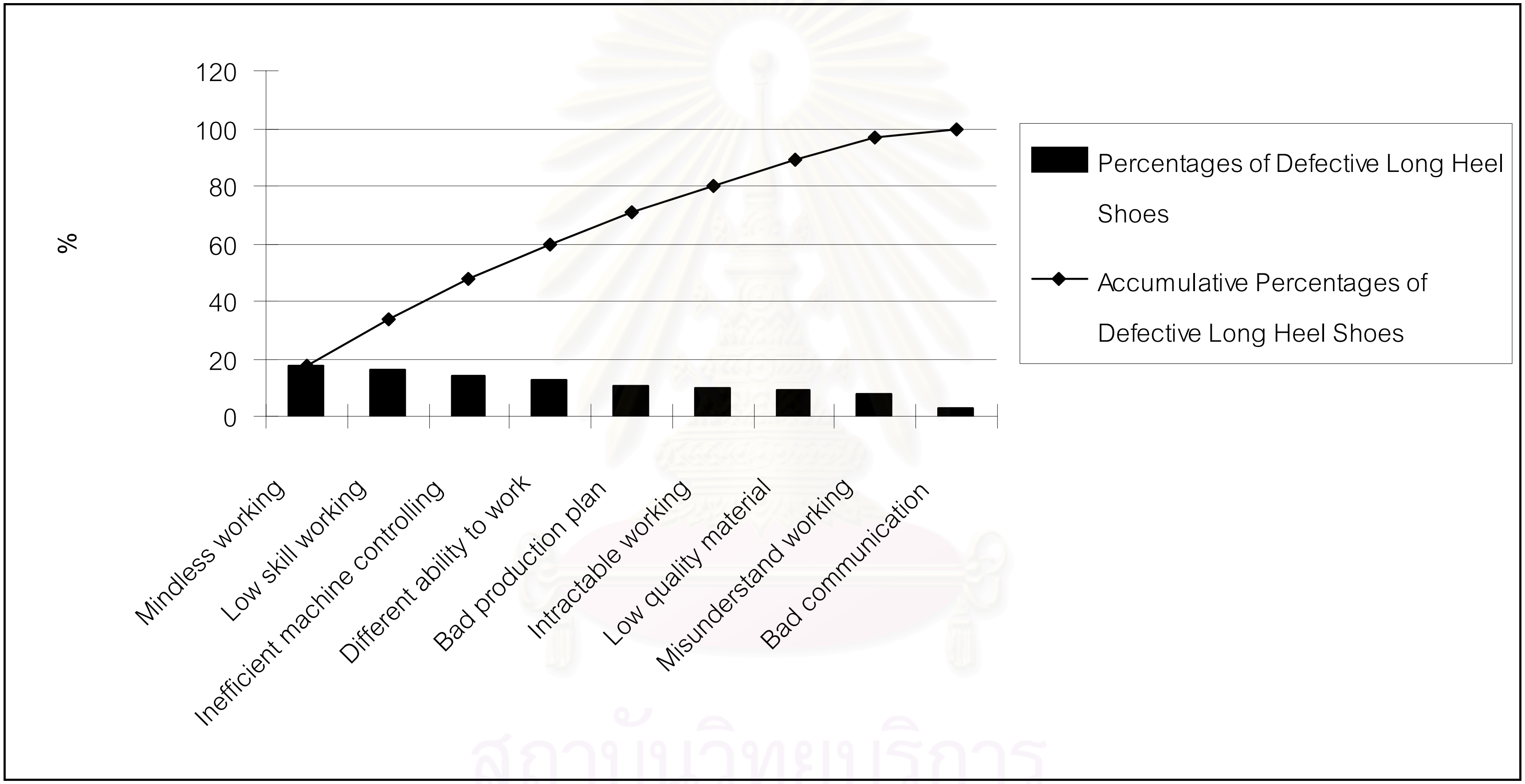


Figure 6-4 Pareto Diagram of Defective Long Heel Shoes in October-December

6.5.4 T-Account in Shoe Assembly Process

The T-account of shoe assembly for short heel shoe in October-December is shown in Table 6-40.

