



**Addis Ababa University**

**Addis Ababa Institute of Technology (AAiT)**

**School of Mechanical and Industrial Engineering (SMIE)**

**Industrial Engineering Department**

**Enhancing the Productivity of the Footwear Industry through  
Work Measurement and Line Balancing Techniques.**

**(Case in Anbessa Shoe Share Company (ASSC))**

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## **Declaration**

I hereby declare that the work which is being presented in this thesis entitled “**Enhancing the productivity of the Footwear industry through Work Measurement and Line Balancing Techniques.**” is original work of my own, has not been presented for a degree of any other university and all the resource of materials used for this thesis have been duly acknowledged.

Moti Melkamu

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Signature

Date

This is to certify that the above declaration made by the candidate is correct to the best of my knowledge.

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## **Abstract**

The footwear industry is one of the most economic sectors, which should be given attention for the development of the Ethiopian country and Ethiopian Leather development strategy has put the footwear industry on the forefront position to accelerate the development of the sector with a huge potential for boosting the country economy and it needs consideration. Ethiopian Footwear Industry sector needs improvements to enhance their productivity and the study focused on the ASSC as a case study and the currently ASSC target plan production per day averagely of cutting, stitching, and lasting and finishing section are 750, 700, and 700 pairs per day respectively of Gentles man's and civilian shoes (EL-028102LB model), but the actual output is 563, 427 and 463 pairs of actual finished shoe output performance of 66% with a line efficiency 61.1%, 50.5%, 52.89% and daily labour productivity of each section is 22.5, 8.1, and 8.9 pairs per day respectively. The existed gap between the target plan and actual output is because of the existed major factors of distance and movement time, high cycle time, bottleneck, less line efficiency, less output per day, and less labour productivity. Then, the study focused on and reduce factors that affect the productivity and enhance the productivity of the ASSC through work measurement and line balance techniques. After apply full of the work measurement and line balance on the ASSC, the result of the study is reduced total of unwanted movement distance with a time, cycle time, number of operations (station), and the labour from the existed are 34m with 136 second per pairs, 498.19second, 8 number operations, and 9 labour and increased line efficiency of the cutting, stitching and lasting, and finishing section to 80.76%, 76.8%, and 75.50% and output per day in pair are 714, 625.3 and 623 with the increased labour productivity per day in pair to 34, 12.3 and 12.7 respectively. Generally, ASSC enhanced productivity of finished footwear output is 623 pairs per day with an additional produced of 160 pairs of shoes per day and the actual finished shoe output performance of the company is increased by 23%.

**Keywords:** Enhancing Productivity, footwear industries, work measurement, Line balance.

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## **Lists of Acronym**

ASSC – Anbessa shoe Share Company	CA- Contingency allowance
ASME - American Society of Mechanical Engineers	FA- Fatigue allowance
KSF = Kangaroo shoe factory	HTA- Heat and temperature allowance
RDSF = Ras Dashen shoe factory	RA- Rest pauses Allowance
WSF = Wallia shoe factory	SA- Standing allowance
EFI – Ethiopian Footwear Industries	WMT – Work Measurement Techniques
ALB - Assembly Line Balancing	IE = industrial Engineering
LB – Line Balance	Lbr – labour
OT - Observed time	Av.OT - Average observed time
PR - Performance rate	A - Allowance
AF- Allowance factor	NT- Normal time
ST- Standard time	L <sub>eff</sub> - Line efficiency
CT- Cycle time	PA- Personal allowance

## **CHAPTER ONE**

### **INTRODUCTION**

#### **1.1 Background of study and justification**

Productivity is widely accepted as one of the most important and it constantly improves their productivity in the manufacturing industry [1], [30] and enhances productivity used in satisfy customers than others [2], [20]. As the customer's demand is high it requires the firm has to increase productivity [3] and because of periodically increasing the demand of the footwear industries in Ethiopia and it needs to improve and enhance their productivity in the sectors [4], [5]. National Bank of Ethiopia in 2017/18 report showed that the GDP shares of agriculture, service and industry were 34.9%, 39.2%, and 27.0% respectively, footwear industries are one among existed and it needs improvement to increase their competitiveness in productivity perspective [6].

Footwear is an active product in international markets [7] and one of the areas of the strategic industrial development plan of the Ethiopian country [4] and The footwear industry in Ethiopia is thriving and it managed to recover the domestic market which had been swept by imported from Chinese [8], According to the benchmark implementation plan for the Ethiopian footwear, the sectors produce a product, but it's not according to its requirement productivity [9]. The footwear industry is one of the many economic sectors, which should be given attention for the development of the country [10] and the Ethiopian Leather development strategy has put the shoe industry in the forefront position to accelerate the development of the sector [2], it has a huge potential for boosting the country economy and it needs consideration [11], [12], [13], because the general of footwear sub-sector, in particular, is far below the desired standards [7]. For the ten years back, the Ethiopia export plan on footwear products are not according to its requirement plan [14] and for the period 2005- 2010 GC, Ethiopia export plan on average 25.6 million USD while its export for the same period was only 4.9 million USD [15], On average the leather footwear industry contributed only 5.9 % to the years 2004/05-2010/11 GC [14]. The plan of Ethiopian Footwear Industry gain 315.5 million USD (63.5%) 2010/2011-2014/2015 GC, but their performance 34.57 million USD (26.03%) and the plan is developed to 485.8 million USD (60%) (2015/16-2020/21 GC), this indicates that the footwear manufacturing sector performance is low and an improvement is required to enhance their productivity to their competitor locally also internationally [16], [4]. Also As international

comparison indicated that footwear productivity in Ethiopia is much lower than that of other industrializing countries such as Myanmar, Vietnam, Cambodia, and Tanzania whose productivity for the same period is between 1.7 and 3.4 times that of Ethiopia and in 2018 report showed that Ethiopia's labour productivity level is still low even among latecomers like Vietnam, Cambodia, Myanmar and Tanzania with 3.4, 2.9, 1.7, and 1.6 times higher, respectively than that of Ethiopia. Even Kenya's labour productivity is 3 to 4 times higher than that of Ethiopia and it needs to improve its productivity [6].

Shoe manufactures sectors need improvement to enhance their productivity [17], because of low productivity, less line efficiency and less labour productivity [4], inefficient work procedure, unwanted movement and customers dissatisfaction [18], improper flow process [13], and poor training [19], high cycle time and waiting time (idle time) with workers [20]. Then, the problems reduce through the application of work measurement and line balance to enhance their productivity. Proper doing of workers play a great role to achieve on increasing productivity of the factory [13], Customer satisfaction is a person's feeling of pleasure resulting from a perceived performance towards company's products or outcome to his or her expectation and training is the effective tools for both personal and organizational success in footwear industries. As the customer's demand is high, the firm has to increase productivity in shoe manufacturing sectors through reducing production time, operation time, ineffective time of the process and repetitive motion and a great deal of effort is required effective production that includes less production time and higher efficiency [1].

## **1.2 Problem statement**

The Ethiopian Footwear Industries needs improvements to enhance their productivity [4], [16] and Anbessa Shoe Company is one of the largest and pioneer shoe industries and distributors in Ethiopia and it has labour intensive [2], [21]. ASSC contribute on the economic development of the country through producing and sharing different types of shoe and the major competitors of the ASSC are Kangaroo shoe factory (KSF), Ras Dashen shoe factory, (RDSF) and Wallia shoe factory (WSF) and their output are 158,400, 172,800 and 164,160 pair per year respectively [79] and ASSC output of 127,680 pairs per year with the same model [78]. This indicated that the productivity of the Anbessa shoe share company (ASSC) is much less than that of the competitor's and it needs improvement.

The current daily target production plan of ASSC is far below of actual output and there is a gap between the target production of the ASSC and the actual output of Gentles man's and

civilian shoes (EL-028102LB model). The target plan production of Gentles man's and civilian shoes (EL-028102LB model) of cutting, stitching, and lasting and finishing section are 750, 700, and 700 pairs per day, but the actual output is 563,427 and 463 pairs with actual finished shoe output performance of the company of 66%, a line efficiency of 61.1%, 50.5%, 52.89% and daily labour productivity of each section are 22.5, 8.1 and 8.9 pairs per day respectively. But Gentles man's and civilian shoes (EL-028102LB model) has high demand, it has high profit for a company and the operation process is the basis for others model among others model. According to analyzed data shows that there are factors that affect the overall productivity of the company. Identified problems in each section are ineffective process time, repetitive motion tasks, distance movement, less working interest (motivation), multi-operation by a single operator and waiting time due to unbalance of each consecutive process/operations (bottleneck in the process), unbalanced labour and improper flow process.

The factors that affect the productivity of the footwear industries are a method of doing the tasks [13], idle time with bottleneck [19] and poor training [19], unwanted movement, ineffective process time and customers dissatisfaction [18]. Then, the study focused on a way to enhance the productivity of Anbessa shoe share company (ASSC) and reduces the major factors that affect the productivity of the company through integration of work measurement with Line balance techniques. The productivity of ASSC is related to the daily productivity, and working conditions (process) of each section. Then, the existence of the gap between daily target production and the actual output shows the existence of a problem related to unwanted movement, improper process flow, improper working condition, and bottleneck with maximum cycle time and idle time which increase ineffective process time and low daily productivity of the company, such problems reduce through a combination of the work measurement with Line balance techniques to enhance their productivity.

It reduced the distance movement between consecutive process flows, properly rearranged process flow, and reduced multi-operation (activity) by single operators through rotated and balanced the workers with work in each station and assembled (join) the process depends on their cycle time to reduced bottleneck. During improvements, it considered the basic process time and existed standard allowances and performance rating of the company and process standards.

The result of the study is reduced ineffective process time, cycle and, reduced bottleneck process, movement distance and fatigue of workers, rearranged the process flow, and also enhanced overall productivity with labour productivity and line efficiency of each section.

### **1.3 Research question**

- 1) What are the factors that affect the productivity and actual finished shoe output performance level of the ASSC?
- 2) What are the existed work measurement and line balance techniques practiced in ASSC?
- 3) What is the relationship between work measurement and line balance application in enhancing productivity?

### **1.4 Objective of the study**

#### **1.4.1 General objective**

The general objective of the study is to enhance the productivity of the footwear industry through work measurement and line balancing techniques in the case study of the ASSC.

#### **1.4.2 Specific objectives**

- ❖ To analyze existed work measurement and line balance techniques of ASSC.
- ❖ To reduce cycle time, unwanted movement, and workers fatigue.
- ❖ To increase output per day, labour productivity, and line efficiency of each section.
- ❖ To improve process flow, bottleneck, and facilitate the production process with the flow of operations.

### **1.5 Significance of the study**

By this study, as a company, it gained increased daily overall productivity with labour productivity and high line efficiency of each section of the company through reduced factors affect their productivity. Also reduced the gap between target and actual daily output, increased customer satisfaction, and reduced workers fatigue, idle time with cycle time. At a country level, enhance job opportunities and reduce poverty by attaining the Ethiopian government goal on poverty reduction and transfer of knowledge.

### **1.6 Scope of the study**

The scope of the study is to assess the existed of the overall Ethiopian footwear industries by referring to different secondary documents and visiting partially those that are located around Addis Ababa city to understand generally where are most challenges faces by industries under

these subsectors arises. After visited, for the study, it selected Anbessa shoe share company (ASSC) as the case study among their competitors, because, depending on the analyzed data the productivity competitiveness of the ASSC is far below the existing competitors and it requires more improvement rather than the others. ASSC used partially of the work measurement and Line balance techniques throughout their production process. Then after, assessed the existed system in detail of the company situation according to the titled, it identified the main factors that affect the productivity competitiveness of the company, especially in the area of the production process including production process time, cycle time, bottleneck, workers movement (motion), process flow, line efficiency and labour productivity of each section of the ASSC.

### **1.7 Limitation of the study**

The study more focused only on the production process of the Gentles man's and civilian shoes (EL-028102LB model) which is the basic output footwear model of the ASSC.

## **CHAPTER TWO**

### **LITERATURE REVIEW**

#### **2.1 Enhancing Productivity**

Productivity as a measure for output and important in industry and also enhance productivity is important for the stakeholders of the organization and country [22], [23]. Higher productivity brings a higher profit margin in a business and increment in productivity level reduces manufacturing cost and can make more profit through productivity improvement [24]. It needs to reduce the factors that affect the productivity of the organization [25]. The productivity of the industries depend on their practices and capabilities to process their working system [26], [22] Sub Saharan countries including Ethiopia shoe factories have labour-intensive and it's a major economic activity of countries and it needs to produce more product to satisfy the customers [27], [28], [29].

In manufacturing sectors, each activity or process is playing a great role in the productivity of the company, and to achieve their objectives it needs to improve the existing system or process of that effect [30] and it used for their growth and productivity [31]. Enhancing productivity is making the production processes of firms and industries more efficient and productive [32] and company needs to improve and update their processing time and working conditions of the organization [29] and also tasks (activities) or working conditions of the workers can create value for a company [30].

A report by the National Bank of Ethiopia in 2017/18 showed that the GDP shares of agriculture, service and industry were 34.9%, 39.2%, and 27.0% respectively.

Among those industries shared in less amount in the economic development of the country and footwear, industries are one among existed and it needs improvement to enhance their productivity. As international comparison indicated that productivity in Ethiopia is much lower than that of other industrializing countries related to Ethiopia footwear industries. In 2018 report showed that Ethiopia's labour productivity level is still low even among latecomers like Vietnam, Cambodia, Myanmar, and Tanzania with 3.4, 2.9, 1.7, and 1.6 times higher, respectively, than that of Ethiopia, Even Kenya's labour productivity is 3 to 4 times higher [6].

Enhancing the productivity of the footwear industry plays a great role in the economic development of developing countries like Ethiopia. To enhance the productivity of the footwear industries, it needs to improve overall productivity, labour productivity, process flow, and

working conditions of the workers in each footwear industry that existed in the country and through acts and apply new ways of doing things [33].

## **2.2 Factors that affect the productivity of the footwear industries those related to Work Measurement and Line Balancing.**

An important and current problem faced in manufacturing industries of developing countries is the existence of factors that affect their productivity and require improvement [29], [22]

### **(A) Less output per day.**

Every activity and process in the industries affect the overall output of the product [22].

**(B) Less labour productivity:** Labour productivity is defined as the amount of output produced divided by the amount of labour expended to produce that output [6]. Improve labour productivity, both by reducing the idle time of workers and ensuring that when workers are working, they are using their effort as productively as possible (including not doing unnecessary tasks or avoidable motions) [34] and Increasing labour productivity may lead to higher production [35], [23].

$$\text{Labor Productivity} = \frac{\text{Output(Value Added)}}{\text{Number of Employees}}$$

### **(C) Improper working conditions and movement of the workers**

The most suitable method for developing products and processes, with the use of the best practices and at the lowest possible costs, is to make high-quality products and get them to satisfy consumers' needs [36]. Improper working condition is the causes of ineffective process time, produce defective products, low productivity and fatigue of the workers and also non-value-added activities [37] and in the companies perform a repetitive task with the same movement for a long period it can affect the production output [38].

### **(D) Less line efficiency of the process**

The line efficiency of each process plays a great role in the end output and it can affect the overall productivity of the organization [4].

### **(E) Improper process flow**

Improper process flow layout is the cause of the increased ineffective process time in the company and it affects the output [38].

### **(F) Ineffective process time**

Excess activities due to inefficient methods, poor work layout and interruptions, and human factors and affect the end output of the company [39], [30] . Reduce the factors and enhance productivity through reducing ineffective time, reduce unwanted movement and fatigue, better-designing process flow, and give training for labour [40].

**(G)Existence of bottleneck with idle and maximum cycle time in the process.**

The existence of the bottleneck in the process affects the output of the company and equalizing the workload across all operations in a line to remove bottlenecks and excess capacity [20], [37]. Bottlenecks limit the capacity and throughput of the production system and it reduced the productivity of the system as a whole. The identification of and clearing bottlenecks are the basis for the improvement of production and economic results achieved by a company [41].

With the existence of high cycle times in the process, the overall output of the company is very less and reduced cycle time, increased labour productivity, and elimination of bottlenecks and machine downtime can be achieved, firms can generally expressively bigger output from their existing facilities and reduce production cycle times through reducing waiting times between processing stages [34]. The cycle time (flow time, or manufacturing lead time) of a job is the time required for the job to go through the factory [42], [43].

$$\text{Cycle time (CT)} = \text{Standard time (ST)} / \text{Labour (Lbr)}$$

### **2.3 Requirements in the enhancement of the Productivity**

In enhancing productivity, it is required to know the conditions and cycle time and bottlenecks of each process with existing labour productivity [23]. Identify the ineffective time that exists in the process and workers working conditions with their movement [44] [22] and also understand the line efficiency of each section [4] with company management system with labour relationship because there is the responsibility and their impact on the output product of the company [45], [46].

### **2.4 Work measurement techniques and basic procedures**

Work measurement is concerned with investigating and eliminating production loss time and improve the workers' ways of doing the job and it's the best way of improving productivity in [47], [48] [49]. In Ethiopian footwear industries, the working condition of workers is not comfortable and not satisfied to do their job [19].

The requirement of work measurement is that help us determine the time a qualified worker would take to complete a specified task when working at a defined speed (rate of working) and

it is concerned with any ineffective time associated with the method and subsequent establishment of time standards for the operation [39], also work measurement technique that focuses on a variety of work (both repetitive and non-repetitive) for manufacturing [48] with designed to establish the time for a qualified worker to carry out a task at a defined rate of working” and Work measurement is mostly concerned with the investigation and reduction of any ineffective time associated with it and its importance on contributing to the planning and control of an operation, and offers a useful basis on which to evaluate alternative ways of delivering work [50]

Work measurement categories into time study and motion study [3], [50].

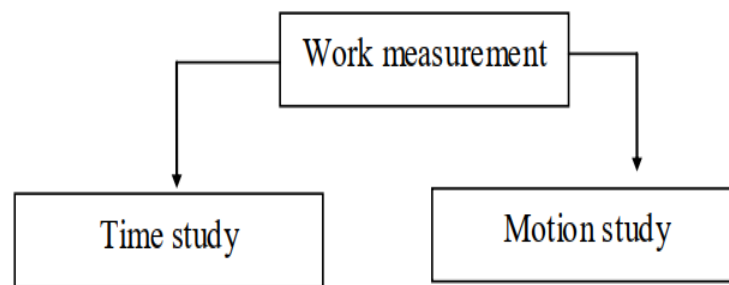


Figure 1: categories of work measurement

The basic procedures of work measurement procedures [51] [52] are:

**Select:** - the work to be studied

**Record:** - all the relevant data relating to the circumstance in which the work is being done, the methods, and the elements of activity in them.

**Examine:** - the recorded data and the detailed breakdown critically to ensure that the most effective methods and motions are being used and that unproductive and foreign elements are separated from productive elements.

**Measure:** - the quantity of work involved in each element, in terms of time, using the appropriate work measurement techniques.

**Compile:** - the standard time for the operation which in the case of stopwatch time study will include time allowance to cover relaxation, personal needs, etc.

**Define:** - precisely the series of activities and methods of operation for which the time has been compiled and issued the time as the standard for the activities and methods specified.

### **2.4.1 Time study**

Time Study is the analysis of a specific job by a qualified worker to find the most efficient method in terms of time and effort and it measures the time necessary for a job or task to be completed using the best method conducted for measuring work in the process [39], [53] and also time study is one of the techniques for analyzing the measurements in a job and One of the methods used to increase the competitiveness of many manufacturing companies. [54]. It concerns an analysis method designed to determine the best way to execute the repetitive task and to measure the time spent by an average worker to complete a given task in a fixed. The purpose of the time study is to improve the effectiveness and the productivity of the workplace in manufacturing industries [47]. Effectively management ineffective time is play a great role on enhancing productivity [39], [53], [55], [56].

#### ***2.4.1.1 Time study producers and basic terms***

Singh (2016) stated that to perform time study in manufacturing industries it needs to follow the basic procedures [3].

- Identifying the job to be timed and operations to be timed.
- Collecting the equipment and arrange machinery required to conduct time study and ensure accuracy in recording time
- Explaining to the worker the improved working procedure and use of tools and fixtures.
- Breaking the job into operations and operations into elements and writing them in a proper format.
- Conducting the observations and recording them on the time study form.
- Rating the performance of the worker.

### **Stopwatch**

The technique was developed to stopwatch time study can observe and record the time taken by the operator using determining the number of cycles for time and then the time average or representative of time can be found depending on the level of the performance of the workers during the observation [54] The stopwatch time is used to analyze a specific process by qualified workers to find the most efficient ways in terms of time moreover, this method measures the time necessary for a work process to be completed using the best ways [48], [39], [53], [57].

**Observed time (OT):** is the process of observing and record the exact amount of time that the operation process is to complete. After identified and recorded the observed time for each process, then calculate the average observed time by using the number receded of times. Also during record the processing time it's better to record 10 times to 15 times of the single given process [58].

**Performance rate (PR):** is the value describing the rate at which an operator is performing and a value of 100 is given for a standard rate at normal condition, but there is less in normal conditions in any manufacturing company sectors and most of the company used as the standard performance rating is between 85 % - 100% with it depend on the existed conditions of the sectors [51], [59] [80]. Now it was time to rate the operator at what performance level he was doing the job, seeing his movement and work speed (and the performance of the workers it depends and determined through unskilled, semiskilled and skilled of the workers [60]

**Allowance (A):** A value describing how the normal time will change, based on fatigue and personal needs of the operator. The basic allowance industry sectors with their standard allowances for Personal and relaxation allowance is between 7% - 12%, fatigue 5 % - 7% contingency 2 % - 6% and delay 5% [59].

**Normal time (NT):** is the adjusted observed time for the process and the adjustment is calculated by determining if the operator was moving at a fast or slow pace.

$$\text{Normal time (NT)} = \text{Average observed time} * \text{Performance rate}$$

### **Standard time and its steps**

Standard time is calculated using normal time that considering allowance based on worker conditions and normal time itself is the time required by a qualified operator to complete his work under normal conditions. The determination of this standard time is very important for production especially for production which uses manual process (human labour) as the main factor and Performance rating is done by comparing the assessment with the ability of existing standards that is the standard of the worker's ability under normal conditions, while an allowance is the allocation of time given to the operator for the fatigue, personal needs, and other reasons beyond the control of the operator, [54], [61].

The Standard time for the proposed method is calculated by stopwatch time study [51], [54] according to the following steps:

- ✓ Selecting the job for the Time study.
- ✓ Obtaining and Recording information:-The information is record using a flow process chart and prepare in a table form.
- ✓ Defining the elements.
- ✓ Measure time duration for each element and asses the Rating factor. The assumption is taken for performance rating. As per this system, the time study observer assigns a rating for the criteria of a particular task and establishes the rating.
- ✓ The Normal time is calculated using the following formula.

$$\text{Normal time} = \text{Average observed time} * \text{performance rate}$$

- ✓ Allowances are given to the normal time calculated above. The allowances are given by considering different kinds of allowances as mentioned in the literature review. Relaxation allowance (personal needs, basic fatigue) and Contingency allowance are allowances which has a great role in calculating standard time.
- ✓ Then the standard time is calculated using the following formula:

Then the standard time, line efficiency, and output per labour are calculated through different formulas [62], [60], [63]

Standard time (ST) = normal time + allowance factor.