Table 6-40 T-Account of Shoe Assembly for Short Heel Shoe in October-December

1 October 2002 – 31 December 2002 Shoe Assembly			
BI		Transfer Cost	
DM Cost	83360	Total Cost	2834168
DL Cost	17283		
FOH Cost	14846		
Production		EI	
DM Cost	2069161	DM Cost	35853
DL Cost	428996	DL Cost	7433
FOH Cost	368508	FOH Cost	6385
		Balance	98315
Total Cost	2982154	Total Cost	2982154

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 6-7 and costs per unit for short heel shoe in Table 6-26.

DM, DL, and FOH costs of EI are calculated from the work-in-process inventory in Table 6-8 and costs per unit for short heel shoe in Table 6-26.

DM, DL, and FOH costs of production are calculated from products that are produced in Table 6-12 and costs per unit for short heel shoe in Table 6-26.

The balance or defect cost in upper making process is calculated in Table 6-36.

The T-account of shoe assembly for long heel shoe in October-December is shown in Table 6-41.

Table 6-41 T-Account of Shoe Assembly for Long Heel Shoe in October-December

1 October 2002 – 31 December 2002 Shoe Assembly for Long Heel Shoe			
BI		Transfer Cost	
DM Cost	75428	Total Cost	2608457
DL Cost	18989		
FOH Cost	16317		
Production		EI	
DM Cost	1795123	DM Cost	31849
DL Cost	451924	DL Cost	8018
FOH Cost	388331	FOH Cost	6890
		Balance	90898
Total Cost	2746112	Total Cost	2746112

DM, DL, and FOH costs of BI are calculated from the work-in-process inventory in Table 6-7 and costs per unit for long heel shoe in Table 6-27.

DM, DL, and FOH costs of EI are calculated from the work-in-process inventory in Table 6-8 and costs per unit for long heel shoe in Table 6-27.

DM, DL, and FOH costs of production are calculated from products that are produced in Table 6-12 and costs per unit for long heel shoe in Table 6-27.

The balance or defect cost in upper making process is calculated in Table 6-38.

6.6 Comparisons of the Results

The manufacturing costs and losses in both upper making and shoe assembly processes are compared between the results before improvements (June-August) and the results after improvements (October-December). The comparisons are demonstrated below.

6.6.1 Comparisons in Upper Making Process

<u>Manufacturing Cost per Unit of Short Heel Shoe in Upper Making Process</u>

Table 6-42 Manufacturing Cost per Unit of Short Heel Shoe
Before and After Cost Reduction in Upper Making Process

Manufacturing Cost of Short Heel Shoe per Unit	June-August	October-December
Direct Material	40.89	40.72
Direct Labor	7.70	7.37
Factory Overhead	6.80	6.16
Total	55.39	54.25

The direct material cost per unit of short heel shoe changes from 40.89 Baht in June-August to 40.72 Baht in October-December or:

40.89-40.72 = 0.17 Baht or 0.42 % decrease.

The direct labor cost per unit of short heel shoe changes from 7.70 Baht in June-August to 7.37 Baht in October-December or:

7.70-7.37 = 0.33 Baht or 4.29 % decrease.

The factory overhead cost per unit of short heel shoe changes from 6.80 Baht in June-August to 6.16 Baht in October-December or:

6.80-6.16 = 0.64 Baht or 9.41 % decrease.

Therefore, the total manufacturing cost per unit of short heel shoe in upper making process decrease:

0.17 + 0.33 + 0.64 = 1.14 Baht per unit.

Manufacturing Cost per Unit of Long Heel Shoe in Upper Making Process

Table 6-43 Manufacturing Cost per Unit of Long Heel Shoe

Before and After Cost Reduction in Upper making Process

Manufacturing Cost of Long Heel Shoe per Unit	June-August	October-December
Direct Material	40.89	40.72
Direct Labor	8.41	7.98
Factory Overhead	7.35	6.66
Total	56.65	55.36

The direct material cost per unit of long heel shoe changes from 40.89 Baht in June-August to 40.72 Baht in October-December or:

40.89-40.72 = 0.17 Baht or 0.42 % decrease.