Line efficiency ( $L_{\text{eff}}$ ) is calculated from total cycle time divided by the number of operations (station) and maximum cycle time of the process.

Total Output = is calculated from available labour \* available working time\* line efficiency of the process divided by standard time.

### **Total task time contents**

There are two components to the work that is contained in any activity:

- 1 The basic work content of the activity
- 2 Additional, or excess, work content

The basic work content is defined as the minimum effort as measured by the time it takes to complete an activity. This amount of time is the theoretical minimum time required to produce the object of interest or complete the process and cannot be reduced Conditions must be perfect so that the required effort is the “minimum” possible. In reality, such an occurrence would be unlikely if not impossible Even if it was possible to eliminate all excess work content, is due

to unwanted movement, poor process arrangement (layout), excess operation by a single operator, Worker tardiness, and absenteeism and poor worker training [49], [54] , [56].

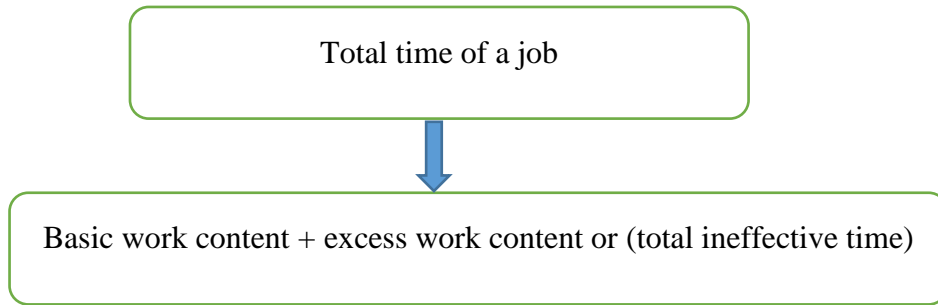



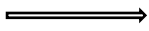



Figure 2: Total time of a job

Basic time is the minimum time theoretically required to produce one unit of output and time for carrying out an element of work at standard rating.

Ineffective time is Excess activities due to poor design of products or services, inefficient methods, poor work layout, and interruptions, and human factors and it measure after to identify the basic operation time and non-value added activities consumed in the process like unwanted movement time, waiting time due to bottlenecks operations, then reduce the ineffective time from basic time of the operations.

During time study it uses different operations and processes with different symbols. According to the American Society of Mechanical Engineers (ASME) flow process symbols uses [39].

Table 1: American Society of Mechanical Engineers (ASME) flow process symbols

Symbol	Name	Meaning
	Operation	A complex action or process changes to another form
	Transport	Movement of people or things.
	Delay	Idle time of people or machines.
	Storage	Longer-term storage of materials or other items.
	Inspection	Checking and examining of items and comparing with standard to ensure correct quality or quantity.

## **Time Study Observation Sheet**

It is a printed form with spaces provided for noting down the necessary information about the operation being studied, like name of the operation, drawing number, and name of the worker, name of time study person, and the date and place of study [51].

## **Sampling techniques**

Sampling is a procedure to select a sample from an individual or a large group of the population for a certain kind of research purpose. There are different sampling techniques under probability sampling there are simple random, stratified, systematic, cluster, and multistage sampling and under non-probability sampling, there are purpose, convenience, snowball, and quota sampling [64], [65] [66].

Purpose sampling is the types of sampling the members of a sample are selected according to the purpose of the study and it is also called deliberate sampling.

## **Work breakdown**

Before making this time study each operation was broken into a definite number of elements, which are not large or too short in time, then selected average cooperative operator(s) [54].

### **2.4.2 Motion study**

Footwear industries have labour-intensive and there is a motion [2] and Motion study is a tool concerned with eliminating non-value added activities and improve the productivity of the company [53]. Motion study aims to facilitate productive and best movement relative to optimal work processes to achieve ideal results and in manufacturing, production, and process setup, process improvement [67].

Job satisfaction has a big impact on how an employee performs his job and have an impact on job safety and employee perception of it and a satisfied employee devotes himself to work, performs orders better, cares for others and himself and meet the performance criteria set by the organization to ensure the quantity and quality of their work [46].

Workers properly working their work without fatigues is paly a great role on the competitiveness of the organization [68] and also reduce defective product, production time and ineffective time and increase the productivity of the organization [69] and it's good for mental and physical of the worker [40]. The sequence of machining is considered as the

optimized sequence and operator motion, plant layout arrangement with time consumptions are used in productivity of the manufacturing [57]. It can eliminate insignificant tasks and non-productive activities. Preoccupation, the layout of production, errors, too much motion, and travel during performing the tasks are examples of non-productive activities and it wasted the production time. Changing the sequence of operations based on the process chart and flow diagram to affect a smooth flow of work through the plant, which can reduce production time. Besides that, changing the sequence of operation also involves the layout of production, rearrange the sequence and layout of operations where it can reduce space utilization with reducing ineffective time in the process [39] , [53].

**Unnecessary motion:** Any motion the employees have to make during their work period that does not add value to the part, such as the location of the process layout, search or stack parts, tools, etc. In addition, walking is also a waste [70].

### **Causes and Effects of repetitive motion**

Safety and health of the workers at workplace are extremely important for the productivity of the company and due to repetitive motion of the workers during their work fatigue can happen because of overload of both mental and physical activities and also when fatigues of workers increase through the time their efficiency also decreased. In manufacturing industries perform repetitive tasks with the same movement for a long period can affect the production output [38].

### **Process flow**

The process flow is one of the basic systems to produce goods and the process implies that all similar production processes are grouped in the same department or area [71].

## **2.5 Line balance**

Line balance is assigning a proper number of workers or machines for each operation to meet the required production rate and it is an effective tool to improve the throughput of the assembly lines while reducing non-value-added activities and it focuses on improving overall efficiency [72]. Line Balancing is equalizing the workload across all operations in a line to remove bottlenecks and excess capacity. Increasing overall efficiency of the single model assembly line by eliminating bottlenecks and reducing the non-value-added activities at each work station by line balancing and work-sharing method [37]. and it is used for smooth flow of production units from one workstation to the next and It utilizes the division of labour principle

to assign the work elements to the workstations so that all stations have nearly an equal amount of work to do with each workman is required to perform at his workstation an assigned amount of work time and repeat on each of the production units as it passes the station [73].

Manufacturing industries must produce large quantities in shorter lead times to stay alive and compete for market share and the production needs a high level of productivity and production lines should be balanced to get a shorter lead time effectively.

Footwear products are assembled as it passes through a series of workstations in a line. In today's competitive global market, companies are mostly striving to strengthen themselves as much as possible in all competitiveness dimensions of business; these demands for optimal production systems, which increases the overall performance of the companies [74]

In footwear, a balance of work in a closing room can be achieved by comparing the work content to be done with the work potential available [73].

### **2.5.1 Assembly Line Balancing**

As a part of manufacturing systems, the assembly line has become one of the most valuable researches to accomplish the real-world problems related to them. Many efforts have been made to seek the best techniques in optimizing assembly lines [20]. To address the improvement areas, Assembly Line Balancing(ALB) was found an appropriate method, and re-allocating operators between work tasks, a reduction in numbers of operators is possible which results in lower costs with lowering costs and increasing production volume, improved productivity is achieved [75].

These systems aim to manufacture products at higher production rates in the shortest time, in the most productive way, cheaply, and with the quality required. Line balancing can be defined as the process of assigning tasks to workstations in such a way that the workstation has approximately equal time requirements.

#### ***2.5.1.1 Types of Assembling Lines***

Assembly lines can be into three classifications based on the number of prototypes assembled on the line and according to the line pace [34].

**A single model assembly line** is line can be described as a line that assembles a single model and it produces many units of one product with no variation. The tasks achieved at each station are the same for all units and products with high demand are intended for this line.

**Mixed model assembly line:** in mixed line producing more than one model simultaneously on the same line and one model is worked at one station, the other product is made at the other positions with many consumers product are assembled on mixed model line.

**Multi-model assembly line:** which a line produces each model in batches and usually workstations are set up to produce the required quantity of the first model then the stations are reconstructed to produce other model and it used when medium demand. It's more economical to use one assembly line to produce several products in batches than build a separate line for each model.

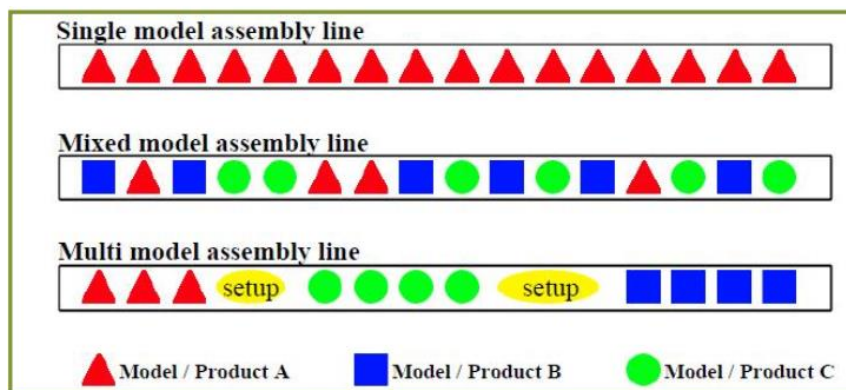


Figure 3: Types of Assembling Lines

### 2.5.1.2 Objectives of Line Balancing

The major objectives of the line balancing stated in [20] are:

- ✚ Minimize the total amount of idle time at the workstations.
- ✚ Eliminate bottlenecks, ensuring a smoother flow of production.
- ✚ Maximize the workforce utilization by minimizing the idle times of the operators.
- ✚ Improve the productivity

### 2.5.1.3 Basic activities in lane balance techniques

The basic activities in the line balance techniques stated in [76] are:

- Calculation of cycle time of the process
- Identifying bottleneck activities

Generally, Effective Line Balancing forms the core of every successful organization as strive to increase productivity without incurring unnecessary costs, and the factors contributing to high costs such as excessive overtime and workforce, high level of inventory, and idle time are all parts of the results of poor line balancing [20].

**Flex Sim 2021 software:** Flexsim is powerful and easy-to-use modelling the layout arrangement of the production process and is also used in many industries [77].

## **2.5 Identified Literature Gaps**

Identified gaps as the overall are: There are no detail-focused papers on the overall output of the company with the others of competitor's daily output and their labour productivity with showing the arrangement of the each operation process in detail form and on enhancing productivity through using work measurement and line balance application in comparing footwear industries productivity in each other.

Then this research can fulfil the identified and exist gap through enhancing productivity in the case of ASSC through work measurement and line balance techniques.

## **CHAPTER THREE**

### **RESEARCH METHODOLOGY**

#### **3.1 Data Source and Collection**

Different data is identified and used as input for the methodology of the research. This research methodology includes primary and secondary data collection methods.

##### **A) Primary Data**

Primary data was obtained by continuous assessment around the field of the study through Questionnaires, informal communication with the manager, supervisor, operator, and workers to get a better understanding area of the problem.

- 1) **Direct Observation-** visited the case company and identify the major causes that affect the competitiveness of the company and it recorded data which related to workers movement (motion), Production flow process, working condition of workers and process time of production department, bottleneck area, daily target and real output product of a company.
- 2) **Questionnaire:** There is a questionnaire that is related to work measurement, time study, motion study, production flow process, bottleneck line balance, and assembly of the process. It prepared a Questionnaire in the English language and ask to depend on the language of the workers understand and closed questions with YES or NO.
- 3) **Interviews** -In-Depth Interviews to get the exact information, include individual interviews as well as “group” interviews production managers, operators, and recorded data in written notes.

##### **Overall prepared questions**

To assess and identify the reason the company recorded less productivity with less customer satisfaction of the ASSC. Prepared major questions related to work measurement and line balance problems those major factors affect the productivity of the factory.

##### **Sampling techniques**

Sampling is the one used to determine the accuracy of the study and procedure to select a sample from an individual or a large group of the population for a certain kind of research purpose.

Purposive sampling (judgmental sampling) is the type of sampling and processed according to the purpose of the study and members for a sample are selected. Because it used the purpose sampling (judgmental sampling) for this study is three major reasons.

- a) Existence of the Covid-19: during the collection of the data it is difficult to select the samples because it is impossible to close to employees according to its requirement.
- b) New rule of the company: because of the existed Covid-19, the company does not allow to distribute the question paper and also direct close to the employees during data collection.
- c) Less interest of the employees: the interest of the employers of the company is less because of the fear of the disease and rule of the company.

Because of that reason, it selected purposive sampling and select interested employers and concerned bodies through self-judgment and read and ask the oral questions with their understanding language.

Then only identified that interested respondent from each section with supervisor, IE, and manager and only read the question for the respondent by keeping the distance and recorded their response on consecutive three days for each section. In the cutting section from 25 employers, the interested and selected are 17, in the Stitching section from 53 employers the interested and selected are 39 and Lasting and finishing section from 52 employers the interested and selected are 40. Of the overall 130 employees, the interested employees are 96.

Then it recorded their all responses from each section of the company and analyzed the data with their frequency by using excel, to identify the major problem that existed in the section and overall of the company which related to the titled of the study and focused on that problems.

## **B) Secondary data**

### **Company and competitor's document and reports**

Company documents and reports are required for the study and data is collected from the production and market department. It identified the existed production condition and it recorded for three years. ASSC produced a different model of shoes depending on the customer's order and among existed shoe types, identified the existed gap between the production target (plan) of the company and the actual output of the product depend on the existed data and reports. Also, gather and record the requirements of the data including daily output and labour productivity with the same model for the study from the major competitors

of the ASSC. Then the data was gathered from the production and market departments of the ASSC and with their competitors through asked of the concerned department.

### Literature Review

For this research, it used different recently published journal articles, proceedings, and books related to the title of the research, to understand the previous and exist conditions of the Ethiopian footwear industries with their strength and existing gap. Also from this different literature, it understands work measurement and line balance techniques, time and motion study and line balance with their benefit, principles and concepts. Identifies and understands the requirements of the standards for the study. The review process helps to identify the major factors that affect productivity and shows the way to enhance the productivity of the footwear industries.

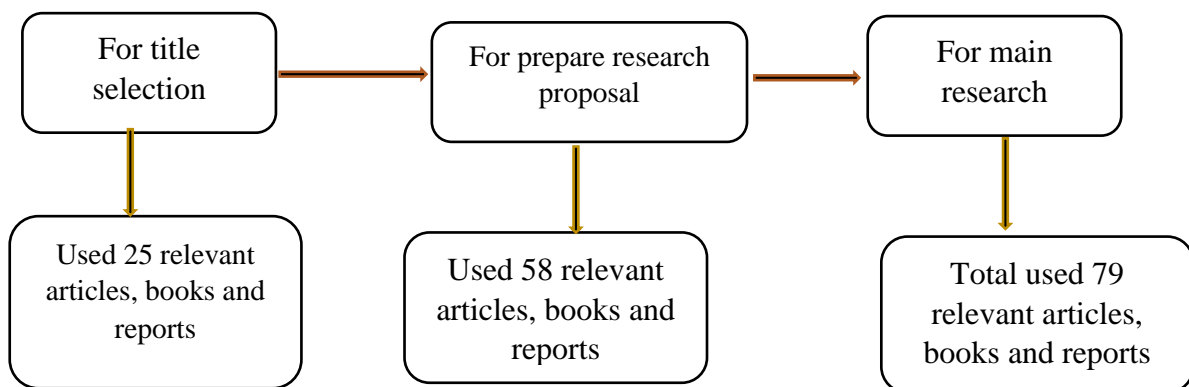


Figure 4: Literature Review framework

### The overall data collection system

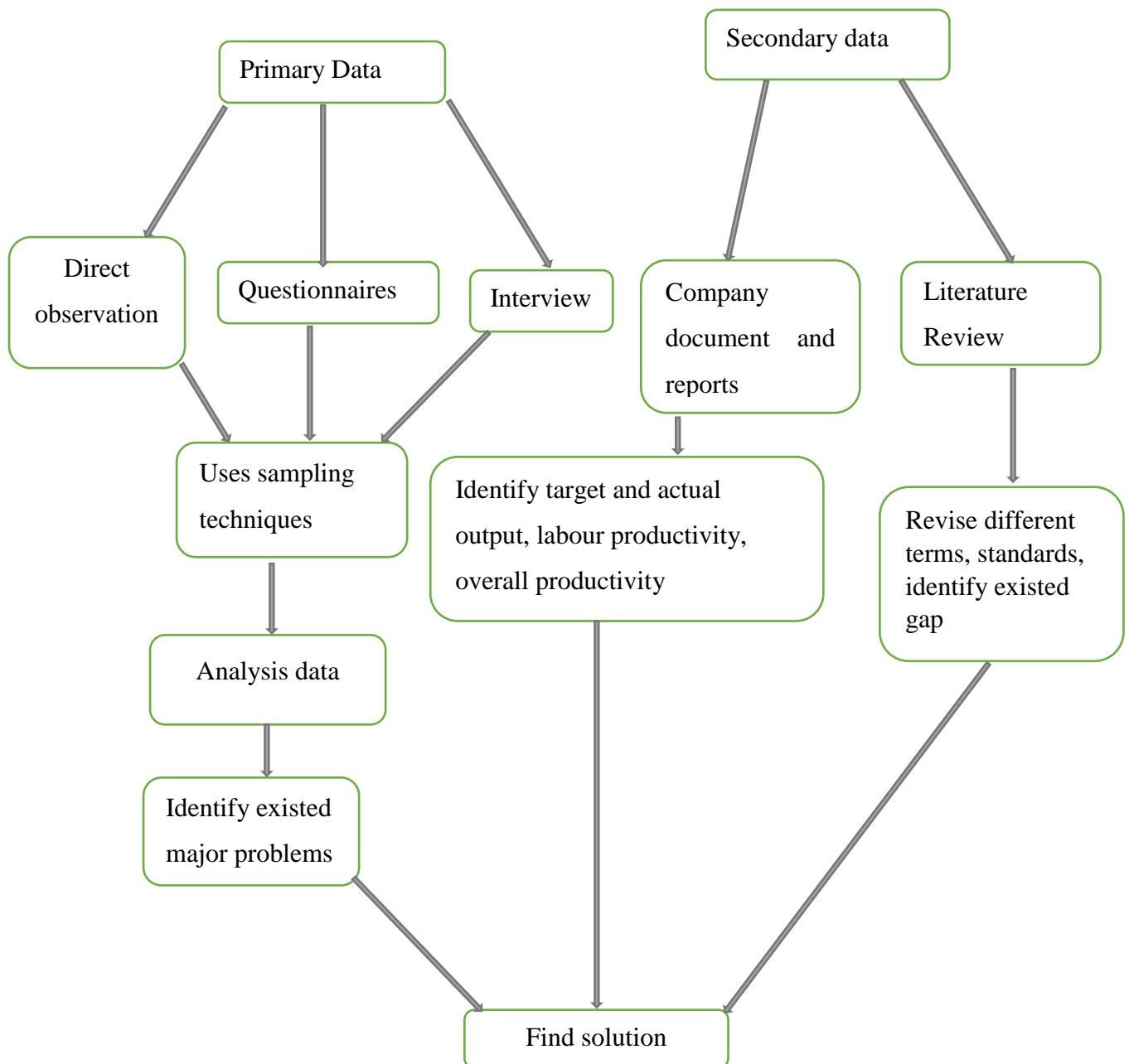


Figure 5: Overall data collection system

### 3.3 Consideration during the study

There is a consideration during the study for both company and workers

**Ethical consideration:** During the study processed and collecting data it needs consideration, because, the existence of different peoples and it needs respectful the existed difference (religion, culture, attitude, interest, etc.) of the employees and rules of the company.

**Human consideration:** there are different postures and physical of workers existed in the company and the operating system of the workers is considered to be effective through the satisfaction of operators during their working time. So in this study, it considers taking the safety of the workers first. Also during the measurement, the movement distance considers enough space for movement which is related to workers' body posture.

**Keep the standards.**

Keep the standard time of any operation with the standard allowance and performance rating of the workers.

**Quality of the product.**

Keep quality of the existed product of the company to enhance their competitiveness.

**3.4 Overall tools, software, and materials used.**

The study used tools, software's and materials in analyzed the input data and the result of the study. Using a stopwatch to measure (observe) the production time that each task take (evaluate the working time), a time study sheet for record and analysis each time of the tasks, a flow process chart for showing the process and operations, distance measurement material (BM tools), which used for measuring distance movement of workers, Flex Sim 2021 software for design and show the arrangement process flow of the section and Microsoft Office 2013 Excel to detail analysis the recorded data and bar graphs for comparing the exist and proposed system with their result and also it used QM for Windows V5 software for analyzed and shows of recommended implementation of the study.

### 3.5 Overall Research Framework

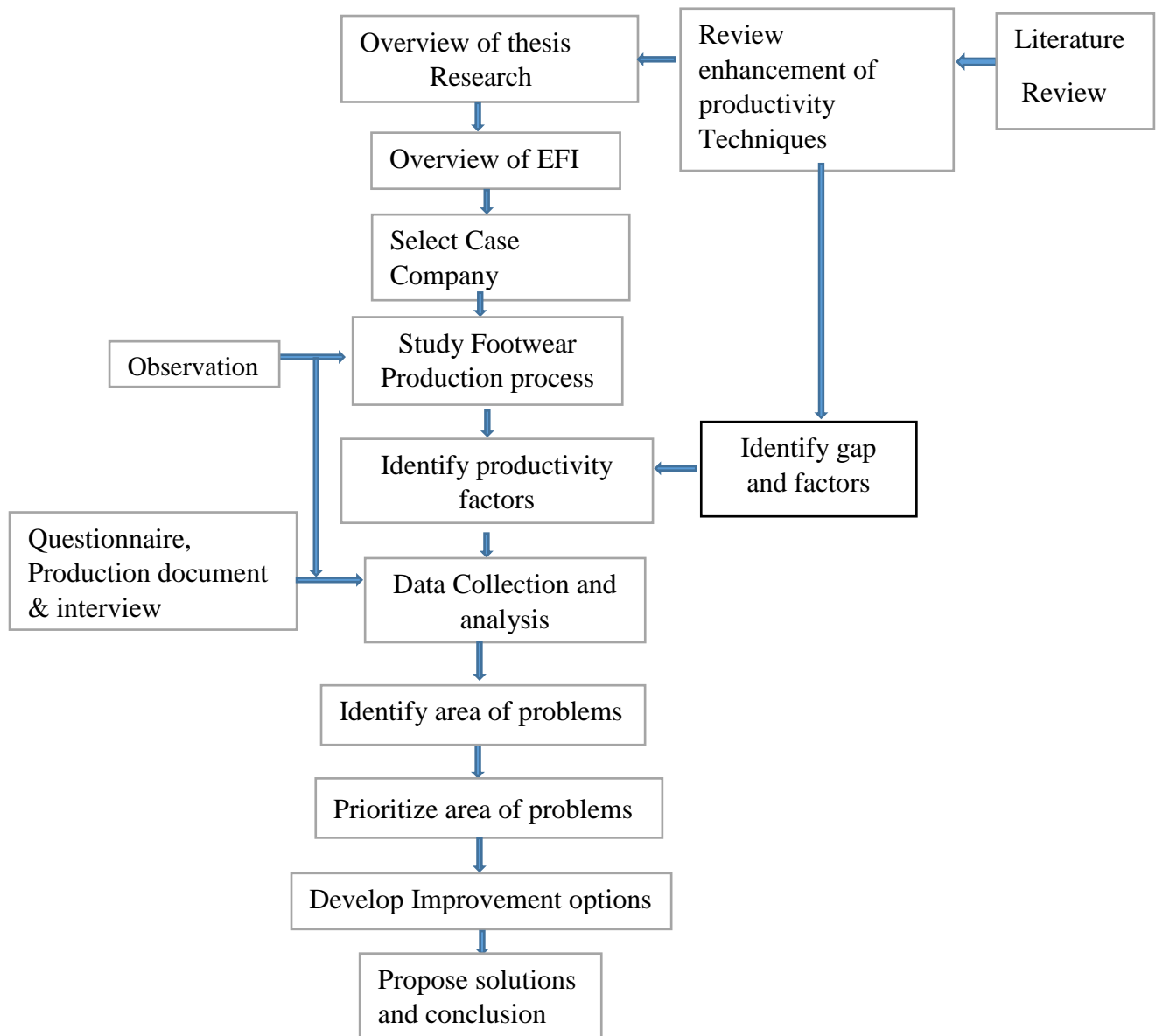


Figure 6: Overall research framework

## **CHAPTER FOUR**

### **BACKGROUND OF ASSC AND IDENTIFICATION**

#### **4.1 Background and production process of ASSC**

The Anbessa shoe share company (ASSC) is one of the oldest shoe manufacturing factories in Ethiopia around 1930. The current form ASSC is the result of many changes and reorganizations which took place over the past 60 years above. In 1930 factory was established under a private entrepreneur who operated for only 3 years and also in 1942 the factory was taken over by an Armenian Entrepreneur Mr. Mardious Drakjan who runs the business for 33 years under the name Darmar shoe factory with a capital of 273, 000 Birr. Also in 1975 Darmar was fully nationalized and organized as two public enterprises namely ANBESSA SHOE FACTORY and AWASH TANNERY and it direct supervision of National leather and Shoe Corporation. On the later DARMAR called ANBESSA SHOE FACTORY started its operation as a public enterprise on February 10, 1975, with affixed capital of 4450000 with a total workforce of 334.

In 1993 the proclamation No.24/85 the National Leather and Shoe Corporation were recognized to operate as an autonomous public enterprise and the capital of the company reached Birr 6,335000 and with a total number of employee is 782. Over its long life, particularly since its nationalization, the factory has tried to meet the demand through producing different models of footwear products.

#### **4.2 Objectives of the ASSC**

- Produce all kinds of leather shoes and shoe uppers that will meet the requirements of the market and supply to local & foreign markets.
- Develop better designs for shoes.
- Develop the replacing the imported raw material with suitable local components
- Participate in any other activity that may contribute to the achievement of its purpose.)

#### **4.3 Types of Products, Inputs, and Supply markets**

Currently, ASSC has been producing above 50 various types of models of shoes with 2200 pairs production, among those Gentles man's and civilian shoe (EL-028102LB model) shared around 21% of the company productivity and it produced throughout the year with high

customer demand and those others it produces depend on the customer's order and the main products being manufactured by:

- ❖ Gentles man's and civilian shoe (EL-028102LB model)
- ❖ Ladies shoe
- ❖ Children's shoe
- ❖ Shoe upper
- ❖ A variety of products
- ❖ Heavy-duty military boots

Among existed shoe types, Gentles man's and civilian shoe (EL-028102LB model) which generate more profit for the company and produces throughout a year, high demand rather than others models, it has a basic process operation for other models and other models production depends on seasonal, less demand and not a continuous process, because it depends on the customer's order. There is a gap between the target production of the ASSC and the real output of Gentles man's and civilian shoes (EL-028102LB model).

### **Inputs and Supply markets**

The company source of input can be:

#### **Local raw materials**

From the local, like Addis Ababa Tannery, Mojo Tannery, and Ethiopian tannery get processed leather of Shoe Upper leather, Shoe lining leather.

#### **Imported raw materials**

The main imported raw material and inputs needed for production in ASSC.

- ✚ PVC granular for sole marking and Last raw materials
- ✚ Chemicals and Packing materials
- ✚ General and special merchandise

### **Markets and Distribution Channels**

The ASSC target is to produce products that are upper, lower, and middle-income of the population. Currently, about 34% of the sale is made direct from the factory to various public institutions that have to provide uniform shoe to their employees and 66% is sold through the factories own retail shops across the nation [78].

### Major competitors of ASSC

The current major competitors of the ASSC are Kangaroo shoe factory, Ras Dashen shoe factory, and Wallia shoe factory.

### 4.4 Organizational structure of ASSC

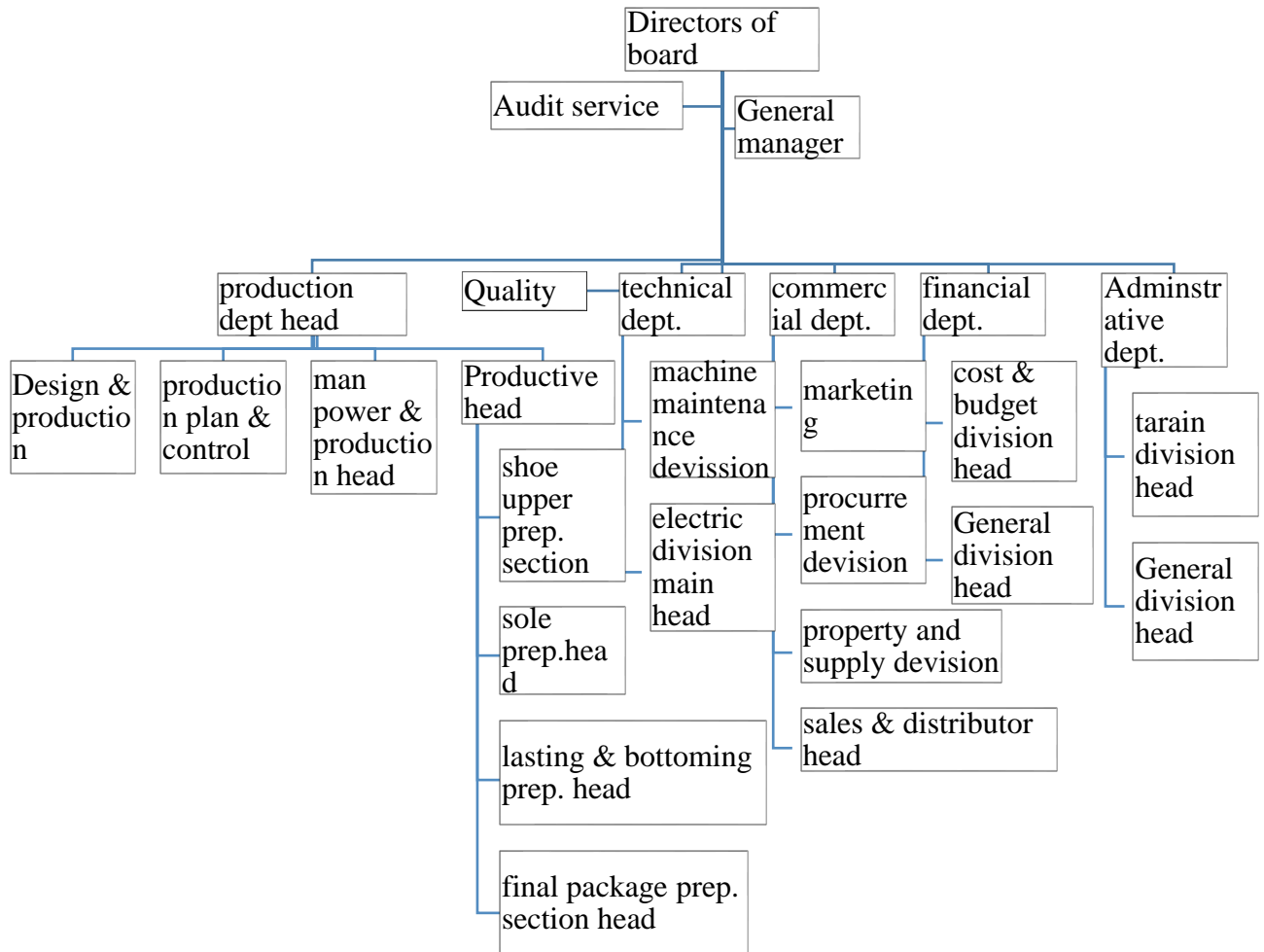


Figure 7: Organizational structure of ASSC

## 4.5 Main production section of ASSC

ASSC has four main sections of the footwear production process. Those are the design section, cutting section, stitching section, and lasting and finishing section.

**Designing:** Designing the shoe is the most primary and important process of footwear manufacturing. It starts with sketching that showcases the creativity of the designer. The the sketch is further converted into three-dimensional shoes, considering all dimensions of the foot and also specify the materials required for making the shoes.

### Major operations and process of cutting section

In the cutting section, materials are cut in various designs, and materials mainly leather is cut manually or by machine. Material saving, quality & productivity are the most concerns of the department. The operation needs a high level of skill as the expensive materials including leathers are cut here. Leathers may also have various defects on the surface which needs to be adjusted in the shoe components.

After raw material (lather) came from the warehouse (store) then directly entered the cutting section. In cutting section there is two major operation process are there, those operations are Pre-cutting (Clicking operation) and Insole preparation and operations.

Pre-cutting (Clicking operation)

✚ In pre-cutting (clicking operation) different operations are there

Upper raw material preparation: it is the process of adjusting, remove unwanted materials from raw materials and prepare of the raw material for the process.

Pre-cutting operation: is cut the lather according to their different shape

Back box skiving: it is doing of the back edge of the material, according to the folded and shaped with the size and it used for the appearance of the shoe.

Stamping: it is the process of printing logo, model, and size number with the process on the inside lining and inner part of the back track.

✚ **Insole preparation and operations**

Insole preparation and operation process also included in the cutting section with different operation processes.

Insole material preparation: it is the process of preparing insole material according to their needs for the model of shoe and insole is an inner part of the shoe that connects the top part of the shoe (upper) with the bottom part (sole, heel).

Cutting texn board: cut the board with their required size and shape.

Cutting shank board: it is a long and thin piece of material between the insole and outsole that is used to support the foot and provide structure.

Shank grooving: it is the process of splice the sole of the shoe with half soling shoes

Shank skiving: it's the operation of taking off the rough fleshy parts from the inner surface of the skin.

Attaching shank: attach an internal part of the supportive structure with insole and outsole

Apply glue: it connecting and arching the bottom of the insole and the surface of the inside of the shoe.

Molding: form according to shoe shapes or form.

Bevelling: it is the process of rounded or angled in the back.

At the end of the process, both Pre-cutting (Clicking operation) and Insole preparation and operation are dispatched at the same place.

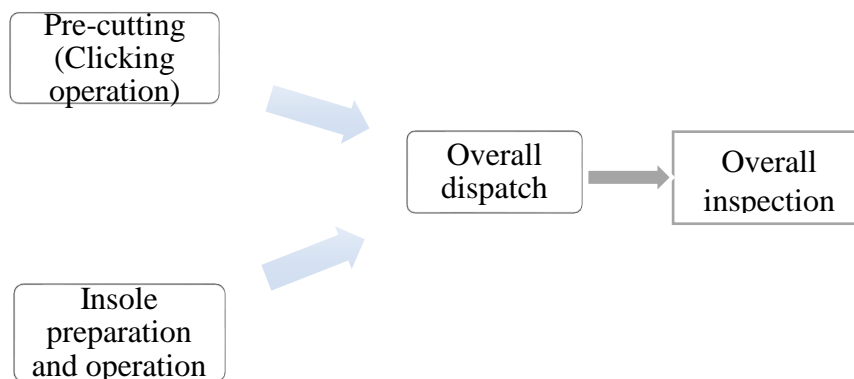


Figure 8: Major cutting section operation process

### Major operation and process of stitching section

In the cutting section, the component pieces are assembled and stitched together, as per the samples, to produce the three-dimensional completed upper and it has a high percentage of manpower in the process of upper making. For the stitching section, Upper, lining and re-

enforced materials come with a batch from the cutting department, and also one batch contains 25 pairs of upper components. After arrived the stitching section it checked the quality of components with the quantity per one batch size. In the stitching section, there is an assembly of the different components of the upper parts of shoes with a flat bed, post bed, zigzag, eyelet machines, and others and also parts of shoes referred to as an upper are vamp, tongue, apron, toecap, counter, quarter, baskets and mudguard, etc. the major operations in the stitching sections are.

**Loading:** the starting point for the mainline of the stitching section and in loading all of the components that are necessary for one complete pair of the shoe are counted and stored until it is loaded and distributed to the stitching department. All the previous activities are considered as a preparation stage. The loading activity is practiced by batching 25 pairs of shoe uppers per batch.

**Marking:** the upper components which go through stitching are marked by silver pencil and this activity is used for workers to follow through the line of marking and it differs from model to model. Marking activities include; eyelet, apron, vamp, sock lining, and upper components.

**Skiving:** it used to reduce the thickness of the upper leather components and for ease of penetrating the needle of the stitching machine. Skiving activities are quarter lining, vamp lining, apron, eyelet face, lining tongue, etc.

**Re-enforcement material attachment:** Re-enforcement materials are cemented with glue and also attached with some of the upper components to avoid tiring, it helps the shoe to have strength and flexibility. Types of re-enforcement materials differ for different components, such as nylon, plastic materials, sponge foam, cloth counter, and collar, etc.

**Stitching:** This stitching process includes combining two similar or dissimilar components. Flatbed stitching machine used for zigzag stitching and post bed machine used for normal stitching with different components include decorations, back strap, stitch and turn, top-line stitch, lock stitch, stitch line, component to component (assembly).

**Folding and Hammering:** upper components are folded to the inside side for making good shape and appearance.

**Back Part Molding:** Heal side of the tomay is molded using a molding machine to keep the shape of the tomay a heel shape.

Pulling and burning threads: in this operation, the threads left out from the stitching operation are pulled out and burned and they are cleaned properly.

Fixing operation: it mainly concerned with the joining of main assembled components and activities include Component to component, toe puff fixing, counter stiffness fixing, sub-assembled lining fixing, and foam fixing.

Cleaning and Inspection: it is the end of stitching operation section and finalizing the tomay (Italy name) as of end products before it is shipped to the lasting section with inspection only eye inspection. The major operation process of the stitching section is shown in the figure below.

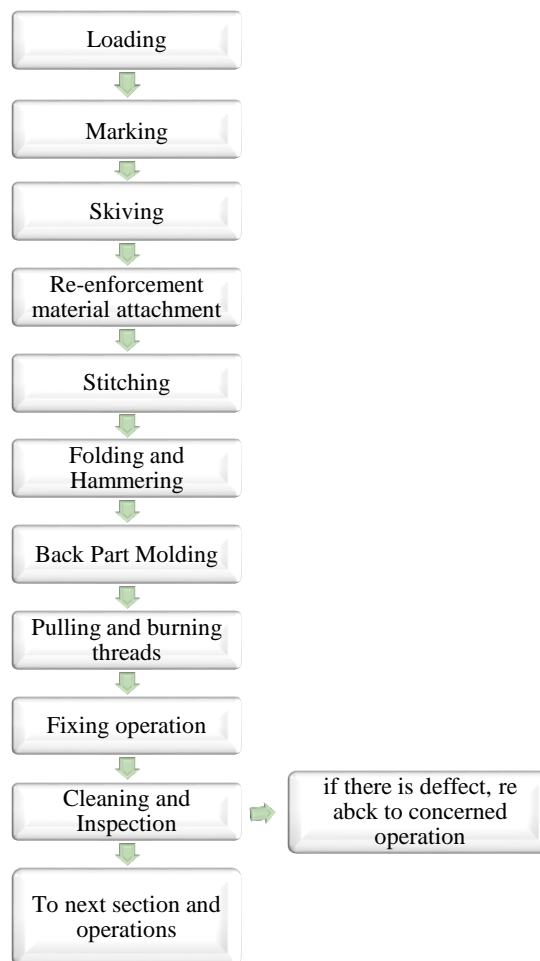


Figure 9: Major operation process of the stitching section

## **Major operation and process of Lasting Section**

In the lasting and finishing section, the upper part is further shaped in the form of a shoe and the next process is to enhance the appearance of the shoe, Special waxes, creams, crayons, solvents with back part molding, upper prepare-hot, toe puff attaching-hot, seat lasting, seat and side lasting-hot, ironing-hot, sole press-hot, and other tools and fixture. The major operations in the lasting and finishing sections are:

Preparation stage: it uses the end products of the stitching section as input i.e. the tomay as well as the sole and the operator's load pair of tomay together with pair of sole on the upper and lower layer of the conveyor. The sole is washed using hydrogen liquid (priming) and then glue to prepare for fixing with daban (local name).

Manual Lasting: To increase the elasticity for ease of insertion to the form and the Tomay and Mucas are inserted to the form after the tomay is properly heated by heating machine.

Hammering Nail: tomay and daban attached the form and finally attached it with a nail to avoid misalignment during the next steps.

Pressing: Lower part of the shoe is closed and made to be pressed to have the right shape with the hot pressing process.

Furnishing Mucus: it is a combining the decorative components using an adhesive material.

Closing/ folding: Mucus edge is cemented with glue and heated and then the process and the back part of the heel are folded by parting machine because of its difficulty to perform it by hand.

Heating: it is properly heated in the heater machine to make it relaxed and the nails are removed from their position as the mucus and the upper component of the shoe are now fixed together.

Grinding: Mucus and upper component together are grinded properly to bring the nose part of the shoe to the shape of the toe.

Roughing: the shoe is ironed and roughed to make them shining and beautiful and remove the dust from the upper parts by using the roughing machine.

Stamping: is the process of attaching the trademark name of the shoe such as the name "ANBESSA shoe number.

Heating and Pressing: The pair of the upper finished component with its pair of the sole are picked from the conveyor and inserted in the heater machine to dry the mastish and alarm code is inserted in between the sole and tomay, then fixes the main sole and the upper component finished part and inserted to the pressing machine to firmly attach both components.

De- lasting (Removing the form): Removed unwanted materials from the completed shoe.

Cooling Activity: is the process of cooling the shoe to return it to its original shape to recover the distorted nature of its elasticity due to so many activities such as ironing and brushing of previous steps and after passing by the cooling machine the inner upper layer sole is inserted.

Apply glue and shining: it is the process of liquid cream is sprayed to polish the shoe.

Inspection and packing: The complete shoe is inspected its quality; leather tearing and stitch problem and also minor activities of finishing such as burning treads, posting the shoe number, price of the shoe, and trademark on the finished shoe, then at the end pack pair of shoe in one.

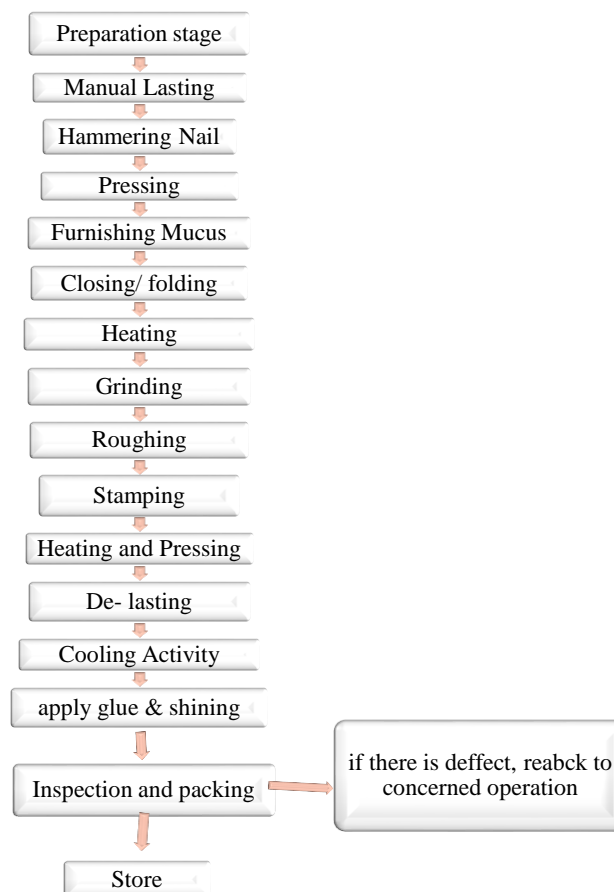


Figure 10: Major operation process of lasting and finishing section

#### 4.6 Analysed questionnaires’ data and identification

From the overall analyzed questionnaires’ data from cutting, stitching and lasting section 82%, 72%, 80% respectively, not know factors affect the productivity of the company. The Customer is satisfied by the product of the company but there is a supply-demand gap on the product, this indicates the existence of the high demand for the product but the amount of the produced product is not matched with the existing demand. According to a respondent response from cutting, stitching, and lasting and finishing section 76%, 67%, and 77.5% respectively, the daily product produced and ordered for customers of the company is not enough and requires improvement.

The major problems that existed and identified those that affect the daily output, direct and indirect affect the overall of the productivity of the company.

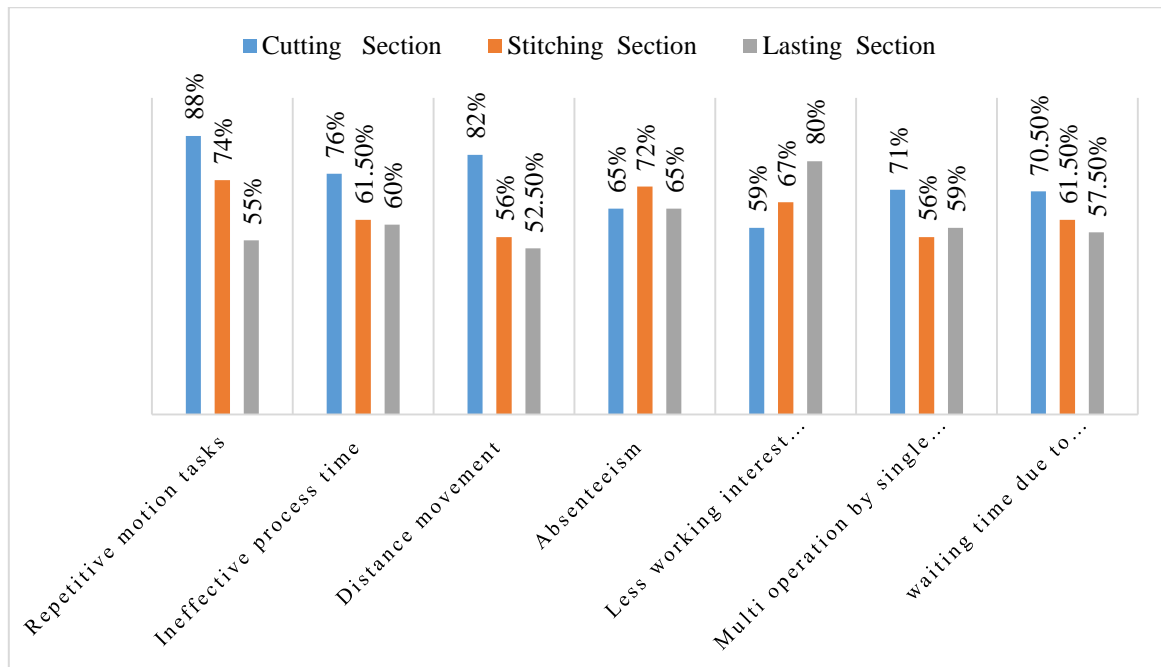


Figure 11: Identified major existed problems affect productivity.