The direct labor cost per unit of long heel shoe changes from 8.41 Baht in June-August to 7.98 Baht in October-December or:

8.41-7.98 = 0.43 Baht or 5.11 % decrease.

The factory overhead cost per unit of long heel shoe changes from 7.35 Baht in June-August to 6.66 Baht in October-December or:

7.35-6.66 = 0.69 Baht or 9.39 % decrease.

Therefore, the total manufacturing cost per unit of long heel shoe in upper making process decrease:

0.17 + 0.43 + 0.69 = 1.29 Baht per unit.

Defect of Short Heel Shoe in Upper Making Process

Table 6-44 Percentage of Defect for Short Heel Shoe in Upper Making Process Before and After Cost Reduction

	June-August	October-December
Percentage of Defect of Short Heel Shoe	3.40	3.02

Percentage of defect changes from 3.41 % to 3.01 % or:

3.40 – 3.02 = 0.38 % decrease.

Defect of Long Heel Shoe in Upper Making Process

Table 6-45 Percentage of Defect for Long Heel Shoe in Upper Making Process Before and After Cost Reduction

	June-August	October-December
Percentage of Defect of Long Heel Shoe	3.41	3.01

Percentage of defect changes from 3.41 % to 3.01 % or:

3.41 – 3.01 = 0.40 % decrease.

6.6.2 Comparisons in Shoe Assembly Process

Manufacturing Cost of Short Heel Shoe per Unit in Shoe Assembly Process

Table 6-46 Manufacturing Cost per Unit of Short Heel Shoe

Before and After Cost Reduction in Shoe Assembly Process

Manufacturing Cost of Short Heel Shoe per Unit	June-August	October-December
Direct Material	74.63	74.23
Direct Labor	16.91	15.39
Factory Overhead	14.50	13.22
Total	106.04	102.84

The direct material cost per unit of short heel shoe changes from 74.63 Baht in June-August to 74.23 Baht in October-December or:

74.63-74.23 = 0.40 Baht or 0.54 % decrease.

The direct labor cost per unit of short heel shoe changes from 16.91 Baht in June-August to 15.39 Baht in October-December or:

16.91-15.39 = 1.52 Baht or 8.99 % decrease.

The factory overhead cost per unit of short heel shoe changes from 14.50 Baht in June-August to 13.22 Baht in October-December or:

14.50-13.22 = 1.28 Baht or 8.83 % decrease.

Therefore, the total manufacturing cost per unit of short heel shoe in shoe assembly process decrease:

0.40 + 1.52 + 1.28 = 3.2 Baht per unit .

The total manufacturing cost per unit of short heel shoe in both upper making and shoe assembly processes decrease:

1.14 + 3.2 = 4.46 Baht per unit.

<u>Manufacturing Cost of Long Heel Shoe per Unit in Shoe Assembly Process</u>

Table 6-47 Manufacturing Cost per Unit of Long Heel Shoe Before and After Cost Reduction in Shoe Assembly Process

Manufacturing Cost of Long Heel Shoe per Unit	June-August	October-December
Direct Material	74.65	74.24
Direct Labor	20.54	18.69
Factory Overhead	17.61	16.06
Total	112.80	108.99

The direct material cost per unit of long heel shoe changes from 74.65 Baht in June-August to 74.24 Baht in October-December or:

74.65-74.24 = 0.41 Baht or 0.55 % decrease.

The direct labor cost per unit of long heel shoe changes from 20.54 Baht in June-August to 18.69 Baht in October-December or:

20.54-18.69 = 1.85 Baht or 9.01 % decrease.

The factory overhead cost per unit of long heel shoe changes from 17.61 Baht in June-August to 16.06 Baht in October-December or:

17.61-16.06 = 1.55 Baht or 8.80 % decrease.