According to analyzed data in chapter five shows, the actual daily produced per day in pairs are far apart from the planned (expected) output of the company. Due to the above major problems raised by employers the productivity of the company is affected, because the existed demand for the product is very high and not matched with the produced product. The company working day in a month is 24 days or 288 days in a year with included two Saturdays in each month.

There is a large gap between the plan (expected) output and the actual output of the company and also company only increased the output plan depend on the demand without improvement of the overall production process of the company.

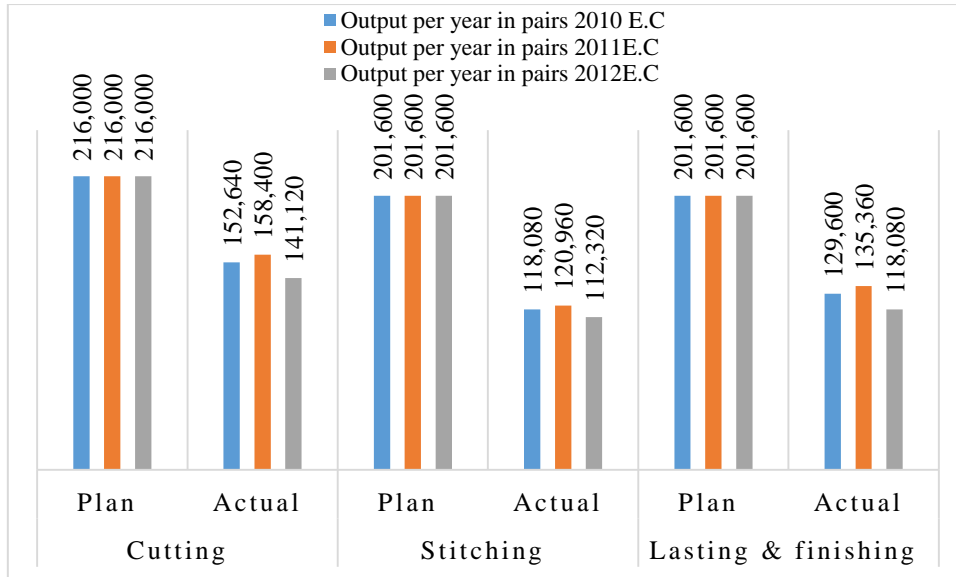


Figure 12: Analyzed data of plan and actual product output

The overall average of the actual output is:

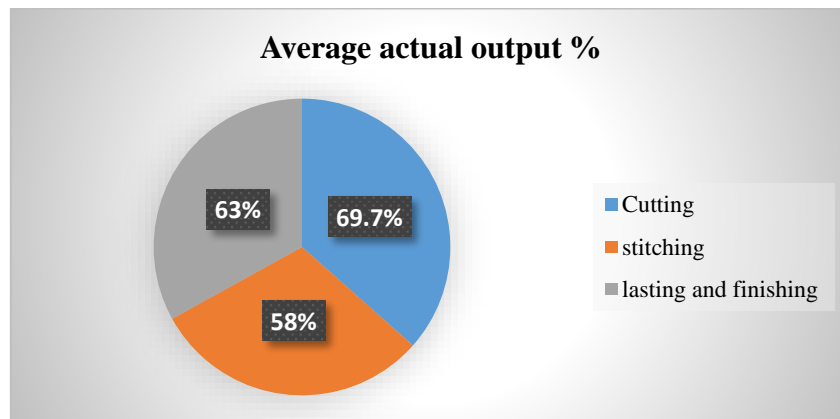


Figure 13: Average actual output

The demand for the product is increasing from year to year and the company production plan also increases in some amount, but there is no improved production system. In case of this, the gap between plans (expected) output and actual output also increased

### 4.7 Analysed data of major competitors output per year of ASSC

The current major competitor’s company of the ASSC are Kangaroo shoe factory, Ras Dashen shoe factory, and Wallia shoe factory. Recorded data on the same and related models are averagely produced in pairs per year [79].

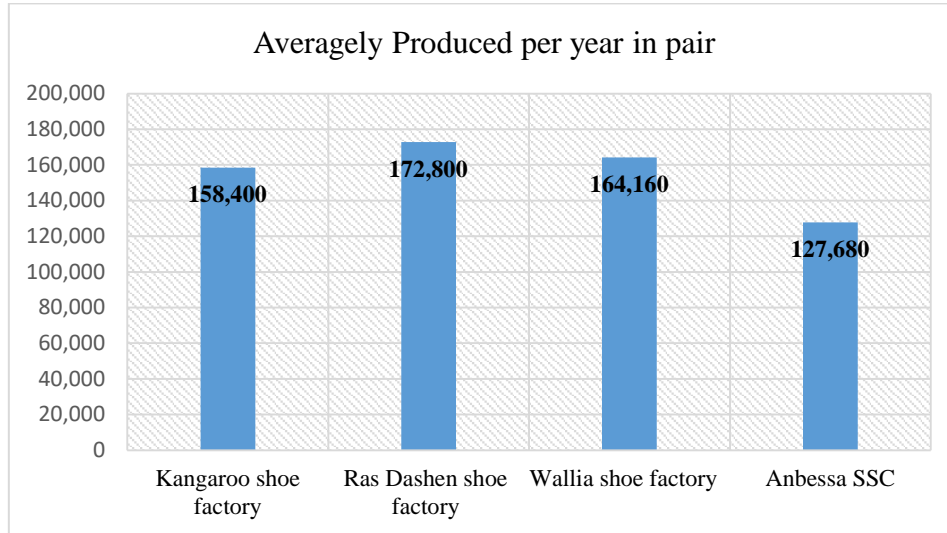


Figure 14: Averagely Produced/ year of competitors

From the above documented and recorded data, the productivity of ASSC has much lower than their competitors in the produced product.

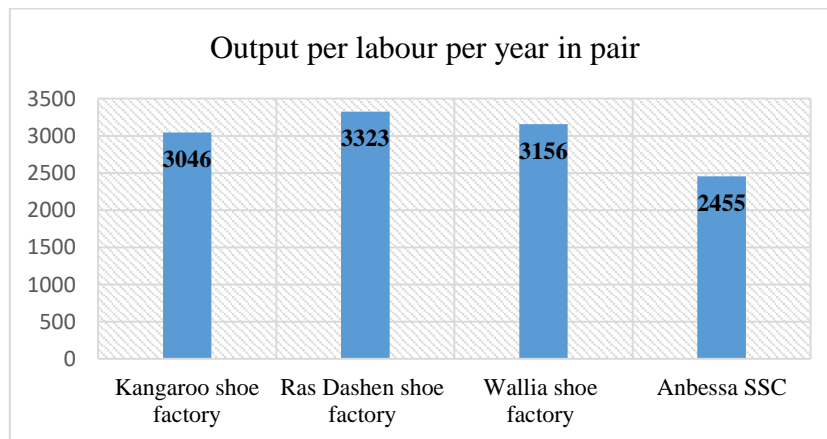


Figure 15: Output per labor per year in pair.

From the above figure the labour productivity (output per labour) in pairs is very low when it compares with the other country, the daily output per labour per for Kangaroo, Ras dashen, Wallia and Anbessa is 10.6,11.5,11 and 8.5 pairs respectively. This indicated that the labor productivity of the ASSC is below their competitors and it needs to improve the labour productivity (labour output per day).

## **4.8 SWOT of the ASSC**

According to identified information through interviews, questioners, and existed data showed the SWOT of the ASSC.

### **Strength**

- ❖ Produce quality products for customers.
- ❖ Responsibility of the workers and management system is identified and known
- ❖ There is a vision on the future strategy
- ❖ Produce different models according to customers ordered and recorded daily activity
- ❖ Participated in the poverty reduction and economic development of the country
- ❖ Create job opportunities for jobless people existed in the country
- ❖ It follows the standard of the allowance and performance rating in the production process.

### **Weakness**

- ❖ Poor consideration of workers and customer satisfaction only focused on produce products and poor customer relationships.
- ❖ Productivity improvement of the company is considered as the management responsibility
- ❖ There is constant plan (target) output through the year and not follow the market
- ❖ Poor motivation and performance-based reward systems
- ❖ There is no proper and effectively uses integrated of both work measurement and line balance in the production process
- ❖ There is an improper flow process, bottleneck, and distance movement with ineffective time in the production process.
- ❖ There is less competence on a market share level, because of shared with less product.
- ❖ The large gap between supply and demand for the product, because of the interest of the customers for the product is high.
- ❖ Poor relationship between workers and management of the company
- ❖ Less labour productivity and line efficiency on the footwear production process
- ❖ Poor communication of the vision of the company is not disseminated to employees.
- ❖ Poor on updating and training the employer's skill.

## **Opportunity**

- ✚ Large market availability, because there is high demand for the product
- ✚ Availability of trained labour force
- ✚ There is high government support
- ✚ Availability of raw material

## **Threat**

- ✚ Unavailability of adequate infrastructure in the country
- ✚ Hard competition from other competitors.
- ✚ Shortage of specialized and experienced labour force

## CHAPTER FIVE

### DATA ANALYSIS AND FINDING

#### 5.1 Observed, recorded time and basic formula

**Observed Time (OT):** The exact amount of time that the operation process is completed and also during record the processing time it's better to record 10 times to 15 times of the single given process [58].

During record time it observes and morning and afternoon, which means five times at the morning working time and five times at afternoon working time. Because more than one operation is operated by a single operator and it needs the difference of the operation time when it works for a long time. Then, the total recorded time in cutting stitching and lasting and finishing section is 190, 370, and 350 respectively with a total of 910 recorded process times.

**Average observed time (Av. OT)** is the total summation of each observed time and divided by the number of observed times.

$$Av.OT = (T_1 + T_2 + T_3 + \dots + T_n) / n. \dots\dots\dots \text{Equation (1)}$$

Where 'T' is observed time and 'n' is a number of observations.

$$Av.OT_{(\text{operation } 1, 2, 3, \dots)} = (T_1 + T_2 + T_3 + \dots + T_{1n}) / n$$

**Performance rate (PR):** Performance rating- Now it was time to rate the operator at what performance level he was doing the job, seeing his movement and work speed and the performance of the workers it depend and determined through unskilled, semiskilled, and skilled of the workers and it measured between [60].

Normal time (NT) is the time required for the workers to perform their work at a normal condition (pace) and is calculated from observed time (Av. OT) and performance rate (PR).

$$NT = Av.OT * PR \dots\dots\dots \text{Equation (2)}$$

$$NT_{(\text{operation } 1)} = Av. OT_{(\text{operation } 1)} * PR_{\text{operation } 1}$$

$$NT_{(\text{operation } 2)} = Av.OT_{(\text{operation } 2)} * PR_{(\text{operation } 2)}$$

$$NT_{(\text{operation } 3)} = Av.OT_{(\text{operation } 3)} * PR_{(\text{operation } 3)} \dots$$

$$NT_{(\text{operation } n)} = Av.OT_{(\text{operation } n)} * PR_{(\text{operation } n)}, \text{ where n is sequence of the operation.}$$

In both case of the PR and A there is a critically studied and recorded in each section of the case study of the company, then it compare with the existed standard and use it ST analyse and calculation. It's deferent in each section and taken and used the average of the overall analysed and constant depend on the section, for the section then,  $NT = Av.OT * PR$ .

**Allowance (A)** is the extra time that is added to the basic operation like personal, fatigue, and unavoidable delays and it depends on the existed conditions in the section.

**The allowance factor (AF)** is calculated from the given allowance (A) and normal time (NT).

$$AF = NT * A \dots\dots\dots\text{Equation (3)}$$

$$AF_{(\text{operation 1})} = NT_{(\text{operation 1})} * A_{(\text{operation 1})}$$

$$AF_{(\text{operation 2})} = NT_{(\text{operation 2})} * A_{(\text{operation 2})}$$

$$AF_{(\text{operation 3})} = NT_{(\text{operation 3})} * A_{(\text{operation 3})} \dots\dots$$

$$AF_{(\text{operation n})} = NT_{(\text{operation n})} * A_{(\text{operation n})}$$

Because of the constant throughout the process, it uses the same value of the allowance during the calculation of the allowance factor and the value of the allowance (A) is constant.

**Standard time (ST)** is calculated from normal time (NT) and allowance factor (AF)

$$ST = NT + AF \dots\dots\dots\text{Equation (4)}$$

$$ST_{(\text{operation 1})} = NT_{(\text{operation 1})} + AF_{(\text{operation 1})}$$

$$ST_{(\text{operation 2})} = NT_{(\text{operation 2})} + AF_{(\text{operation 2})}$$

$$ST_{(\text{operation 3})} = NT_{(\text{operation 3})} + AF_{(\text{operation 3})} \dots\dots$$

$$ST_{(\text{operation n})} = NT_{(\text{operation n})} + AF_{(\text{operation n})}$$

Where n is a sequence of the operation and 'AF' is the allowance factor of each operation process.

**Cycle time (CT)** is the time to complete a task or collection of tasks and is used to assess and determine the bottleneck of the operation. Improve cycle time through improving the displaced workers on each operation those have high cycle time, process rearrangement and as a reduction in cycle time often results in making more, faster, with fewer resources [43].

$$\text{Cycle time (CT)} = \text{Standard time (ST)} / \text{Labour (Lbr)}$$

$$CT = ST / Lbr \dots\dots\dots \text{equation (5)}$$

$$CT_{(operation\ 1)} = ST_{(operation\ 1)} / Lbr_{(operation\ 1)}$$

$$CT_{(operation\ 2)} = ST_{(operation\ 2)} / Lbr_{(operation\ 2)}$$

$$CT_{(operation\ 3)} = ST_{(operation\ 3)} / Lbr_{(operation\ 3)}$$

$$CT_{(operation\ n)} = ST_{(operation\ n)} / Lbr_{(operation\ n)}, \text{ where 'n' is sequence of the operation.}$$

Line efficiency ( $L_{eff}$ ) = (total cycle time) / (Number of operation \* Maximum cycle time of operation process in the section)

$$(L_{eff}) = [(T_{CT}) / (N_{op} * M_{CT})] * 100 \dots\dots\dots \text{equation (6)}$$

Capacity per day of each process = [(available working time/ standard time of each process)\* a number of labour on each process].

$$\text{Capacity per day of each process} = [(28800/ST)*lbr] \dots\dots\dots \text{equation (7)}$$

Total output ( $T_{(O/P)}$ ) = (Total number of labour in a line \* available time (min) \* line efficiency) / total standard time)

$$T_{O/P} = (T_{(Lbr)} * A_T * L_{eff}) / ST \dots\dots\dots \text{equation (8)}$$

Output per labour (O/P /Lbr) = total output per a day / total number of labour in a line

$$O/P /Lbr = T_{(O/P)} / T_{(Lbr)} \dots\dots\dots \text{equation (9)}$$

**5.1.1 Existing system of each section of ASSC**

**5.1.1.1 Cutting section operation process**

The starting operation of the footwear is in the cutting section and in the cutting section there are major operations are clicking operation and insole preparation with the operation. Clicking operation includes a pre-cutting operation (sock foam, mudguard foam, apron foam, collar foam, back count Eva, quarter ren eye stay, and back box), back box skiving, and stamping (model, size & date) on tongue and pictograph on the quarter lining. Insole preparation with operation included cutting texn board, cutting shank board, shank grooving, shank skiving, attaching shank steel with shank board by revetting, apply glue on texn board, and shank board then attaching texn with shank board, molding, bevelling, and dispatch.

Table 2: Sequence of operation, movement distance with a time of cutting section

Activity	○	⇒	D	▽	□	Distance movement(m)	movement time (sec)	Remrk
raw material storage preparation						6	24	Deduce excess distance
pre-cutting operation						4	16	
back box skiving						3.5	14	
stamping						4	16	
Upper collect						4.5	18	unwanted movement
upper arrange and dispatch						4	16	
sole material store and preparation						4	16	
cutting texn board						2	8	
cutting shank board						2.5	10	
shank grooving						2	8	
shank skiving						2	8	
attaching shank						3.5	14	
apply glue						4	16	
molding						2	8	
beveling						2	8	
Insole collect						4.5	18	unwanted movement
insole arrange and dispatch						3.5	14	
count and overall dispatch						2	8	
overall inspection						0	0	
Total						60	240	

Total distance of 60m and movement time 240second (4minute)

In this movement distance case, every finished (in the process) and other activity is manually moved by the workers throughout the working time and the workers carry the material or in-process material for the next process and also the movement way is not a comfortable and straight line, in case of this problem the motivation of the worker for work is very less due to fatigue and it increases process time with less output. To reduce such a problem it needs to reduce movement distance and rearrange the flow process of the operations by assembling (joining) the same activities at the same place.

### Flow process and arrangements of cutting section

On this cutting section, there is a Clicking operation and insole preparation with the operation are there and at the end of their operation process in each flow, it combined and goes to the next operation (stitching section).

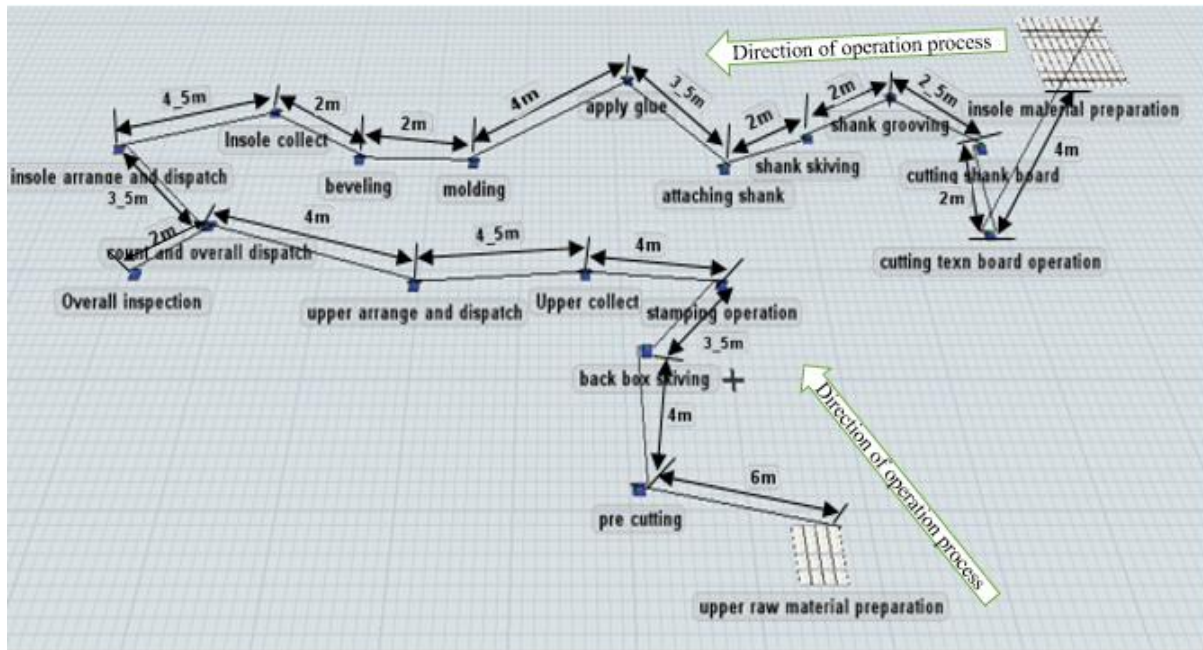


Figure 16: Flow process and arrangements of cutting section

From the above flow process figure, there is a long-distance move in some continuative operation, because of this long-distance movement it consumes time and it has fatigue for workers when it works throughout the working box time, then it requires reducing the distance between consecutive operation those has long distance and combine (join) the same process together with arranging the sequences of the process. Also, there is in some operations there is an excess number of workers and it needs to rotate (transfer) to the other operators who require additional workers to reduce process time.

**Performance rate (PR) and allowance for cutting section.**

In the company, there is a critically assessed on the performance and allowance needed and recorded for each section. For this study, it takes both performance and allowance through comparing the standard with the existed on the company, then it fulfils the standard required amount.

According to the critically studied and recorded for cutting section, there is a performance rate and allowance of the company and also those are match with existed standard. In cutting section there are different types of the allowance are there with recorded different values in the section

In the cutting section, the performance rate is 92% and also the types of allowances in the cutting section are Personal allowance (PA), Fatigue allowance (FA), and Contingency allowance (CA)

Table 3: Types of allowance for cutting section.

Types of Allowance	Percent
Personal allowance	11%
Fatigue allowance	5%
Contingency allowance	6 %
<b>Total</b>	<b>22%</b>

**Recorded the time on the time study sheet**

A record exists process time of each process to determine their normal time and standard time with the output of each section. To determine more accurately the observed time (OT) of the process it record ten (10) times and then it uses the general formula:

$$\text{Average observed Time (Av.OT)} = (T1 + T2 + T3 + T4 + T5 + T6 + T7 + T8 + T9 + T10) / 10$$

$$\text{Normal Time (NT)} = \text{Av.OT} * \text{PR}$$

The average performance rate of the cutting section is 92% throughout the operation process and is located between the standard.

Total allowance (TA) = Personal allowance (PA) + Fatigue allowance (FA) + Contingency allowance (CA)

$$TA_{(\text{cutting section})} = PA + FA + CA \dots\dots\dots \text{equation (10)}$$

$$TA_{(cs)} = 11\% + 5\% + 6\%$$

$$TA_{(cs)} = 22\%$$

$$\text{Allowance Factor (AF)} = \text{NT} * 22\%$$

$$\text{Standard Time (ST)} = \text{NT} + \text{AF}$$

In this case, the working time per day of the company is 8 hours (480minute) or 28800 seconds.

Table 4: Recorded the time on the time study sheet of the cutting section

Time Study Sheet												
Production of shoe		shoe model: Gentles man's and civilian shoes (EL-028102LB model)										
section - cutting section				Time Study Observer Moti M								
No. operation (activity) = 19				Date.3-7/5/2013E,C				Performance rate 92% and allowance 22%				
Operations		Observed time (stopwatch Reading) (sec)										
		T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Av.OT(sec)
upper raw material preparation		48	47	47	49	48	49	47	48	49	48	48.0
pre-cutting operation		54	56	55	55	55	56	54	54	56	57	55.2
back box skiving		37	39	37	38	38	39	36	38	38	40	38.0
Stamping		54	54	56	55	55	56	54	55	55	56	55.0
Upper collect		38	37	39	38	38	38	37	38	39	39	38.1
upper arrange and dispatch		56	58	57	60	59	58	56	59	58	59	58.0
insole material preparation		29	29	30	30	31	31	29	30	30	32	30.1
cutting texn board		29	28	31	30	31	31	30	29	30	31	30.0
cutting shank board		28	28	30	29	30	31	28	29	30	29	29.2
shank grooving		27	27	29	28	29	29	27	29	28	29	28.2
shank skiving		31	30	32	31	32	32	31	31	31	32	31.3
attaching shank		24	25	27	26	26	26	24	26	27	26	25.7
apply glue		31	30	30	32	31	32	31	30	32	31	31.0
Molding		28	28	29	30	29	29	29	28	28	30	28.8
Bevelling		24	25	24	26	26	27	24	26	25	26	25.3
Insole collect		44	44	44	45	46	46	43	44	46	46	44.8
insole arrange and dispatch		35	35	37	36	36	36	35	35	36	37	35.8
count and overall dispatch		28	29	27	28	28	30	27	29	28	26	28.0
overall inspection		35	34	35	36	36	36	36	34	35	36	35.3

From the above observed and recorded time it calculates the Standard Time (ST) through using the Ov.OT and with overall performance rating and allowance factors.