Therefore, the total manufacturing cost per unit of long heel shoe in shoe assembly process decrease:

0.41 + 1.85 + 1.55 = 3.81 Baht.

The total manufacturing cost per unit of long heel shoe in both upper making and shoe assembly processes decrease:

1.29 + 3.81 = 5.1 Baht.

Defect for Short Heel Shoe in Shoe Assembly Process

Table 6-48 Percentage of Defect for Short Heel Shoe in Shoe Assembly Process Before and After Cost Reduction

	June-August	October-December
Percentage of Defect of Short Heel Shoe	3.86	3.32

Percentage of defect changes from 3.86 % to 3.32 % or:

3.86 – 3.32 = 0.54 % decrease.

Defect for Long Heel Shoe in Shoe Assembly Process

Table 6-49 Percentage of Defect for Long Heel Shoe in Shoe Assembly Process Before and After Cost Reduction

	June-August	October-December
Percentage of Defect of Long Heel Shoe	3.87	3.33

Percentage of defect changes from 3.86 % to 3.32 % or:

3.87 – 3.33 = 0.54 % decrease.

CHAPTER 7

CONCLUSION AND SUGGESTION

7.1 Conclusion

From the study, the three main problems in the factory that are analyzed in this research include:

1. Data collection and documentation problem. The factory does not have the effective data collection and documentation system to collect the information in manufacturing processes for manufacturing process costing and decision making of the production plan and control in the factory.

2. Manufacturing process costing problem. The factory does not calculate the actual manufacturing costs in manufacturing processes of each product type. There is no calculation of direct material costs for work-in-process, direct labor costs, common factory overhead costs, mutual factory overhead allocations, and t-accounts.

3. Loss in manufacturing process problem. The factory does not consider and analyze the volumes and causes of losses in manufacturing processes. Therefore, the factory does not know how to reduce the losses in manufacturing processes. There is no method for loss reduction to reduce the manufacturing costs in the factory.

Originally, the factory does not keep the crucial information in each process in manufacturing system so it cannot calculate the actual manufacturing costs. Additionally, the factory also does not record the causes of mistake and type of problem so the factory does not know what is the problem and how it occurs.

At first, the factory roughly calculates the manufacturing costs per units without separately calculating the costs per unit in each main production line. The factory divides the manufacturing costs into 4 main groups: material, subcontract's product, labor, and factory overhead cost described as followings.

1. Material cost is calculated by including all raw material costs per unit of synthetic leather sheets (26.44 Baht), P.V.C. linings (7.46), Pigskin linings (5.6 Baht), and P.V.C. socks (2.3 Baht).
2. Subcontract's product cost is calculated by including all subcontract's product costs per unit of insoles (8.5 Baht), outsoles (9.8 Baht), and heels (11.66 Baht).
3. Labor cost is calculated from the labor rate (167 Baht) of all workers in production lines (96 workers) per productivity in a day (approximately 700 pairs of a shoe).
4. Factory overhead cost is assumed as 20% of all manufacturing costs above.

After improvements, the factory sets up the data collection methods to collect the direct material costs, direct labor costs, and factory overhead costs for each manufacturing process in the factory.

The documents are created to record the essential information that is necessary for manufacturing process costing. These documents include material bill, labor hour report, overhead bill, maintenance list, machine hour report, production volume report, and work-in-process report.

Costing is the process of estimating and then determining the total cost of producing a product, including the cost of materials, labors and overheads, as well as the general expenses of business operations. The manufacturing process costs are calculated separately in two main production lines: upper making and shoe assembly processes. In each process, the factory has to calculate the equivalent units, direct material costs, direct labor costs, common factory overhead, mutual factory overhead allocation, conversion costs, direct labor cost per hour, factory overhead cost per hour, and cost structures, including t-accounts for each product type (short and long heel shoes).