Table 5: Standard time, capacity, labour, and cycle time with identified problems in cutting.

Operation	ST (second)	Capacity per day	Number of labour	Cycle time in second	Manual/machine	Remark
upper raw material preparation	53.88	534.57	1	53.875	Manually	Add lbr
pre-cutting operation	61.96	929.68	2	30.978	head traveling m/c	
back box skiving	42.65	1350.49	2	21.326	skiving m/c	Reduce lbr
stamping	61.73	933.07	2	30.866	stamping m/ c	
Upper collect	42.76	673.47	1	42.763	Manual	Cancel
upper arrange and dispatch	65.10	884.80	2	32.550	Manual	
insole material preparation	33.78	852.47	1	33.784	Manual	
cutting texn board	33.67	855.31	1	33.672	traveling head cutting m/c	
cutting shank board	32.77	878.74	1	32.774	traveling head cutting m/c	
shank grooving	31.65	909.90	1	31.652	grooving m/c	
shank skiving	35.13	819.79	1	35.131	shank skiving m/c	
attaching shank	28.85	998.42	1	28.846	reveting m/c	
apply glue	34.79	827.72	1	34.794	insole cementing m/c	
molding	32.33	890.95	1	32.325	insle molding m/c	
Beveling	28.40	2028.40	2	14.198	beveling m/c	Reduce lbr
Insole collect	50.28	1145.50	2	25.142	Manual	Cancel

insole arrange and dispatch	40.18	716.74	1	40.182	Manual	
count and overall dispatch	31.43	916.40	1	31.427	Manual	
overall inspection	39.62	726.89	1	39.621	Manual	
Total	780.97		25	625.906		

From the above time study sheet, the total exist standard time (ST) of the cutting section is 780.97sec (13.016minutes) and total labour is 25 with a total cycle time of 625.906 second

From the above table, most of the operation processes are processed by the machine and some operations are processed manually. Also, the total standard time is 780.97 seconds and the total cycle time is 625.906 seconds with a maximum cycle time of 53.875 second

Total cycle time = 625.906 second

Total standard time (ST) = 780.97second

Number of Station = 19

Total number of labour = 25

Available time 28800 second

Maximum cycle time = 53.875 second

Line efficiency = [(total cycle time) / (Number of operation \* Maximum cycle time)] \*100

Line efficiency = [(625.906 second) / (19 \* 53.875 second)] \*100

Line efficiency = 0.611 \*100

Line efficiency = **61.1%**

Total output per day = (number of labour in a line \* available time (min) \* line efficiency) / total ST)

Output per a day = (25 \* 28800 \* 0.611 /780.97second

= **563 pair/day**

Output per labour = total output per day/total number of labour in a line

= 563/25 = **22.5 pairs/ labour/ day**

Plan (target) output is 750 pairs per day but the real output is 563 pairs per day.

In each section, it recorded that the operation process has a high cycle time with less capacity output in the given bellow figure and table.

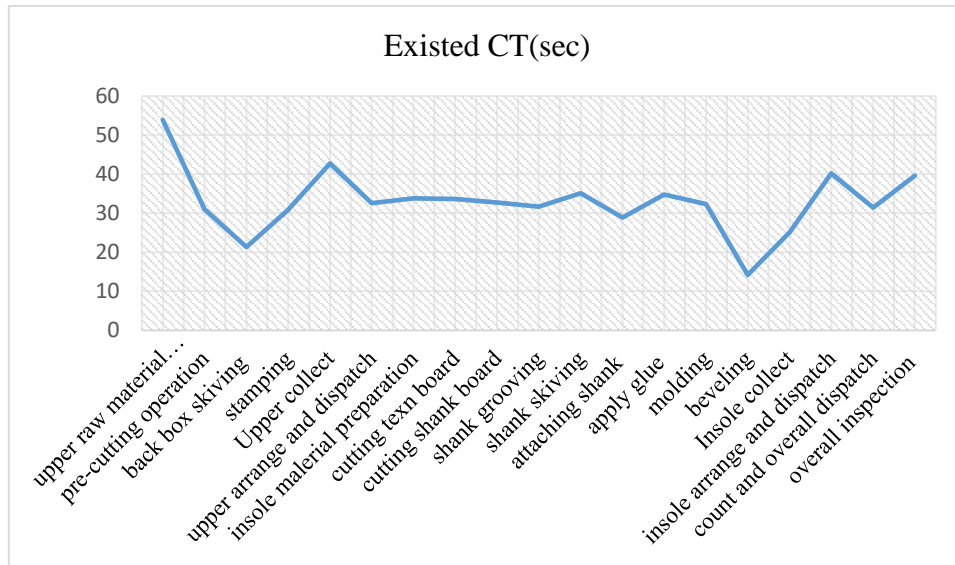


Figure 17: Existed CT of cutting section

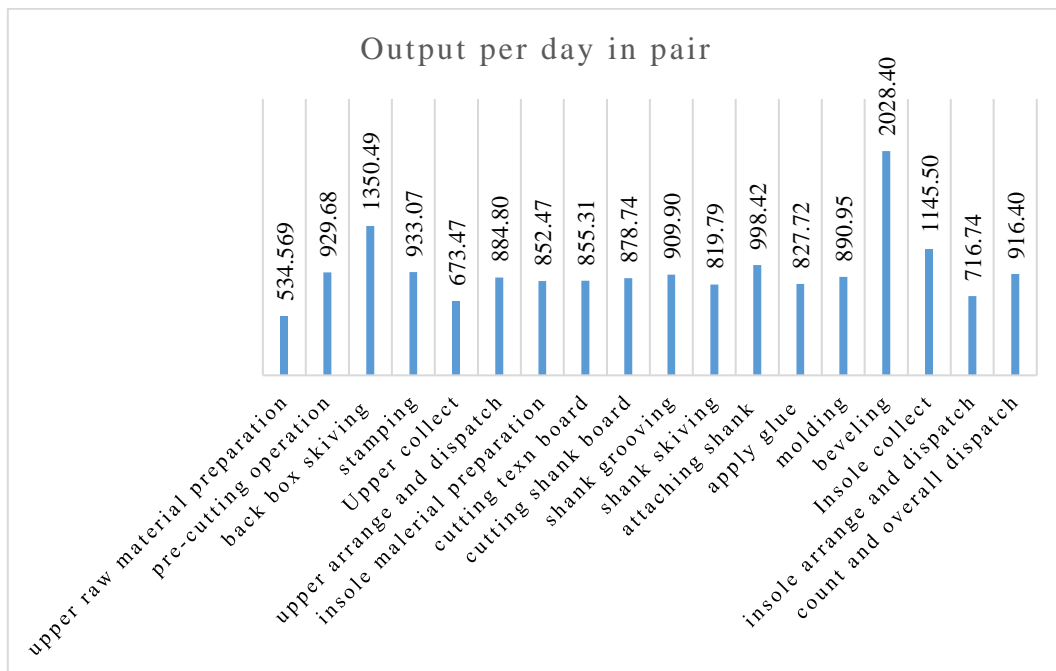


Figure 18: Output capacity per day in each operation in cutting section

In the table below, some operations are less capacity output per day with consuming high cycle time, then it needs to add a labor and other operations has high capacity output with excess labor and less cycle time, it needs to reduce labor to form smooth and balance the process.

Both upper and insole collect are unwanted activity because it is the same with arrangement and dispatching of each case, so both cancel and directly merge with upper arrange and dispatch and insole arrange and dispatch respectively.

Table 6: Identified operations have required improvement in cutting section

<b>Operation</b>	<b>Capacity per day</b>	<b>Number of labour</b>	<b>CT</b>	<b>Remark</b>
Upper raw material preparation	534.57	1	53.875	Add lbr
Back box skiving	1350.49	2	21.326	Reduce lbr
Upper collect	673.47	1	42.763	Cancel
Beveling	2028.40	2	14.198	Reduce lbr
Insole collect	1145.50	2	25.142	Cancel

### 5.1.1.2 Stitching section operation process

The cut component pieces are assembled and stitched together, as per the samples, to produce the three-dimensional completed upper and it has a high percentage of manpower in the process of upper making.

Table 7: Sequence of operation and movement distance and time of stitching section

Activity	Symbol					Distance mov't(m)	Movement time(Sec)
	○	⇒	□	▽	□		
loading						3.5	14
marking						2	8
skiving and quarter lining						2.5	10
attach nylon and reinforcement						2	8
attach textile adhesive						2	8
decorative stitch on quarter						4	16
stitch back count lining						2	8
stitch mudguard lining and counter						2	8
apply glue and attach apron						2	8
apply glue and attach mudguard						2	8
re-cut apron and mudguard						2	8
marking mudguard						2	8
skiving vamp with its lining						2	8
stitch mudguard with mudguard lining						2	8
stitch apron with its lining						3.5	14
apply glue and attach back count						2	8
stitch back count with quarter						2	8
stitch complete quarter and quarter lining						2	8
insert collar foam by applying glue						2	8
turning						2	8
hammering around collar						2	8
in process quality inspection						2	8
stitch around eye stay and collar						2	8
trimming around eye stay and apron						2	8
skiving 45 degree for mudguard						2	8
punch eyelet place						2	8
apply glue and attach quarter rd						2	8
stitch quarter over mudguard						2	8
trimming around quarter lining						2	8
stitch quarter lining bottom						4.5	18
punch closed hole						2	8
insert counter stiffener by applying glue						2	8
cutting and cleaning excess thread						3.5	14
burning the excess thread						2	8
temporary shoe lacing						2	8
final QC						2	8
Collect and arranging pairwise						2	8
Total		to finishing section				83.5	334

The total exists movement distance is 83.5m with a total movement time of 334 seconds (5.57minutes). In this movement distance case, every finished (in the process) and other activity is manually put on the conveyor and moved by the conveyor.

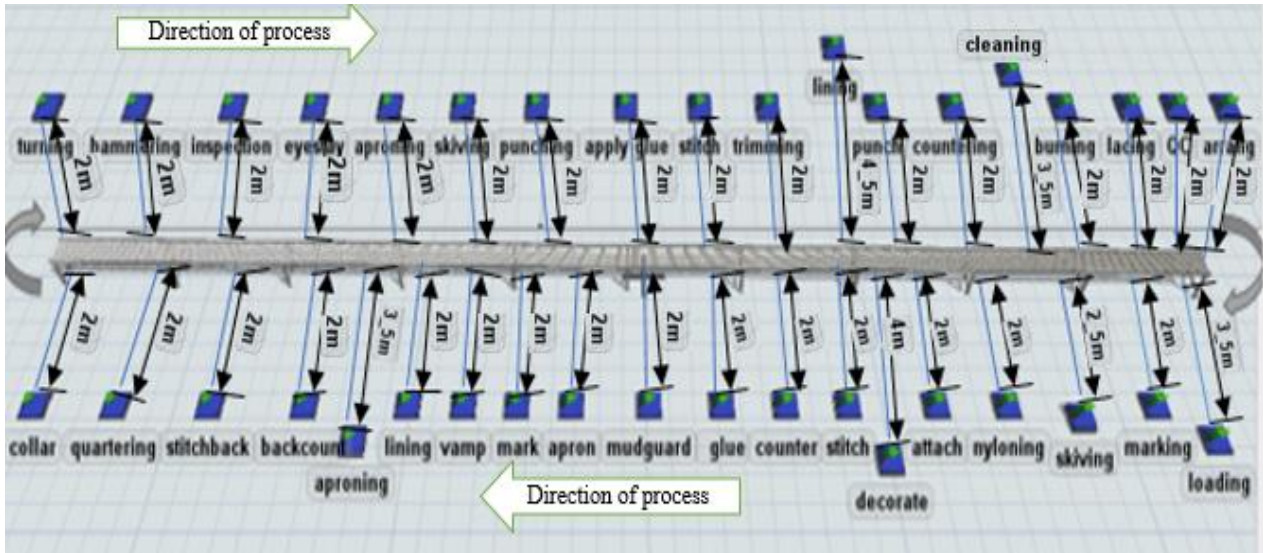


Figure 19: Flow process and arrangements of stitching section.

According to show from the above figure of the process flow of the stitching section, all of the operation processes are arranged according to their sequence of the operations, and each activity is moved through both labor and conveyor.

Table 8: Types of allowance for stitching section

Types of Allowance	Percent
personal allowance	10%
fatigue allowance	7%
Contingency allowance	2%
Delay allowance	3%
<b>Total</b>	<b>22%</b>

**Observed and recorded time of the stitching section**

The table below recorded on Time Study Sheet has observed time (stopwatch Reading) (sec) to calculate OT, NT, AF and ST with an output of each operation per day of working hours existed in the stitching section

$$\text{Average observed Time (Av.O.T)} = (T_1 + T_2 + T_3 + T_4 + T_5 + T_6 + T_7 + T_8 + T_9 + T_{10}) / 10$$

$$\text{Normal Time (NT)} = \text{Av.O.T} * \text{PR}$$

According to the critically studied and recorded for stitching section, there is a performance rate and allowance of the company and also those are match with existed standard. In stitching

section there are different types of the allowance are there with recorded different values in the section

The average performance rate of the stitching section is 87% throughout the operation process.

Total allowance (TA) = personal allowance (PA) + fatigue allowance (FA) + Contingency allowance (CA) + Delay allowance (DA)

$$TA_{\text{(stitching section)}} = PA + FA + CA + DA \dots\dots\dots \text{equation (11)}$$

$$TA_{\text{(ss)}} = 10\% + 7\% + 2\% + 3\%$$

$$TA_{\text{(ss)}} = 22\%$$

$$\text{Allowance Factor (AF)} = NT * 22\%$$

$$\text{Standard Time (ST)} = NT + AF$$

During record time it observes and records morning and afternoon, which means five times at the morning working time and five times at afternoon working time. Because more than one operation is operated by a single operator and it needs the difference of the operation time when it works for a long time.

Table 9: Observed and recorded time of the stitching section

Time Study Sheet											
Production of shoe	shoe model: Gentles man's and civilian shoes (EL-028102LB model)							Time Study Observer Moti M			
section - stitching section							Date .10 -15 /5/2013 E,C				
No. operation (activity) = 37							Performance rate 87% and allowance 22%				
Operations	Observed time (stopwatch Reading) (sec)										
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	AV.OT
Loading	57	56	56	57	57	58	56	56	57	58	56.8
Marking	71	70	71	71	72	71	69	71	72	72	71
skiving and quarter lining	55	55	57	56	57	57	55	55	57	57	56.1
attach nylon and reinforcement	51	51	53	52	53	52	53	52	53	54	52.4
attach textile adhesive	31	33	32	32	33	33	31	32	32	33	32.2
decorative stitch on quarter	45	46	47	47	47	48	46	46	47	48	46.7

stitch back count lining	42	42	44	44	45	44	43	42	45	44	43.5
stitch mudguard lining and counter	35	34	36	36	37	36	34	35	37	36	35.6
apply glue and attach apron	74	75	75	77	76	76	74	75	75	78	75.5
apply glue and attach mudguard	74	74	76	75	76	76	75	74	76	76	75.2
re-cut apron and mudguard	37	36	36	35	38	37	36	35	37	38	36.5
marking mudguard	31	31	30	32	31	32	32	31	30	32	31.2
skiving vamp with its lining	37	36	38	37	39	38	36	37	39	38	37.5
stitch mudguard with mudguard lining	27	27	28	29	28	28	29	29	28	30	28.3
stitch apron with its lining	30	30	31	31	32	32	31	30	31	32	31
apply glue and attach back count	74	74	76	75	76	76	74	75	75	76	75.1
stitch back count with quarter	31	30	31	32	32	33	31	32	31	32	31.5
stitch complete quarter and quarter lining	53	55	55	54	56	57	54	54	55	57	55
insert collar foam by applying glue	48	48	51	50	51	51	48	49	51	51	49.8
Turning	50	50	52	52	52	53	51	50	52	53	51.5
hammering around collar	29	31	30	32	32	32	29	31	32	32	31
in process quality inspection	29	29	31	30	32	32	30	29	31	32	30.5
stitch around eye stay and collar	54	55	54	57	56	58	56	55	55	57	55.7
trimming around eye stay and apron	35	37	35	36	37	37	35	36	36	38	36.2
skiving 45 degree for mudguard	34	34	36	35	35	36	35	34	36	35	35
punch eyelet place	54	53	55	57	55	56	54	55	55	57	55.1
apply glue and attach quarter	73	75	74	76	76	76	75	75	74	76	75
stitch quarter over mudguard	43	44	44	43	45	44	43	44	44	45	43.9
trimming around quarter lining	32	34	35	33	34	36	32	34	35	35	34
stitch quarter lining bottom	33	31	32	32	30	34	32	31	32	33	32
punch closed hole	37	39	41	40	38	39	37	39	40	40	39
insert counter stiffener by applying glue	40	40	42	41	42	42	42	40	41	42	41.2
cutting and cleaning excess thread	74	75	75	77	76	76	76	75	75	77	75.6
burning the excess thread	35	34	36	35	35	35	35	34	35	36	35
temporary shoe lacing	34	36	37	37	36	36	36	36	35	37	36
final QC	35	35	37	36	37	37	36	35	37	37	36.2
Collect and arranging pairwise	35	36	35	36	37	37	36	36	35	37	36

From the above observed and recorded time it calculates the Standard Time (ST) through using the Ov.OT and with overall performance rating and allowance factors for the section.

Table 10: Standard time, capacity, labour, and cycle time with identified problems in stitching

Operations	ST (sec)	Capacity per day	Lb	CT (sec)	Remark	Manual or machine
loading	60.288	477.71	1	60.288	Add labour	manual on the table
marking	75.359	382.17	1	75.359	Add labour	manual on the table
skiving and quarter lining	59.545	483.67	1	59.545	Add labour	skiving m/c
attach nylon and reinforcement	55.617	1035.65	2	27.809		manual on the table
attach textile adhesive	34.177	1685.34	2	17.089	Reduce labour	rotary coupling m/c
decorative stitch on quarter	49.567	1162.05	2	24.784	Merge and reduce labour	PBSN M/C
stitch back count lining	46.171	1247.54	2	23.085		PBSN M/C
stitch mudguard lining and counter	37.786	762.19	1	37.786		zig zag m/c
apply glue and attach the apron	80.136	359.39	1	80.136	Add labour	manual on the table
apply glue and attach mudguard	79.817	360.82	1	79.817	Add labour	manual on the table
re-cut apron and mudguard	38.741	743.40	1	38.741		cutting m/c
marking mudguard	33.116	869.68	1	33.116		manual on the table
skiving vamp with its lining	39.803	723.57	1	39.803		skiving m/c
stitch mudguard with mudguard lining	30.038	1917.60	2	15.019	Merge and reduce labour	PBSN M/C
stitch apron with its lining	32.903	875.29	1	32.903		PBSN M/C
apply glue and attach back count	79.711	361.30	1	79.711	Add labour	manual on the table
stitch back count with quarter	33.434	861.40	1	33.434		PBDN M/C

stitch complete quarter and quarter lining	58.377	493.34	1	58.377	Add labour	PBSN M/C
insert collar foam by applying glue	52.858	544.86	1	52.858	Merge	manual on the table
turning	54.662	1053.75	2	27.331		manual on the table
hammering around collar	32.903	1750.58	2	16.452	Reduce labour	hammering m/c
in process quality inspection	32.373	889.64	1	32.373		manual on the table
stitch around eye stay and collar	59.120	974.29	2	29.560		PBSN M/C
trimming around eye stay and apron	38.423	1499.11	2	19.211	Reduce labour	trimming m/c
skiving 45 degrees for mudguard	37.149	1550.51	2	18.575	Reduce labour	45-degree skiving m/c
punch eyelet place	58.483	492.45	1	58.483	Add labour	eyeleting m/c
apply glue and attach a quarter	79.605	361.79	1	79.605	Add labour	manual on the table
stitch quarter over mudguard	46.595	1854.26	3	15.532	Reduce labour	PBDN M/C
trimming around the quarter lining	36.088	798.06	1	36.088		trimming m/c
stitch quarter lining bottom	33.965	847.94	1	33.965		zig zag m/c
punch closed hole	41.395	695.74	1	41.395		manual on the table
insert counter stiffener by applying glue	43.730	1975.77	3	14.577	Merge and reduce labour	manual on the table
cutting and cleaning excess thread	80.242	358.91	1	80.242		manual on the table
burning the excess thread	37.149	775.26	1	37.149		hot blow m/c
temporary shoe lacing	38.210	753.72	1	38.210		manual on the table
final QC	38.423	749.56	1	38.423		manual on the table
Collect and arranging pairwise	38.210	2261.16	3	12.737	Reduce labour	manual on the table
Total	1804.168		53	1499.56		

From the above table the total ST exist is 1804.168 seconds, with a total of 53 labours and a total CT is 1499.56 seconds and also there is manually processed and using different machines in different processes and also it identified the process those needed to add and reduce the number of labour according to its requirement.