The new manufacturing costing method is set up to provide product unit cost information for product pricing, cost control, inventory valuation, and financial statement presentation. It helps the factory for accumulating and accounting of product-related costs for a period of time. Besides, the manufacturing costs are accumulated by and assigned to the manufacturing processes

In process costing methods, the useful documents are created. The examples are the work in process accounts (one for each process), production cost reports, determinations of total manufacturing costs (each period), and unit cost computations (total manufacturing costs/units produced during the period). The production cost report presents computing of the physical unit flow, equivalent units of production, and unit production costs. The equivalent units of production also help the factory to measure of the work performed during the period, expressed in fully completed units and to determine the cost per unit of completed product

For the factory, the losses in manufacturing processes are analyzed and divided into two main terms: quality and quantity terms for the results of manufacturing losses by using fish bone diagrams.

The losses in manufacturing processes based on quality consist of:

1. Different ability to work of workers.
2. Low skills of workers.
3. Inefficient machine controlling of workers.
4. Mindless working of workers.
5. Low quality of materials.
6. Bad communication of methods in the factory.

The losses in manufacturing processes based on quantity consist of:

1. Misunderstand working of workers.
2. Intractable working of workers.
3. Lack of material in a period.
4. Bad production plan.
5. Bad inventory control.
6. Bad material order.

Defect costs in upper making process of both product types: short heel and long heel shoes are shown in Table 7-1.

Table 7-1 Defect Cost in Upper Making Process in June-August

Product Type	Defect (Unit)	Defect Cost (Baht)
Short Heel	1018	56387
Long Heel	898	50875
Total	1916	107259

Defect costs in shoe assembly process of both product types: short heel and long heel shoes are shown in Table 7-2.

Table 7-2 Defect and Cost in Shoe Assembly Process in June-August

Product Type	Defect (Unit)	Defect Cost (Baht)
Short Heel	1090	115584
Long Heel	956	107837
Total	2046	223421

The steps of manufacturing process cost reduction for the factory are list as following:

1. Create the standard process costing method and cost structure for the shoe manufacturing process of the factory.
2. Calculate the shoe manufacturing process costs of the factory in June-August 2002 (before cost reductions).
3. Improve the shoe manufacturing processes by reducing manufacturing losses based on the worker, material, and method resources in the factory to reduce the manufacturing costs.
4. Calculate the shoe manufacturing process costs of the factory in October-December 2002 (after cost reductions).
5. Compare the manufacturing costs between the costs before and after cost reductions to find the results of process cost reductions for the factory.

Losses in the manufacturing processes for the factory are reduced by improving the factors such as workers, materials, and methods in the manufacturing processes. Loss reductions are concluded as following:

1. Losses based on the workers in the manufacturing processes for different ability to work, low skills are reduced by introducing training and orientation program for the new workers in every manufacturing process.

2. Losses based on the workers in the manufacturing processes for mindless and intractable working are reduced by setting up motivation systems and incentives to stimulate the workers to work carefully.

3. Losses based on the workers in the manufacturing processes for inefficient machine controlling and misunderstand working are reduced by creating job description documents for the workers in the factory to work efficiently.

4. Losses based on the materials in the manufacturing processes cannot be reduced because these losses are the uncontrollable losses in the factory.

5. Losses based on the methods in the manufacturing processes for bad production plan are reduced by using multi-skilled labor and creating production time schedules to help managers plan and control the production processes effectively.

6. Losses based on the methods in the manufacturing processes for bad communication are reduced by creating order documents in each work.

7. Losses based on the methods in the manufacturing processes for bad inventory control and bad material order are reduced by using inventory documents to record the actual level of inventory for better decision making.

After manufacturing process cost reduction in the factory, the costs per unit are reduced so the manufacturing costs in the factory also decrease. The results of costs per unit are shown in the following tables.

<u>Upper Making Process</u>

Table 7-3 Manufacturing Cost per Unit of Short Heel Shoe

Before and After Cost Reduction in Upper Making Process

Manufacturing Cost of Short Heel Shoe per Unit	June-August (Baht per unit)	October-December (Baht per unit)
Direct Material	40.89	40.72
Direct Labor	7.70	7.37
Factory Overhead	6.80	6.16
Total	55.39	54.25

Table 7-4 Manufacturing Cost per Unit of Long Heel Shoe

Before and After Cost Reduction in Upper making Process

Manufacturing Cost of Long Heel Shoe per Unit	June-August (Baht per unit)	October-December (Baht per unit)
Direct Material	40.89	40.72
Direct Labor	8.41	7.98
Factory Overhead	7.35	6.66
Total	56.65	55.36

<u>Shoe Assembly Process</u>

Table 7-5 Manufacturing Cost per Unit of Short Heel Shoe

Before and After Cost Reduction in Shoe Assembly Process

Manufacturing Cost of Short Heel Shoe per Unit	June-August (Baht per unit)	October-December (Baht per unit)
Direct Material	74.63	74.23
Direct Labor	16.91	15.39
Factory Overhead	14.50	13.22
Total	106.04	102.84

Table 7-6 Manufacturing Cost per Unit of Long Heel Shoe

Before and After Cost Reduction in Shoe Assembly Process

Manufacturing Cost of Long Heel Shoe per Unit	June-August (Baht per unit)	October-December (Baht per unit)
Direct Material	74.65	74.24
Direct Labor	20.54	18.69
Factory Overhead	17.61	16.06
Total	112.80	108.99

According to the cost structures of the factory, the most part of the manufacturing cost is the direct material cost. Generally, manufacturing cost reductions should emphasize on reducing of direct material costs but the problems of the losses in manufacturing process based on the material resources are uncontrollable because of bad quality materials from suppliers. Therefore, manufacturing cost reductions for the factory are aimed to reduce the losses based on workers and methods of production planning and controlling in manufacturing processes. That's why the direct material cost, the most part of cost structure in shoe manufacturing, is reduced in only few amounts.

However, the defect costs in manufacturing processes, which occur from the mistakes based on the resources of problem such as workers and methods, are reduced. The defect cost before and after cost reductions of each resource of problem are shown below.

Upper Making Process

Table 7-7 Defect Costs Based on Resources of Upper for Short Heel Shoe

Resource of Problem	Defect Cost Before Improvement (Baht)	Defect Cost After Improvement (Baht)
Man	45143	39440
Material	3656	3960
Method	7588	6727
Total	56387	50127

From Table 5-2 and Table 6-29, the defect costs on each resource of upper for short heel shown are shown in Table 7-7 and Figure 7-1.

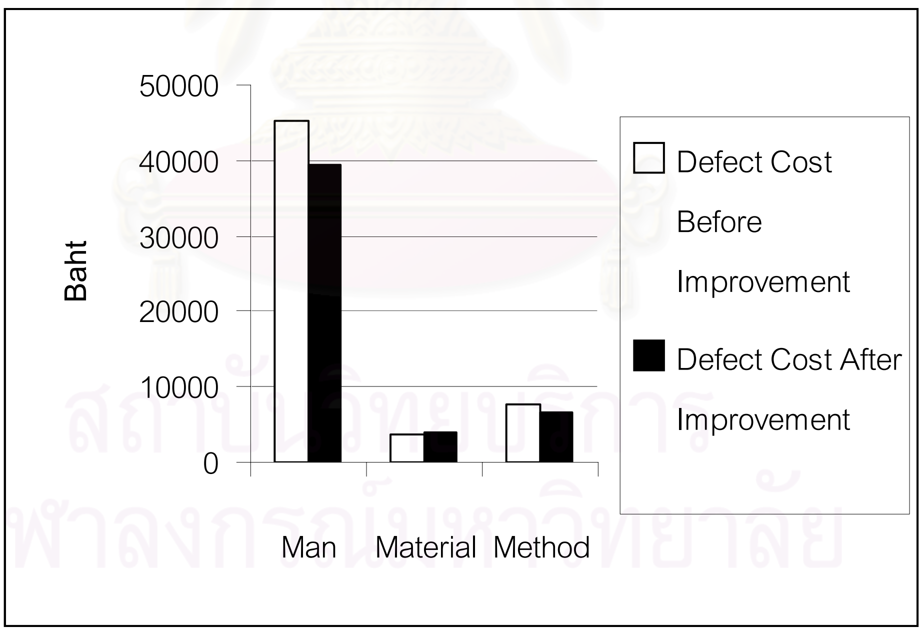


Figure 7-1 Losses from Each Resource of Upper for Short Heel Shoe

Table 7-8 Defect Costs Based on Resources of Upper for Long Heel Shoe

Resource of Problem	Defect Cost Before Improvement (Baht)	Defect Cost After Improvement (Baht)
Man	39825	35707
Material	2719	3654
Method	8328	5315
Total	50872	44676