Total cycle time = 1499.56 second

Total standard time (ST) = 1804.168 second

Number of Station = 37

Number of labour = 53

Available time 28800 second

Maximum cycle time = 80.242second

Line efficiency = [(total cycle time) / (Number of operation \* Maximum cycle time)] \*100

$$= [(1499.56 \text{ second}) / (37 * 80.242\text{second})] *100$$

$$= [ (1499.56) / 2968.95] *100$$

$$= 0.5050 *100 = \underline{\underline{50.50\%}}$$

Total output per day = (number of labour in a line \* available time (min) \* line efficiency) / (total ST (sec) )

$$= (53 * 28800 * 0.505) / 1804.168 \text{ second}$$

$$= 770,955.5 /1804.168$$

$$= \underline{\underline{427\text{pair per day}}}$$

Output per labour = total output per a day / total number of labour in a line

$$= 427/53 = \underline{\underline{8.1 \text{ pairs/ labour/ day}}}$$

Plan (target) output is 700 pair per day but the real output is 427 pair per a day

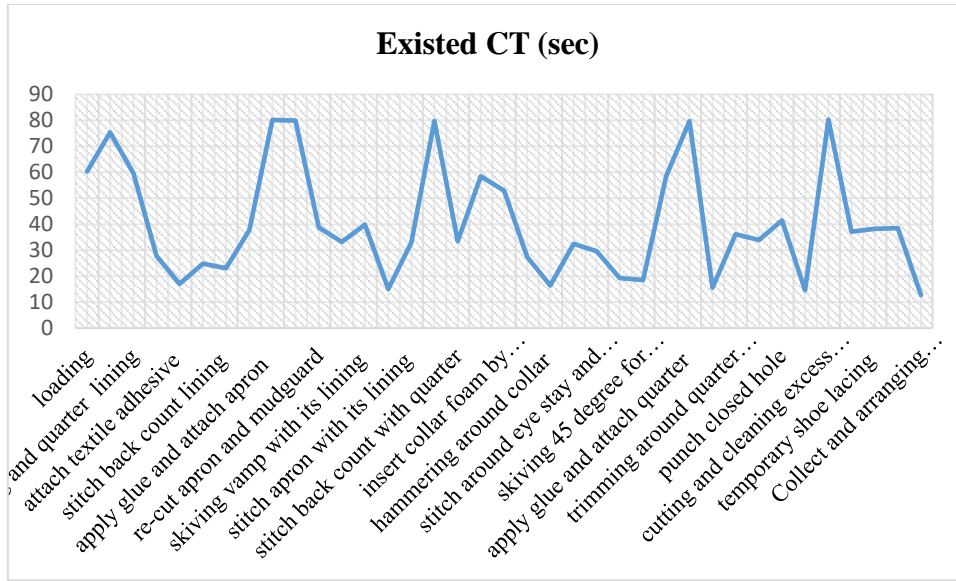


Figure 20: Existed CT of stitching section

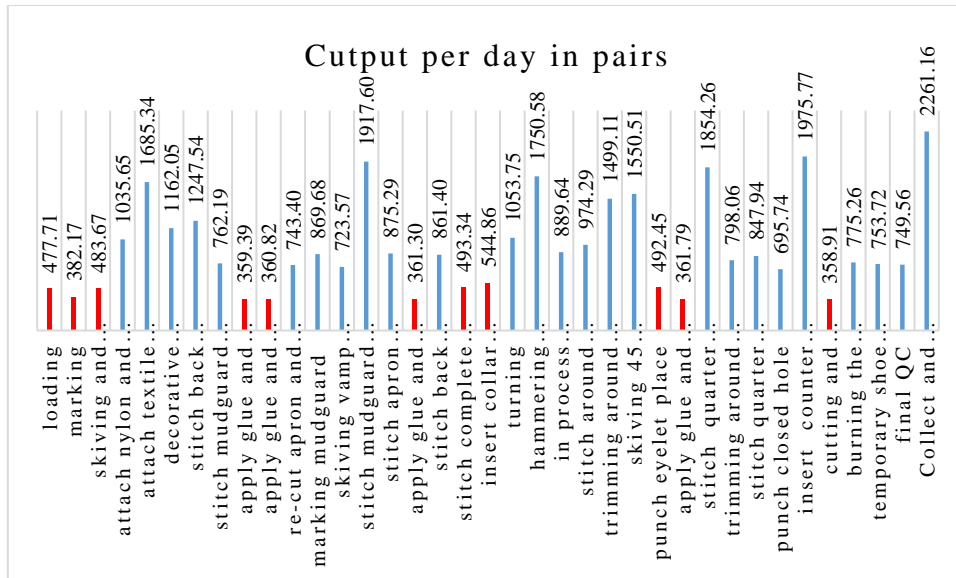


Figure 21: Identified major bottleneck operations in stitching section

In the table below, some operations are less capacity output per day with consuming high cycle time, then it needs to add a labor and other operations has high capacity output with excess labor and less cycle time, it needs to reduce the number of labor. Also, merge those consecutive operations, those have less and high capacity with cycle time and excess labor to form smooth and balance the process.

Table 11: Identified operations require improvement in stitching section

Operations	Capacity per day	Labour	CT (sec)	Remark
loading	477.71	1	60.288	Add labour
marking	382.17	1	75.359	Add labour
skiving and quarter lining	483.67	1	59.545	Add labour
attach textile adhesive	1685.34	2	17.089	Reduce labour
decorative stitch on quarter	1162.05	2	24.784	Merge and reduce labour
stitch back count lining	1247.54	2	23.085	
apply glue and attach apron	359.39	1	80.136	Add labour
apply glue and attach mudguard	360.82	1	79.817	Add labour
stitch mudguard with mudguard lining	1917.60	2	15.019	Merge and reduce labour
stitch apron with its lining	875.29	1	32.903	
apply glue and attach back count	361.30	1	79.711	Add labour
stitch complete quarter and quarter lining	493.34	1	58.377	Add labour
insert collar foam by applying glue	544.86	1	52.858	Merge
turning	1053.75	2	27.331	
hammering around collar	1750.58	2	16.452	Reduce labour
trimming around eye stay and apron	1499.11	2	19.211	Reduce labour
skiving 45 degrees for mudguard	1550.51	2	18.575	Reduce labour
punch eyelet place	492.45	1	58.483	Add labour
apply glue and attach quarter	361.79	1	79.605	Add labour
stitch quarter over the mudguard	1854.26	3	15.532	Reduce labour
insert counter stiffener by applying glue	1975.77	3	14.577	Merge and reduce labour

cutting and cleaning excess thread	358.91	1	80.242	
Collect and arranging pairwise	2261.16	3	12.737	Reduce labour

The above-identified and listed process has high cycle time and low capacity per day, it requires adding the number of the labour and merge the process with others according to its requirement's to reduce cycle time and smooth flow of the production process.

### 5.1.1.3 Lasting and finishing section operation process

In lasting and finishing there is enhance of the appearance of the shoe, Special waxes, creams, crayons, solvents, etc. are used.

Table 12: Sequence of operation and movement distance and time of stitching section

Activity	Symbol					Distance mov't(m)	Movement time(sec)
	○	⇒	D	▽	□		
last loading and insole						2	8
last cleaning						2	8
loading upper, toe cap steel						2.5	10
roughing around center of out sole						2	8
out sole cleaning						2	8
attaching insole on last						2	8
back part molding						2	8
insert to steam						2	8
insert last and side closing						2	8
apply glue on sides of the upper						2	8
insert to steam						4	16
creaming on upper and inserting in heat tunnel						4.5	18
pounding						2	8
in process quality inspection						2	8
first level upper roughing						2	8
second level upper roughing						2	8
first adhesive coating on upper						2	8
first adhesive coating on out sole						2	8
second adhesive coating on upper and sole						2	8
sole and upper dryer						2	8
sole and upper re-activator						2	8
attachin sole with upper						2	8
attachin sole with upper and pressing						2	8
remove temporary shoe lacing						2	8
de-lasting						2	8
cleaning excess glue						4.5	18
ironing to remove wrinkle						2	8
painting on over rough place						2	8
apply cream on upper						2	8
apply glue and insert sock lining						4.5	18
shoe lacing						2	8
inserting tissue paper						2	8
final brushing for shine						2.5	10
final quality inspection						4.5	18
arregment and packege						2	8
Total						83	332

From the above table, the total movement distance is 83m and the total movement time is 332 second (5.73 minute). Flow process arrangements of lasting and finishing section:

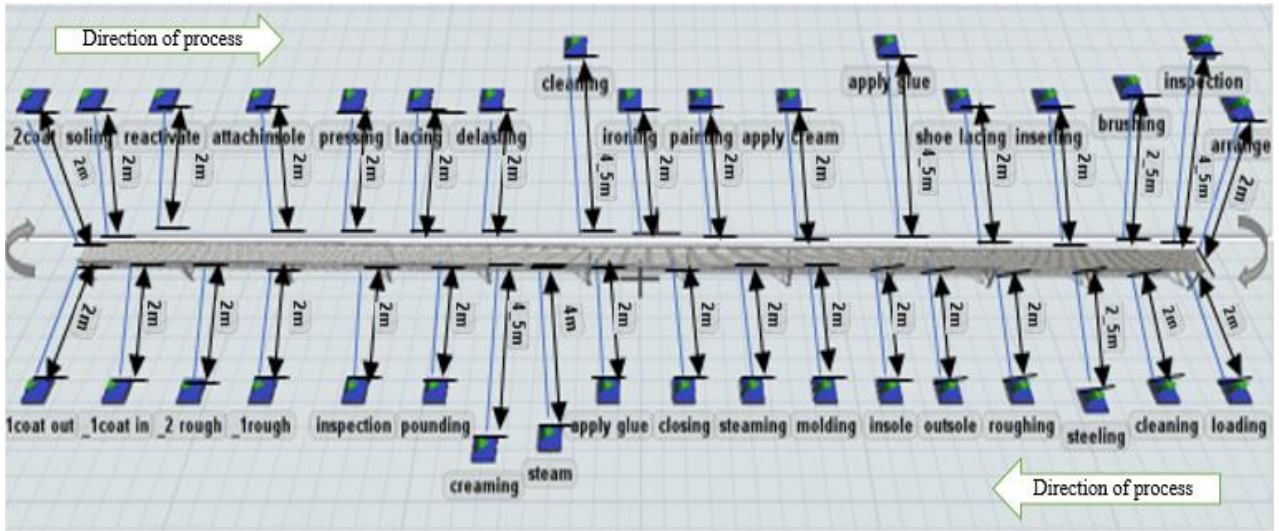


Figure 22: Flow process arrangements of lasting and finishing section

According to show from the above figure of the process flow of the lasting and finishing section also all of the operation processes are arranged according to their sequence of the operations and each activity is moved through both labor and conveyor.

According to the critically studied and recorded for lasting and finishing section, there is a performance rate and allowance of the company and also those are match with existed standard. In lasting and finishing section there are different types of the allowance are there with recorded different values in the section.

Table 13: Types of allowance for lasting and finishing section

Allowance	Percent
Fatigue	5
Contingency	2
Heat and temperature	4
Personal	10
Total Allowance	21%

**Observed and recorded time of the lasting and finishing section**

In the table below recorded on Time Study Sheet has observed time (stop watch Reading) (sec) to calculate OT, NT, AF and ST with output of each operation in per day of working hours

existed in the lasting and finishing and In the lasting and finishing section performance rate is 87%.

$$\text{Average observed Time (Av.O.T)} = (T1 + T2 + T3 + T4 + T5 + T6 + T7 + T8 + T9 + T10) / 10$$

$$\text{Normal Time (NT)} = \text{OT} * \text{PR}$$

Total allowance (TA) = Fatigue allowance (FA) + Contingency allowance (CA) + Heat and temperature allowance (HTA) + Personal allowance (PA)

$$TA_{(\text{lasting section})} = FA + CA + HTA + PA \dots\dots\dots \text{equation (12)}$$

$$TA_{(ls)} = 5\% + 2\% + 4\% + 10\%$$

$$TA_{(ls)} = 21\%$$

$$\text{Allowance Factor (AF)} = \text{NT} * 21\%$$

$$\text{Standard Time (ST)} = \text{NT} + \text{AF}$$

During record time it observes and records morning and afternoon, which means five times at the morning working time and five times at afternoon working time. Because more than one operation is operated by a single operator and it needs the difference of the operation time when it works for a long time.

Table 14: Observed and recorded time of the lasting and finishing section

Time Study Sheet											
Production of shoe	shoe model: Gentles man's and civilian shoes (EL-028102LB model)								Time Study Observer Moti M.		
Section - Lasting and finishing section							Date .17 – 21/5/2013 E,C				
No. operation (activity) = 35							Performance rate 87% and allowance 21%				
Operations	Observed time (stopwatch Reading) (sec)										
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	AV.OT
last loading and insole	58	60	59	62	62	62	60	60	59	63	60.5
last cleaning	29	29	31	32	31	32	30	29	31	32	30.6
loading upper, toe cap steel	54	55	55	57	56	57	56	55	55	56	55.6

roughing around centre of out sole	37	36	37	37	38	37	37	36	37	38	37
out sole cleaning	35	35	36	36	37	37	36	35	36	37	36
attaching insole on last	29	30	29	31	31	32	30	31	30	31	30.4
back part molding	55	54	54	55	57	56	56	54	57	55	55.3
insert to steam	36	37	36	38	37	38	36	37	37	38	37
insert last and side closing	66	65	65	66	67	67	66	65	67	66	66
apply glue on sides of the upper	35	37	36	35	37	37	35	37	36	37	36.2
insert to steam	54	56	55	56	56	56	55	56	55	56	55.5
creaming on upper and inserting in heat tunnel	59	58	61	61	62	63	60	60	62	61	60.7
Pounding	30	31	30	30	31	31	30	31	30	31	30.5
in process quality inspection	34	36	35	35	36	36	35	36	35	37	35.5
first level upper roughing	33	33	34	35	35	35	35	33	34	35	34.2
second level upper roughing	36	35	38	37	37	38	36	36	38	37	36.8
first adhesive coating on upper	64	65	65	66	65	66	65	64	65	67	65.2
first adhesive coating on out sole	36	36	37	38	37	38	37	36	37	38	37
second adhesive coating on upper and sole	33	36	34	35	37	37	35	36	35	35	35.3
sole and upper dryer	32	32	33	34	34	36	33	32	34	35	33.5
sole and upper re-activator	34	35	35	34	36	36	34	35	35	36	35
attaching sole with upper	61	60	61	61	63	62	61	60	62	62	61.3
attaching sole with upper and pressing	101	100	101	101	102	102	100	99	100	102	100.8
remove temporary shoe lacing	36	35	35	37	36	35	37	36	37	37	36.1
de-lasting	44	43	46	45	44	45	46	46	43	44	44.6
cleaning excess glue	66	66	67	65	67	68	66	64	65	68	66.2
ironing to remove wrinkle	59	61	60	61	58	59	61	62	58	61	60

painting on over rough place	35	34	35	35	35	36	35	34	36	35	35
apply cream on upper	32	31	31	33	32	32	32	31	33	31	31.8
apply glue and insert sock lining	45	45	46	45	46	46	46	45	46	45	45.5
shoe lacing	65	66	65	67	66	67	65	66	65	68	66
inserting tissue paper	61	61	60	62	61	61	62	59	62	61	61
final brushing for shine	36	35	35	37	34	36	35	34	37	35	35.4
final quality inspection	40	40	42	41	42	42	41	40	42	42	41.2
Arrangement and packed	35	36	36	37	36	36	36	35	36	37	36

From the above observed and recorded time it calculates the Standard Time (ST) through using the Ov.OT and with overall performance rating and allowance factors for the section.

### Standard time, capacity, labour, and cycle time with identified problems

Table 15: Standard time, capacity, labour, and cycle time with identified problems in lasting and finishing section

Operations	ST	Capacity output	Labour	CT	Remark	Manual or machine
last loading and insole	63.69	1356.61	3	21.229	Reduce labour	machine or manual
last cleaning	32.21	894.06	1	32.213		manually on the table
loading upper, toe cap steel	58.53	984.11	2	29.265		manually on the table
roughing around the center of the outsole	38.95	739.41	1	38.950		manually on the table
out sole cleaning	37.90	759.95	1	37.897		roughing m/c
attaching insole on last	32.00	899.94	1	32.002		manually on the table
back part molding	58.21	494.72	1	58.214	Add labour	manually on the table

insert to steam	38.95	739.41	1	38.950		back part molding m/c
insert last and side closing	69.48	414.52	1	69.478	Add labour	manually on the table
apply glue on the sides of the upper	38.11	755.75 2	1	38.108		the table used as a tool and tanilia
insert to steam	58.42	985.88	2	29.212		manually on the table
creaming on the upper and inserting in a heat tunnel	63.90	901.42	2	31.949		steam and heel seat lasting m/c
Pounding	32.11	896.99	1	32.107		manually on the table
in process quality inspection	37.37	770.65	1	37.371		pounding m/c
first level upper roughing	36.00	799.95	1	36.002		manually on the table
second level upper roughing	38.74	743.43	1	38.739		roughing m/c
first adhesive coating on upper	68.64	419.60	1	68.636	Add labour	roughing m/c
first adhesive coating on the outsole	38.95	739.41	1	38.950		manually on the table
second adhesive coating on upper and sole	37.16	775.02	1	37.160		manually on the table
sole and upper dryer	35.27	816.66	1	35.265		manually on the table
sole and upper re-activator	36.84	1563.3 3	2	18.422	Reduce labour	dryer m/c
attaching sole with upper	64.53	446.30	1	64.531	Add labour	re-activator m/c

attaching sole with upper and pressing	106.11	542.82	2	53.056	Add labour	manually on the table
remove temporary shoe lacing	38.00	1515.69	2	19.001	Reduce labour	pressing m/c and chiller m/c
de-lasting	46.95	613.41	1	46.950		manually on the table
cleaning excess glue	69.69	1239.80	3	23.230	Reduce labour	de-lasting m/c
ironing to remove wrinkle	63.16	911.94	2	31.581		excess glue remover m/c
painting on over rough place	36.84	1563.33	2	18.422	Reduce labour	ironing m/c
apply cream on upper	33.48	860.32	1	33.476		manually on the table
apply glue and insert sock lining	47.90	1202.56	2	23.949	Marge	manually on the table
shoe lacing	69.48	414.52	1	69.478		manually on the table
inserting tissue paper	64.21	1345.49	3	21.405	Reduce labour	manually on the table
final brushing for shine	37.27	1545.66	2	18.633	Reduce labour	manually on the table
final quality inspection	43.37	664.03	1	43.371	Marge and reduce labour	brushing m/c
Arrangement and pack	37.90	1519.90	2	18.949		manually on the table
<b>Total</b>	<b>1710.32</b>		<b>52</b>	<b>1286.15</b>		

In the above table, there is remarked those processes require adding and reduce the number of labour according to its requirement, and also there is manually processed and using different machines in a different process.

Total standard time (ST) is 1710.32second and total labour is 52 with a total cycle time of 1286.15 second

Total cycle time = 1286.15 second

Total Standard Time = 1710.32second

Number of Station = 35

Number of labour = 52

Available time 28800 second

Maximum cycle time = 69.478 second

Line efficiency = [(total cycle time) / (Number of operation \* Maximum cycle time)] \*100

$$= [(1286.15 \text{ second}) / (35 * 69.478 \text{ second})] *100$$

$$= [1286.15 / 2431.73] *100$$

$$= [0.5289] *100 = \underline{\underline{52.89\%}}$$

Total output per day = (number of labour in a line \* available time (min) \* line efficiency) / (total ST (sec))

$$= (0.5289 * 52 * 28800) / 1710.32\text{second}$$

$$= 792,085.57 / 1710.32 = \underline{\underline{463 \text{ pairs per day}}}$$

Output per labour = total output per a day / total number of labour in a line

$$= 463 \text{ pairs per day} / 52 = \underline{\underline{8.9 \text{ pair per day per labour}}}$$

Plan is 700 pair per day but, the real output is 463 pairs per day

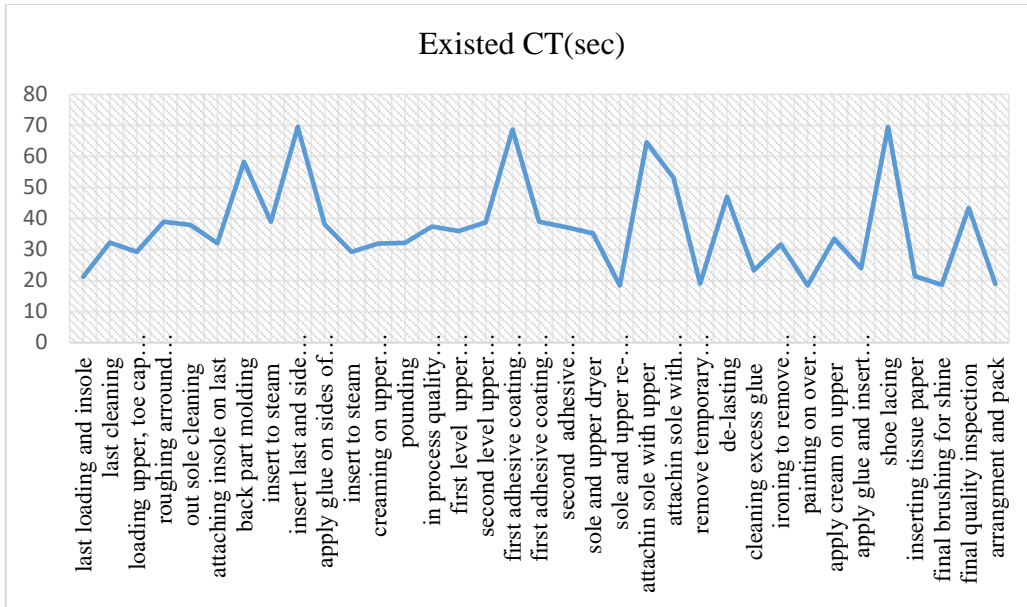


Figure 23: Existed CT of lasting and finishing section

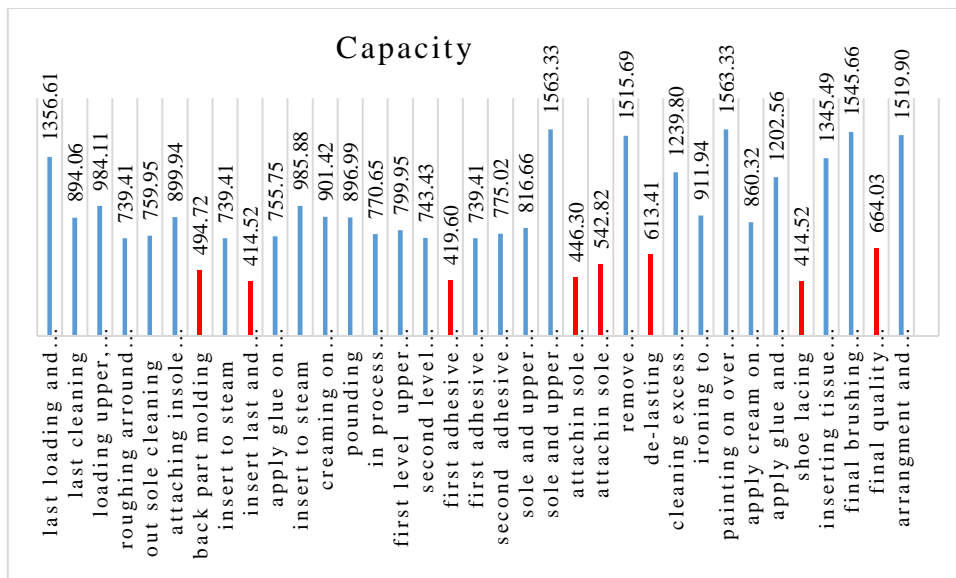


Figure 24: Major bottleneck operations in lasting and finishing section

In the table below, some operations are less capacity output per day with consuming high cycle time, then it needs to add a labor and other operations has high capacity output with excess labor and less cycle time, it needs to reduce the number of labor. Also merge those consecutive operations, those have less and high capacity with cycle time and excess labour to form smooth and balance the process.