From Table 5-4 and Table 6-31, the defect costs on each resource of upper for long heel shown are shown in Table 7-8 and Figure 7-2.

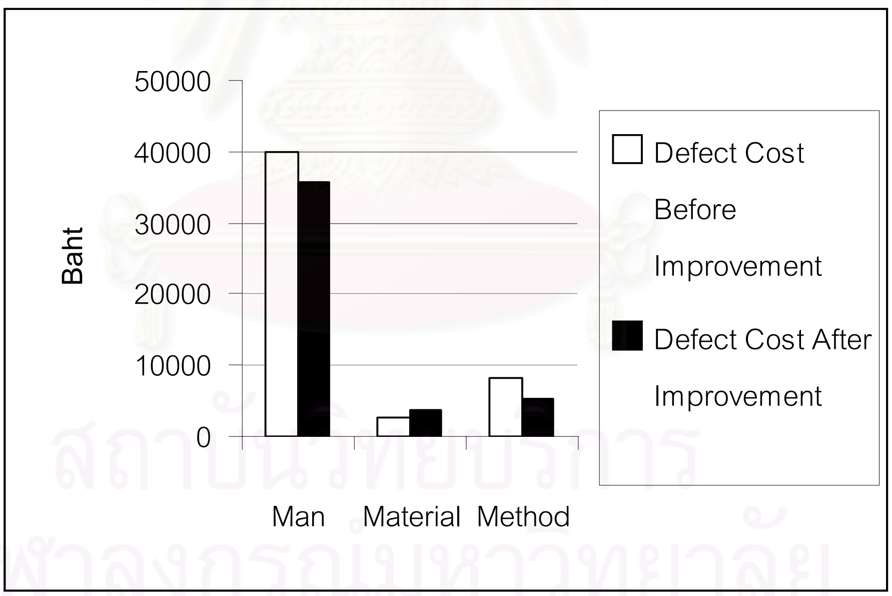


Figure 7-2 Losses from Each Resource of Upper for Long Heel Shoe

<u>Shoe Assembly Process</u>

Table 7-9 Defect Costs Based on Resources of Short Heel Shoe

Resource of Problem	Defect Cost Before Improvement (Baht)	Defect Cost After Improvement (Baht)
Man	85574	73325
Material	4030	7919
Method	25980	17071
Total	115584	98315

From Table 5-9 and Table 6-36, the defect costs on each resource of short heel shown are shown in Table 7-9 and Figure 7-3.