Table 16: Identified operations require improvement in lasting and finishing section

Operations	Capacity output	Labour	CT	Remark
last loading and insole	1356.61	3	21.229	Reduce labour
back part molding	494.72	1	58.214	Add labour
insert last and side closing	414.52	1	69.478	Add labour
first adhesive coating on upper	419.60	1	68.636	Add labour
sole and upper re-activator	1563.33	2	18.422	Reduce labour
attaching sole with upper	446.30	1	64.531	Add labour
attaching sole with upper and pressing	542.82	2	53.056	Add labour
remove temporary shoe lacing	1515.69	2	19.001	Reduce labour
cleaning excess glue	1239.80	3	23.230	Reduce labour
painting on over rough place	1563.33	2	18.422	Reduce labour
apply glue and insert sock lining	1202.56	2	23.949	Marge
shoe lacing	414.52	1	69.478	
inserting tissue paper	1345.49	3	21.405	Reduce labour
final brushing for shine	1545.66	2	18.633	Reduce labour
final quality inspection	664.03	1	43.371	Marge and reduce labour
Arrangement and pack	1519.90	2	18.949	

The above-identified and listed process has high cycle time and low capacity per day and it requires to add the number of the labour and marge the process with others according to its requirement's to reduce cycle time and smooth flow of the production process.

### 5.2 Compression output per day of each section

Compare the overall cutting, stitching, and lasting and finishing section with their ST, movement time, and the number of labour, average output in pairs per day.

Table 17: Output per day in pair of each section

Sections	O/P per day in pair
Cutting section	563
Stitching section	427
Lasting & finishing section	463

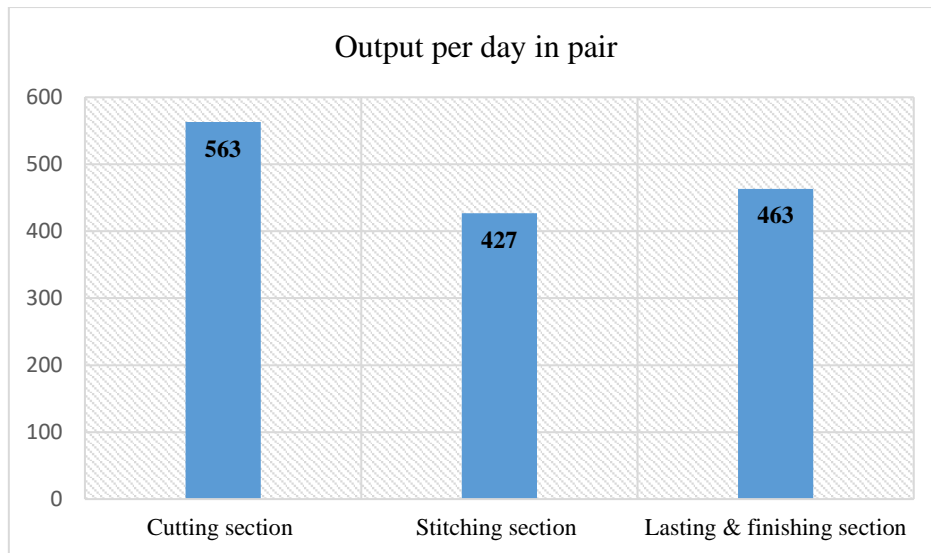


Figure 25: Output per day in pair of each section

Table 18: Comparison of Expected (plan) and actual output per day of each section

Sections	Target output per day in pair	Actual output per day in pair
Cutting section	750	563
Stitching section	700	427
Lasting & finishing section	700	463

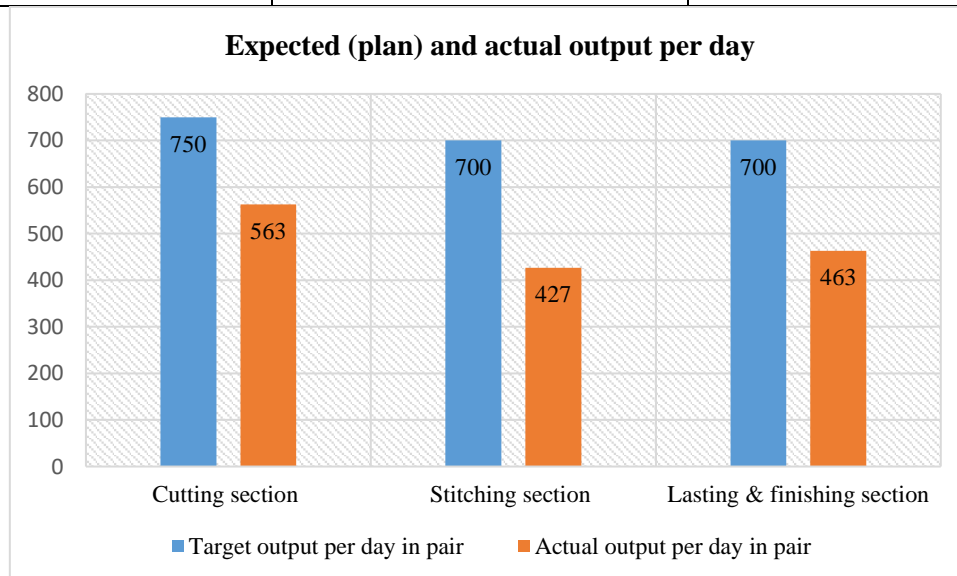


Figure 26: Comparison of Expected (plan) and actual output per day of each section

### 5.3 Summarized the overall of the existing of each section

Table 19: Summarized the overall of the existing conditions of each section

Terms	Cutting section	Stitching section	Lasting & finishing section
Total ST(sec)	780.97	1804.168	1710.32
Movement distance (m)	60.5	83.5	83
Movement time(sec)	240	334	332
Number of station	19	37	35
CT (sec)	625.906	1499.56	1286.15
Number of labour	25	53	52
Line efficiency	61.1%	50.5%	52.89%
Output per day	563pair	427pair	463 pair
Output per labour per day	22.5pair	8.1 pair	8.9 pair/day

### 5.4 Overall identified problems in each section

Among the seven wastes (Overproduction, inventory, motion, defects, over-processing, waiting, and transport), motion of the workers and transporting the finished for next operations, over production (output) in some operation, waiting in the operations and in the section are included in the identified problems including others problems. In detailed and generalized problems are in the table below

Table 20: Overall identified problems in each section

Exist major overall problems in the section	Comment (propose solution )
Unwanted movement between the consecutive operation of labour	Reduce the existing distance between consecutive operations and also conveyor without affecting the standard movement space of the workers.
Waiting time between the operation and also sections	Balance the operation process of the section depend upon the standard available minute value and also reduces with ineffective time exist in the process.
High cycle time in some operation	Reduce ineffective time and add or rotate the labours to the operation process those have high cycle time operations in the section.

Excess labour in some operation	Reduce the number of the labour those not much affect the processing time of the process and add those process have high cycle time.
Improper flow process of the operation	Properly arrange the flow process of each operation those have the problem in each section.
Less line efficiency in the section	Reduce maximum cycle time and excess labour on the operation of the section.
Less overall output per day and output per labour	Reduce those major factors that affect the overall output and increase the output per labour.
Less management and workers relationship	Propose ways to increase the relationship between the management system and workers to enhance the productivity of the company.

## CHAPTER SIX

### PROPOSED RESULT AND DISCUSSION

#### 6.1 Basic ways and steps of enhancement of the productivity.

To enhance the productivity of the ASSC it focused on the major two of the following things.

- ❖ Reduce the overall factors that affect the productivity of the company.
- ❖ Enhance the overall productivity of the company.

#### 6.1.1 Consideration and procedures to reduce the overall factors that affect productivity

1) Major overall factors affect the productivity of ASSC

##### a) Ineffective process time

The ineffective process time is a time of nonvalue activities due to improper flow of the process with distance movement of the workers in the process and also inefficient methods doing the work during working time.

##### ✓ Improper process flow and distance movement of the workers

According to analyzed and identified in chapter five there is a distance movement of workers in an ASSC within each section of the production process and the distance movement of the workers in cutting, stitching, and lasting and finishing section is 60m, 83.5m, and 83m with movement time 240, 334 and 332 seconds respectively.

This all movement distance consumes much of the time on each section and nonvalue added activity and it is the cause of the fatigue for workers because the process is it's a repetitive process throughout the working time. Then it needs to reduce those distance movements from all sections of the production process with consumed time. To reduce the unwanted movement in all sections, it needs to apply proper process flow and arrange the process

##### ✓ Existed the idle (excess) labour in some operation process and lack of the labour in another operation process.

**Existence of the idle (excess) labour:** according to analyzed and identified data showed in chapter five, there is an excess number of the labour assigned in some operations in each section. It means that the operation consumed a few-cycle time with less labour and the others of the labour are idle or majorly not participated in the process and also it produces less amount of the product with the excess number of labour. The other operations consume much less cycle

time with assigned self-labour. In this case, it needs to reduce and transfer (rotate) to another operation process that requires labour and assemble the operations.

**lack of the labour:** in this case, there is lack of the labour in some operation and due to this reason the process consume high operation process cycle time with less output and also it creates fatigue on the worker those work on such place (operation). On such an operation it needs to add additional labour to reduce the operation cycle time with the fatigue of the labour and increase the output of the process.

✓ **Existed bottleneck operation process**

In the analyzed and identified data there is a bottleneck in some operation processes with less daily output because the consecutive operation process cycle time is not properly balanced and there is a waiting time for the next operation. In ASSC the major cause of the bottleneck is due to unbalanced labour assigned on some of the operation processes. Then, it needs to reduce those bottleneck operations through added (transferred) labour with a balanced operation process cycle time.

**b) Existed less line efficiency**

The line efficiency of each section depends on the existence of total cycle time and the number of operations (station) with the maximum cycle time of the process. This indicated that when the number of operations (station) is increased with a maximum cycle time of the process the overall efficiency of the line is decreased. The existed line efficiency of cutting, stitching, and lasting and finishing section is 61%, 50.5%, and 52.89% respectively. Then to increase the line efficiency of the section, it needs to assemble and balance that operation has much less cycle time and add the labour on the operation have maximum cycle time, because less line efficiency indicated that less output in the section with a high number of station and labour.

**c) Less labour productivity (output per labour)**

Labour productivity depends on the total output of the section and the number of labour that existed in the section of the operation process line. The existed labour productivity of the cutting, stitching, and lasting and finishing section is 22.5, 8.1, and 8.9 pairs per day. This indicated that its low labour productivity exists in ASSC and it required improvement on labour output per day through increases the overall output of the section with assemble the operation process and add (rotating) labour on the operation those have a bottleneck and high cycle time and reduce labour those idle from the section.

**d) Less workers motivation and management relationship.**

In ASSC there are fewer workers and management relationships and the management system is only considering the profit of the company not on a workers working conditions and satisfaction.

**2) Consideration during improvement in the section**

There is a consideration during improvement in each case and section, like:

Consideration during reduce the distance movement:

- ✓ Considering types of operation especially by manual (on a table) or machine
- ✓ Considering working environment like released heat from the machine during the process
- ✓ Considering the existence of the other model of operation in the company.
- ✓ Keeping the existed performance rating and allowance of the company.

Consideration during assembling the operation

- ✓ Types of operation especially by manual (on the table) or machine.
- ✓ Standard time is given for the operation
- ✓ Number and skill of the labour on the operation.
- ✓ Effects on before and after of the consecutive operation

Consideration during adding (rotating) and reducing the labour

- ✓ Identify bottleneck area.
- ✓ Number of the labour on the operation process
- ✓ Types of the operation (manually or machine)
- ✓ The skill of the labour
- ✓ Cycle time of the operation process

The overall enhancement of the productivity of the ASSC gained through reduced of:

- ❖ Distance movement time of unwanted movement
- ❖ Bottleneck operations
- ❖ Workers fatigue
- ❖ Process and cycle time
- ❖ Number of operation (station)

And also through increased of:

- ❖ Line efficiency
- ❖ Labour productivity
- ❖ Capacity output per day of each operation section
- ❖ Balanced and proper flow process
- ❖ Management and workers relationship

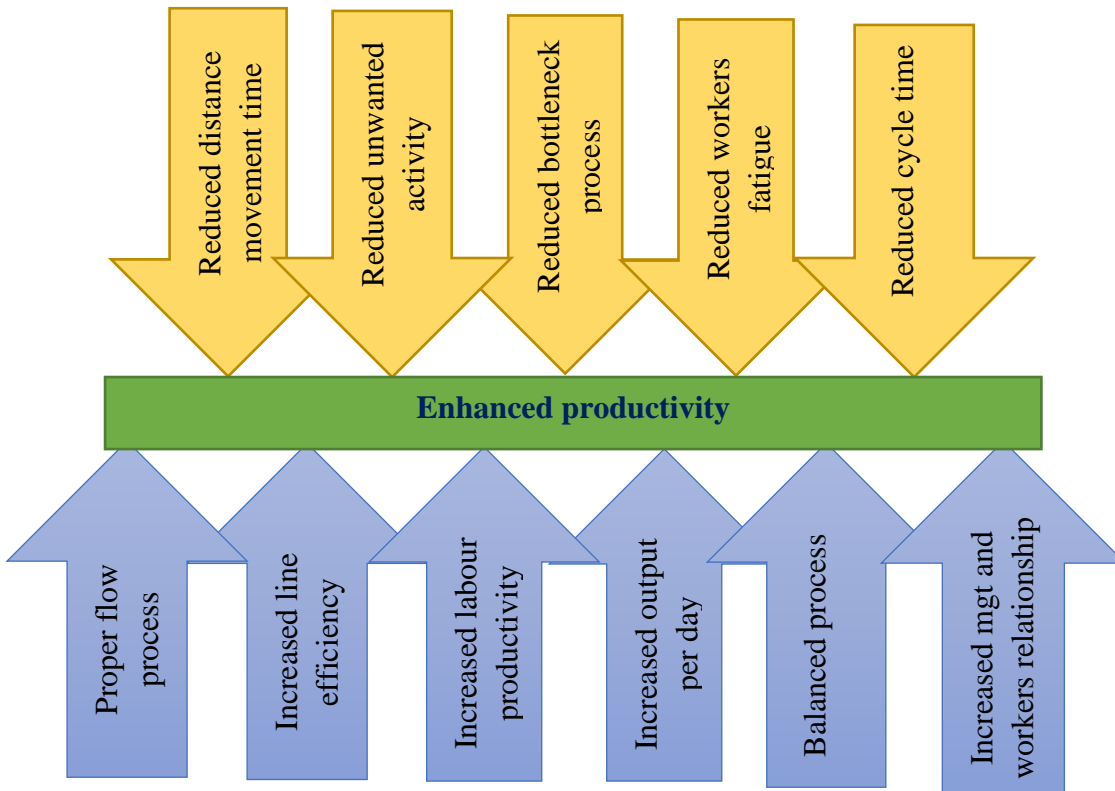


Figure 27: Overall ways of enhancing productivity.

The above figure it focused and processed all together acts for enhancement of the productivity.

## 6.2 Improvements of the ASSC for enhancement of productivity

### 6.2.1 Improvement in Cutting section

In the cutting section, the major operations classes are pre-cutting (clicking operation) and Insole preparation and operations. Then, in this section it needs to improve the following things:

- ✚ Merge (join) the existed the same activities, like the finished stamping activities with upper arrange and dispatch and bevelling with insole arrange and dispatch.
- ✚ Add labour on the process has high cycle time and reduce the excess labour from those has very less cycle time of the process.
- ✚ Properly redesign and rearrange the flow process of the section.

- ✚ Reduce the movement distance according to comfortable and adjustable for both workers and the flow process of the section.

Table 21: types of skill of labor and their deference.

Types of skill	Definitions
Skilled labor	Who have specialized training for a particular profession and have a long practical experience of the job. Example Industrial engineers, managers, overall quality checker, production manager, planner, purchaser and Machine operator man.
Semi skill labor	Who have only a part of a professional training of their work, but have sufficient experience on their field and they are paid less than to skilled workers. Example shoe maker operator, stitch man.
Unskilled labor	Those who do not require any specialized professional skill and they paid low. Example helper, collector.

Table 22: Cutting section identified improvement operations

Operation	Proposed
upper raw material preparation	Add labour one (1) and reduce distance movement to 3m
Upper collect	Cancel the activity
back box skiving	Reduce one labour
Bevelling	Reduce one labour
Insole collect	Cancel the activity

Then on the above operation, there is a change in the distance movement with time is located on the bellow table.

Table 23: Improved distance and time movement in cutting section

Activity	Symbol					Distance movement(m)	movement time (sec)
	○	⇒	◻	▽	□		
raw material storage preparation						3	12
pre-cutting operation						4	16
back box skiving						3.5	14
stamping						4	16
upper arrange and dispatch						4	16
sole material store and preparation						4	16
cutting texn board						2	8
cutting shank board						2.5	10
shank grooving						2	8
shank skiving						2	8
attaching shank						3.5	14
apply glue						4	16
molding						2	8
beveling						2	8
insole arrange and dispatch						3.5	14
count and overall dispatch						2	8
overall inspection						0	0
Total						48	192

$60m - 48m = 12m$  and  $240second - 192second = 48second$

From the above table despatching activity is cancelled with reduced three labour from both activity lines of the operation process and directly collect with overall finished operation from both and directly to the overall dispatch and inspection. Then the overall reduced distance movement is 12 meters with 48second seconds in the production process of pair of shoes.

The rearranged flow process is prepared according to smooth and balanced the process with less movement of workers during the time and also in each operation process arrangements are considered of types of operation especially by manual (on a table) or machine , working environment, and other model of operation.

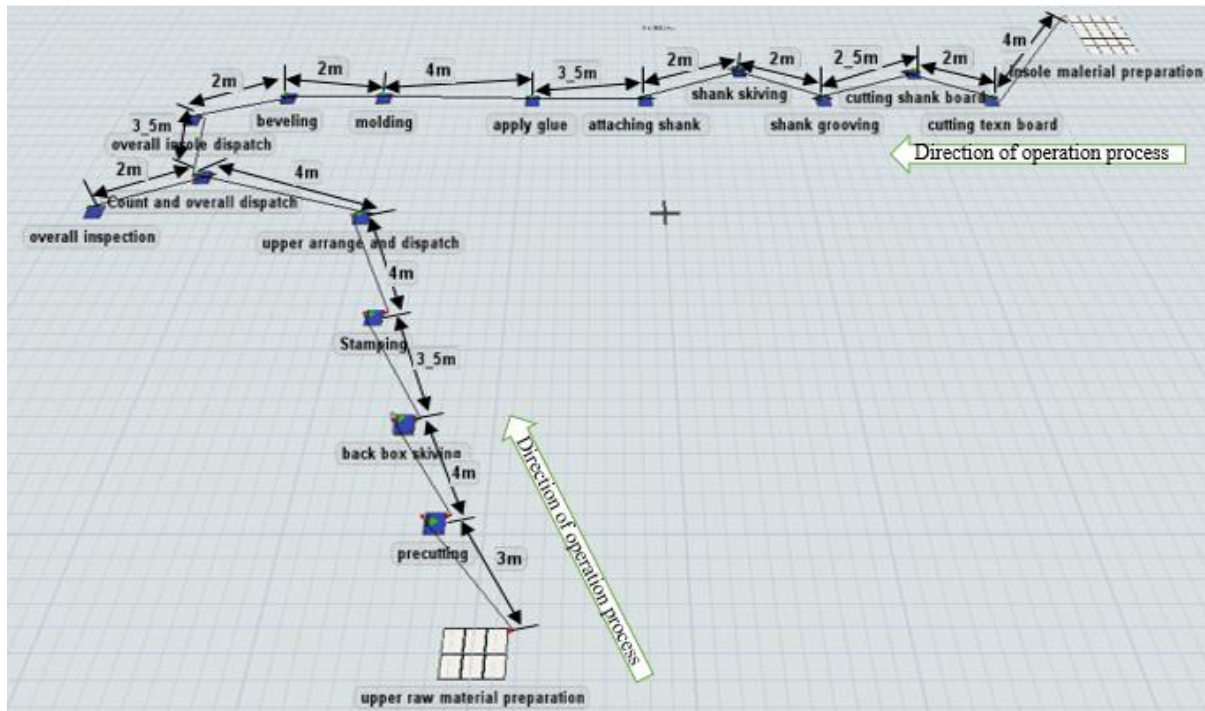


Figure 28: Improved and rearrangement of the process flow of cutting section

**6.2.1.1Balanced and capacity output per day of cutting section**

In the cutting section, most of the consecutive operation processes are worked by using a different machine, in case that it is impossible to emerge the process and only balancing the number of workers on the line of the operation process. Then, in upper collect, back box skiving, beveling and insole collect, a total of 5 labour are reduced and add one (1) labour in upper raw material preparation.

Table 24: Capacity output, reduced bottleneck, and labor with cycle time after balanced process of cutting section

Operations	ST (sec)	Capacity per day	Labour	CT (sec)
upper raw material preparation	53.88	1069.14	2	26.938
pre-cutting operation	61.96	929.68	2	30.978
back box skiving	40.97	702.99	1	40.968
Stamping	61.73	933.07	2	30.866
upper arrange and dispatch	65.10	884.80	2	32.550
insole material preparation	33.78	852.47	1	33.784
cutting texn board	33.67	855.31	1	33.672
cutting shank board	32.77	878.74	1	32.774

shank grooving	31.65	909.90	1	31.652
shank skiving	35.13	819.79	1	35.131
attaching shank	28.85	998.42	1	28.846
apply glue	34.79	827.72	1	34.794
Molding	32.33	890.95	1	32.325
Bevelling	31.65	909.90	1	31.652
insole arrange and dispatch	36.25	794.41	1	36.254
count and overall dispatch	31.43	916.40	1	31.427
overall inspection	37.82	761.40	1	37.825
<b>Total</b>	<b>683.77</b>		<b>21</b>	<b>562.435</b>

Reduced number of labour = existed number of labour – proposed. Then, 25 – 21 = 4 labour is reduced

Reduced cycle time = existed CT (sec) – proposed CT(sec)

$$= 625.906 \text{ second} - 562.435 \text{ second} = 63.471 \text{ second pair shoe}$$

After balanced all of the process, the processes are smoothly processed

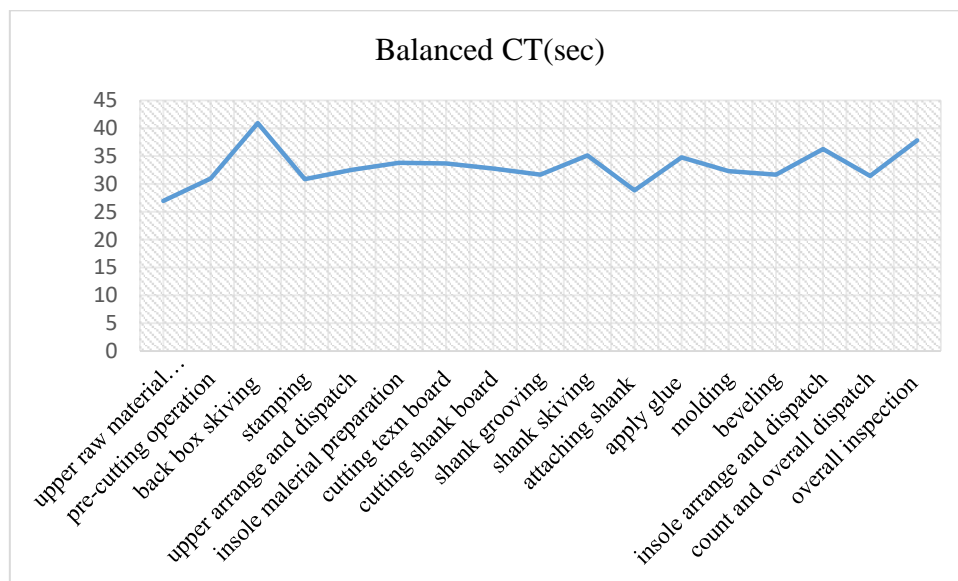


Figure 29: Balanced cycle time of cutting section

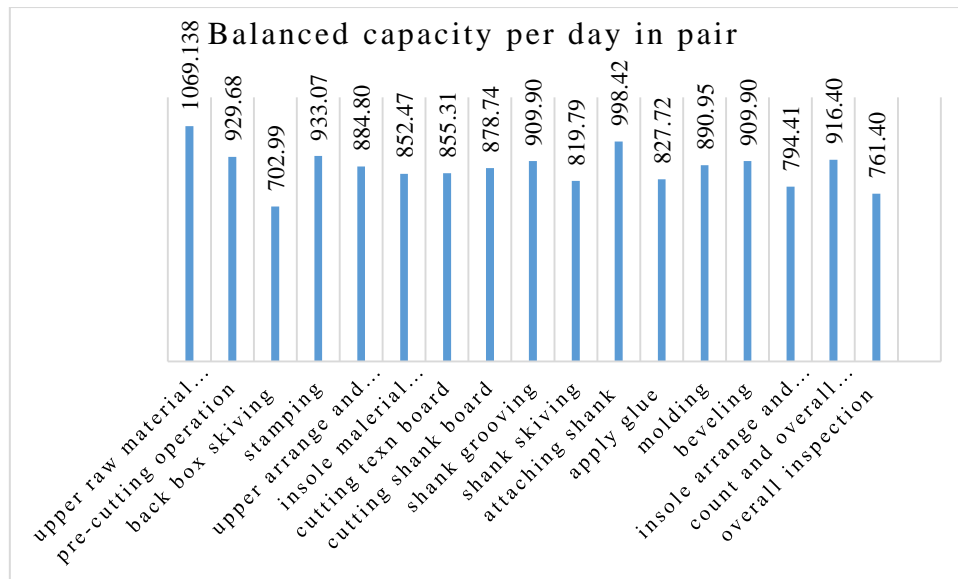


Figure 30: Balanced capacity per day

Total ST= 683.77 second

Total CT = 562.435 second

Available working time per day = 28800 second (480minute)

Total labour = 21

Total operation (station) = 17

Maximum cycle time = 40.968 second

Line efficiency = [(562.435 second)/ (16 \*40.968 second)] \*100

$$= [0.8076]*100$$

$$= \underline{\underline{80.76\%}}$$

Total output per day = (0.8076\*21\*28800)/ 683.77 second = **714 pair per day**

Labour output per day = 714 pair per day / 21 labour = **34 pair per labour per day**

Generally in the cutting section, the proposed result of Line efficiency, total output per day, number of labour, and Labour output per day are 80.76%, 714 pairs per day, 21 and 34 pairs per labour per day respectively.