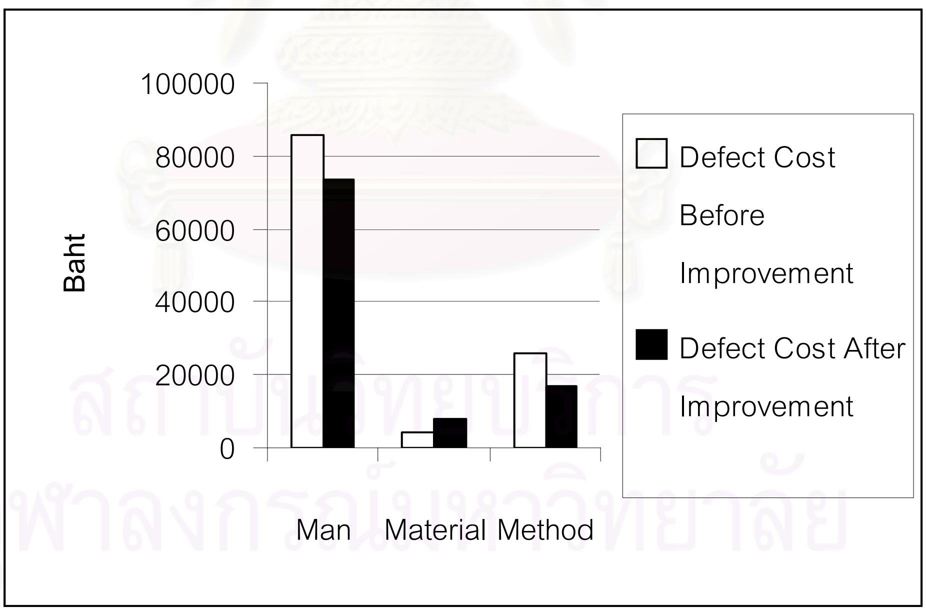


Figure 7-3 Losses from Each Resource of Short Heel Shoe

Table 7-10 Defect Costs Based on Resources of Long Heel Shoe

Resource of Problem	Defect Cost Before Improvement (Baht)	Defect Cost After Improvement (Baht)
Man	81329	70190
Material	2256	8174
Method	24252	12534
Total	107837	90898

From Table 5-11 and Table 6-38, the defect costs on each resource of long heel shown are shown in Table 7-10 and Figure 7-4.

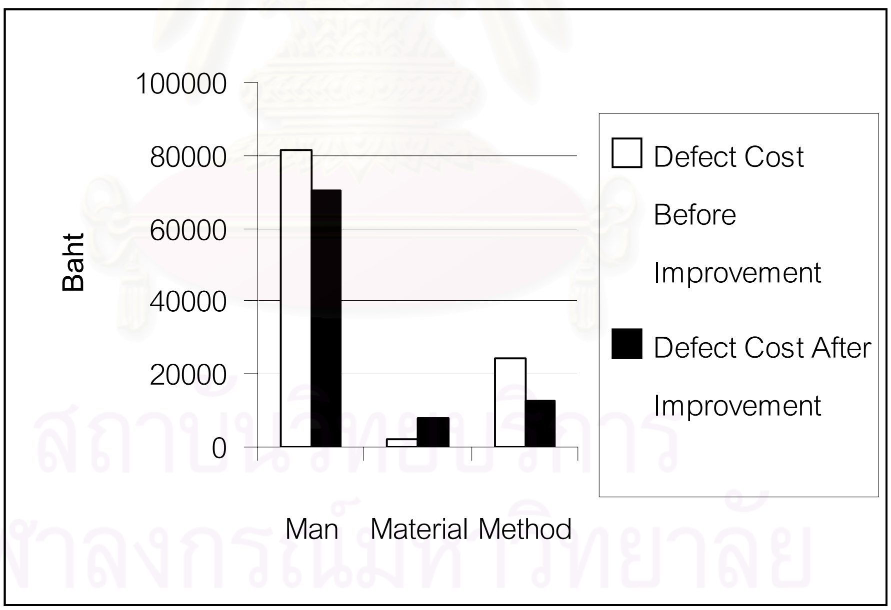


Figure 7-4 Losses from Each Resource of Long Heel Shoe

7.2 Suggestion

This research of manufacturing process cost reduction indicates many further studies as followings:

1. The manufacturing costing methods that are used to calculate the manufacturing costs accurately are the bases of decision making for the executives.

2. Production plan and control can be improved in the higher level for studying work methods or techniques by using the basic information that are set up.

3. Inventory control can be developed for analysis of the appropriate point of ordering materials and the proper level of inventory by using the information that are collected and documented.

4. The factory should have the systematic quality assurance system to measure and appraise the results in the manufacturing processes for quality improvements of the products in the future.

5. The factory should adjust the organization and job description every year or when the work methods are changed to be compatible with the current system in the factory.

6. The factory should apply computer programs of information technology (IT) to control production and inventory more efficiently and to make decisions in production plan more rapidly.

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Biography

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