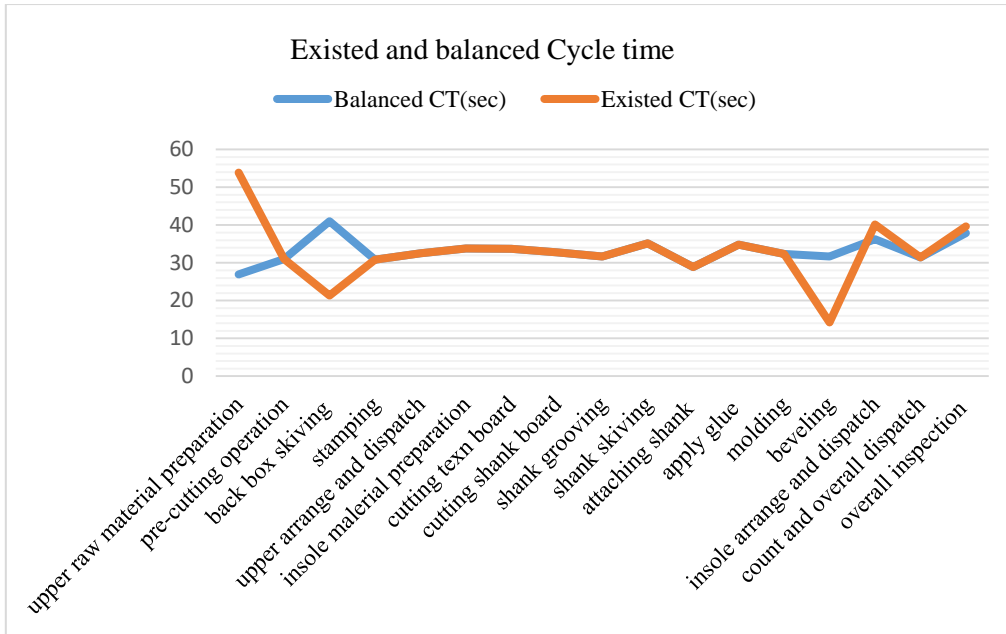


Figure 31: Comparison of existed and balanced Cycle time

### 6.2.2 Improvements in stitching section

After detailed analysis and identification of the place of operation process that has major bottleneck operations and idle labour, it merges the operations and rotates the labour on the requirement process and reduces from the idle. Then the overall stitching operation that requires improvement is identified on the bellow table.

A semi-skilled worker has some training and skills, but not enough to do specialized work, Unskilled workers are those workers who lack technical training or skill and Skilled workers are those highly trained, educated, or experienced segments of the workforce that can complete more complex mental or physical tasks on the job

Table 25: Stitching section identified improvement operations

Operations	Proposed	Types of skill
loading	Add one labour	Semiskilled
marking	Add one labour	Unskilled
skiving and quarter lining	Add one labour	Semiskilled
attach textile adhesive	Reduce one labour	Unskilled
decorative stitch on quarter	Merge both and reduce one labour	Skilled
stitch back count lining		
apply glue and attach the apron	Add one labour	Unskilled
apply glue and attach mudguard	Add one labour	Unskilled

stitch mudguard with mudguard lining	Merge both and reduce one labour	Skilled
stitch apron with its lining		
apply glue and attach back count	Add one labour	Unskilled
stitch complete quarter and quarter lining	Add one labour	Skilled
insert collar foam by applying glue	Merge	
turning		
hammering around collar	Reduce one labour	Unskilled
trimming around eye stay and apron	Reduce one labour	Skilled
skiving 45 degrees for mudguard	Reduce one labour	Skilled
punch eyelet place	Add one labour	Skilled
apply glue and attach a quarter	Add one labour	Unskilled
stitch quarter over the mudguard	Reduce two labour	Skilled
insert counter stiffener by applying glue	Merge and reduce one labour	Unskilled
cutting and cleaning excess thread		
Collect and arranging pairwise	Reduce two labour	Semiskilled

From the above table some operation processes are merged, then when the process operation merges the distance movement and movement time is reduced.

Table 26: Improved distance and time movement in stitching section

Activity	Symbol					Distance mov't(m)	Movement time(sec)
	○	⇒	D	▽	□		
loading						3.5	14
marking						2	8
skiving and quarter lining						2.5	10
attach nylon and reinforcement						2	8
attach textile adhesive						2	8
decorative stitch on quarter and stitch back count lining						2	8
stitch mudguard lining and counter						2	8
apply glue and attach apron						2	8
apply glue and attach mudguard						2	8
re-cut apron and mudguard						2	8
marking mudguard						2	8
skiving vamp with its lining						2	8
stitch mudguard with mudguard lining and stitch apron with its lining						2	8
apply glue and attach back count						2	8
stitch back count with quarter						2	8
stitch complete quarter and quarter lining						2	8
insert collar foam by applying glue and turning						2	8
hammering around collar						2	8
in process quality inspection						2	8
stitch around eye stay and collar						2	8
trimming around eye stay and apron						2	8
skiving 45 degree for mudguard						2	8
punch eyelet place						2	8
apply glue and attach quarter rd						2	8
stitch quarter over mudguard						2	8
trimming around quarter lining						2	8
stitch quarter lining bottom						4.5	18
punch closed hole						2	8
insert counter stiffener by applying glue and cutting and cleaning excess thread						2	8
burning the excess thread						2	8
temporary shoe lacing						2	8
final QC						2	8
Collect and arranging pairwise						2	8
Total						70.5	282

From the above table, the total movement distance is 70.5m with a movement time of 282second.

83.5m – 70.5m = 13m and 334 second – 282 seconds = 52 seconds, which means that 13m with 52 seconds is reduced in pair of the shoe production process.

**Flow process and arrangements**

In process flow arrangements the number of operations is reduced because of the existence of the merged operations. In the proposed system the number of the operations is 33 and it is as follows in the following process flow figure

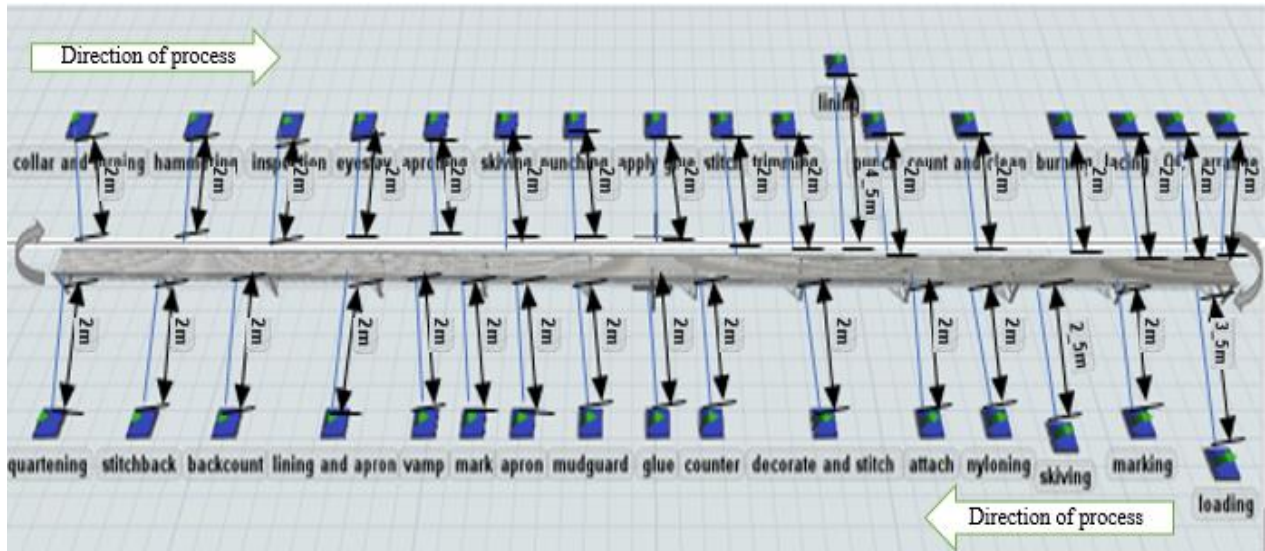


Figure 32: Improved and rearrangement of the process flow of stitching section

**6.2.2.1 Balanced and capacity output per day of stitching section**

Table 27: Capacity output, reduced bottleneck, and labor with cycle time after balanced process of stitching section

Operations	ST(sec)	Capacity	Labour	CT(sec)
Loading	60.28752	955.422	2	30.144
Marking	75.3594	764.337	2	37.680
skiving and quarter lining	59.54454	967.343	2	29.772
attach nylon and reinforcement	55.61736	1035.648	2	27.809
attach textile adhesive	34.17708	842.670	1	34.177
decorative stitch on quarter and stitch back count lining	95.76	902.256	3	31.920
stitch mudguard lining and counter	37.8566	760.766	1	37.857
apply glue and attach apron	80.16	718.563	2	40.080
apply glue and attach mudguard	79.8	721.805	2	39.900
re-cut apron and mudguard	38.7411	743.397	1	38.741
marking mudguard	33.0803	870.609	1	33.080
skiving vamp with its lining	39.8025	723.573	1	39.803
stitch mudguard with mudguard lining and stitch apron with its lining	62.94	915.157	2	31.470
apply glue and attach back count	79.8	721.805	2	39.900
stitch back count with quarter	33.42	861.759	1	33.420

stitch complete quarter and quarter lining	58.377	986.690	2	29.189
insert collar foam by applying glue and turning	107.52	803.571	3	35.840
hammering around collar	32.88	875.912	1	32.880
in process quality inspection	32.4	888.889	1	32.400
stitch around eye stay and collar	59.11998	974.290	2	29.560
trimming around eye stay and apron	38.42268	749.557	1	38.423
skiving 45 degrees for mudguard	37.149	775.256	1	37.149
punch eyelet place	58.48314	984.899	2	29.242
apply glue and attach quarter	79.605	723.573	2	39.803
stitch quarter over mudguard	46.59546	618.086	1	46.595
trimming around the quarter lining	36.0876	798.058	1	36.088
stitch quarter lining bottom	33.9648	847.937	1	33.965
punch closed hole	41.3946	695.743	1	41.395
insert counter and applying glue and cutting and cleaning excess thread	123.96	696.999	3	41.320
burning the excess thread	37.149	775.256	1	37.149
temporary shoe lacing	38.2104	753.721	1	38.210
final QC	38.42268	749.557	1	38.423
Collect and arranging pairwise	38.2104	753.721	1	38.210
<b>Total</b>	<b>1804.29814</b>		<b>51</b>	<b>1181.591</b>

From the above table, the total cycle time is 1181.591 seconds with 51 labours. The reduced CT (sec) is 1499.56 second - 1181.591 second = 317.959 second with reduced labour of 53 - 51 = 2 labour. After balanced all of the production processes the flow of the operations is smoothly processed and also the balanced Cycle time (CT) of each operation is:

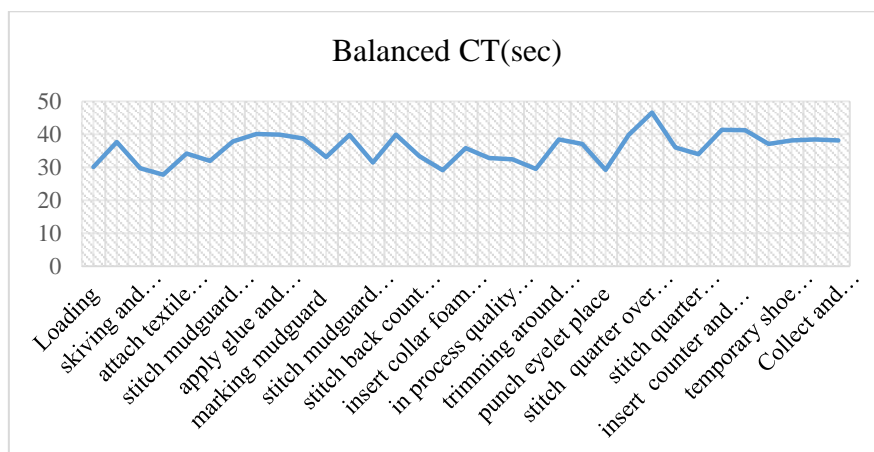


Figure 33: Balanced cycle time of stitching section

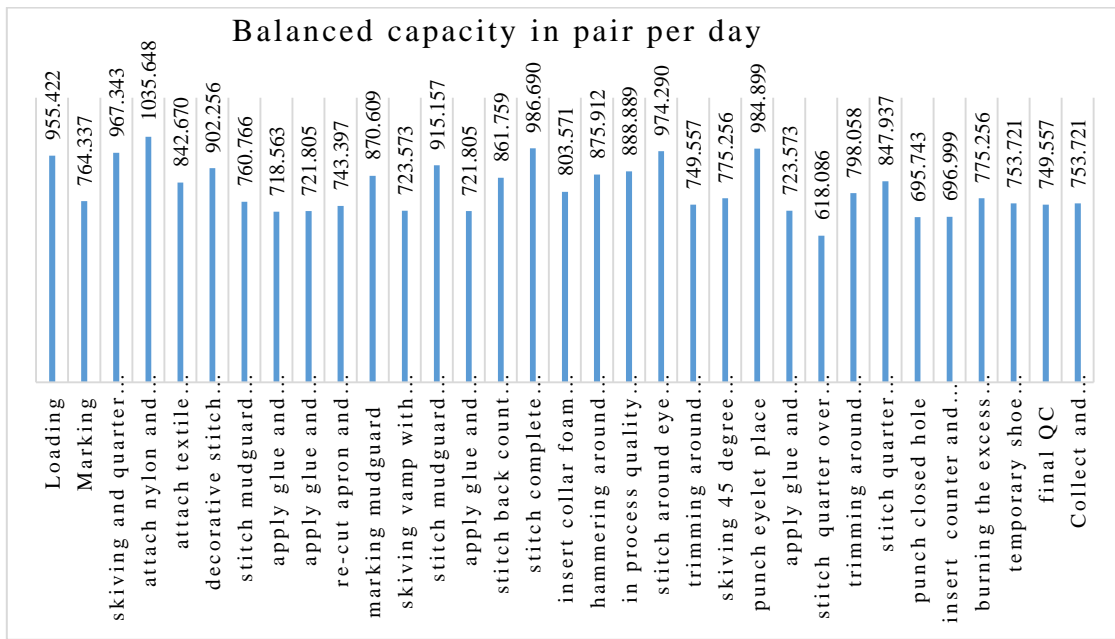


Figure 34: Balanced capacity of stitching section

Then, after balanced of the operation calculate the line efficiency, total output and labour productivity per day.

$$\text{Total ST (sec)} = 1804.29814$$

$$\text{Total CT (sec)} = 1181.591$$

$$\text{Number of labour} = 51$$

$$\text{Number of operation (station)} = 33$$

$$\text{Available time per day} = 28800 \text{ second}$$

$$\text{Maximum CT (sec)} = 46.595$$

$$\text{Line efficiency} = [(1181.591)/(33*46.595)] * 100$$

$$= [0.768]*100$$

$$= \underline{\underline{76.8\%}}$$

$$\text{Total output per day} = (0.768 * 51 * 28800) / 1804.29814$$

$$= \underline{\underline{625.3 \text{ pair per day}}}$$

$$\text{Labour output per day} = 625 \text{ pair} / 51 = \underline{\underline{12.3 \text{ pair per labour per day.}}}$$

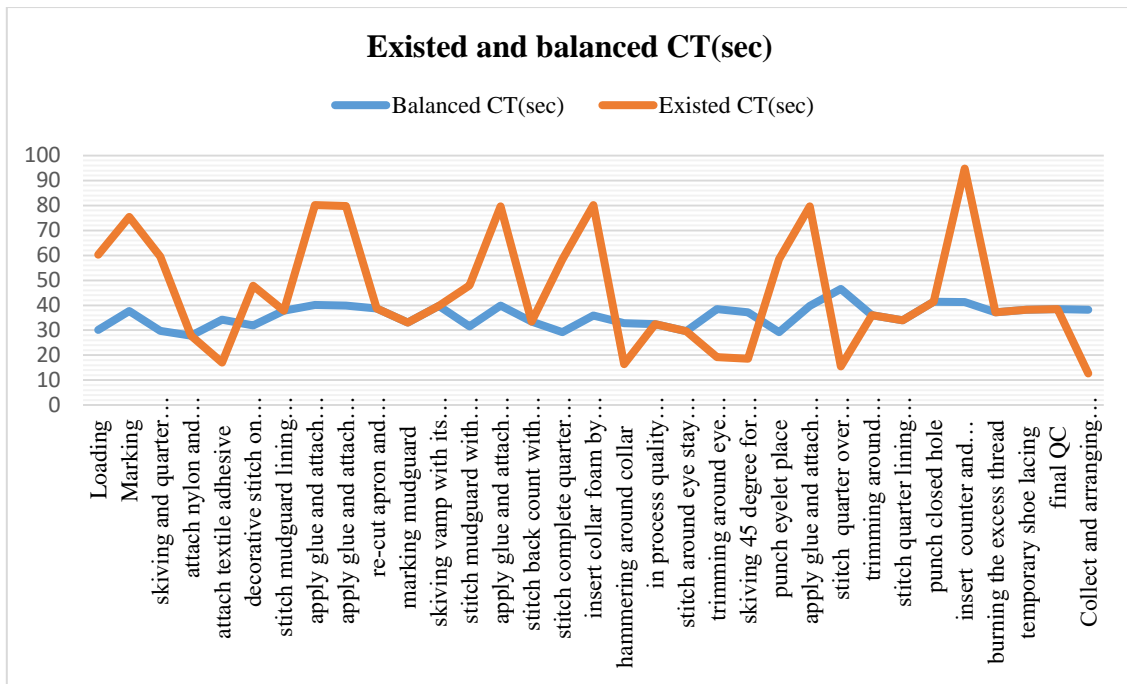


Figure 35: Comparison of existed and balanced Cycle time of stitching

### 6.2.3 Improvement of Lasting and finishing section

Also in the lasting and finishing section, there is identified and take improvement in some operations that require improvement.

Table 28: Lasting and finishing section identified for improvement operations

Operations	Proposed	Types of skill
last loading and insole	Reduce one labour	Unskilled
back part molding	Add one labour	Unskilled
insert last and side closing	Add one labour	Skilled
first adhesive coating on upper	Add one labour	Unskilled
sole and upper re-activator	Reduce one labour	Unskilled
attaching sole with upper	Add one labour	Skilled
attaching sole with upper and pressing	Add one labour	Skilled
remove temporary shoe lacing	Reduce one labour	Unskilled
cleaning excess glue	Reduce one labour	Unskilled
painting on over rough place	Reduce one labour	Skilled
apply the cream on upper	Merge	
apply glue and insert sock lining		

inserting tissue paper	Reduce one labour	Skilled
final brushing for shine	Reduce one labour	Skilled
final quality inspection	Marge and reduce one labour	semiskilled
Arrangement and pack		

Table 29: Improved distance and time movement in lasting and finishing section

Activity	Symbol					Distance mov't(m)	Movement time(sec)
	○	⇒	D	▽	□		
last loading and insole						2	8
last cleaning						2	8
loading upper, toe cap steel						2.5	10
roughing around center of out sole						2	8
out sole cleaning						2	8
attaching insole on last						2	8
back part molding						2	8
insert to steam						2	8
insert last and side closing						2	8
apply glue on sides of the upper						2	8
insert to steam						4	16
creaming on upper and inserting in heat tunnel						4.5	18
pounding						2	8
in process quality inspection						2	8
first level upper roughing						2	8
second level upper roughing						2	8
first adhesive coating on upper						2	8
first adhesive coating on out sole						2	8
second adhesive coating on upper and sole						2	8
sole and upper dryer						2	8
sole and upper re-activator						2	8
attachin sole with upper						2	8
attachin sole with upper and pressing						2	8
remove temporary shoe lacing						2	8
de-lasting						2	8
cleaning excess glue						4.5	18
ironing to remove wrinkle						2	8
painting on over rough place						2	8
apply cream on upper						2	8
apply glue and insert sock lining and shoe lacing						2	8
inserting tissue paper						2	8
final brushing for shine						2.5	10
final quality inspection with arrengment and pack						2	8
Total						74	296

From the above table, the total distance is 74m with a distance movement of 296 seconds.

83m – 74m = 9m and 332 second – 296second = 36 second .Then the reduced distance is 9m with a reduced movement distance time of 36 seconds. Also, the flow process and arrangement are below figure.

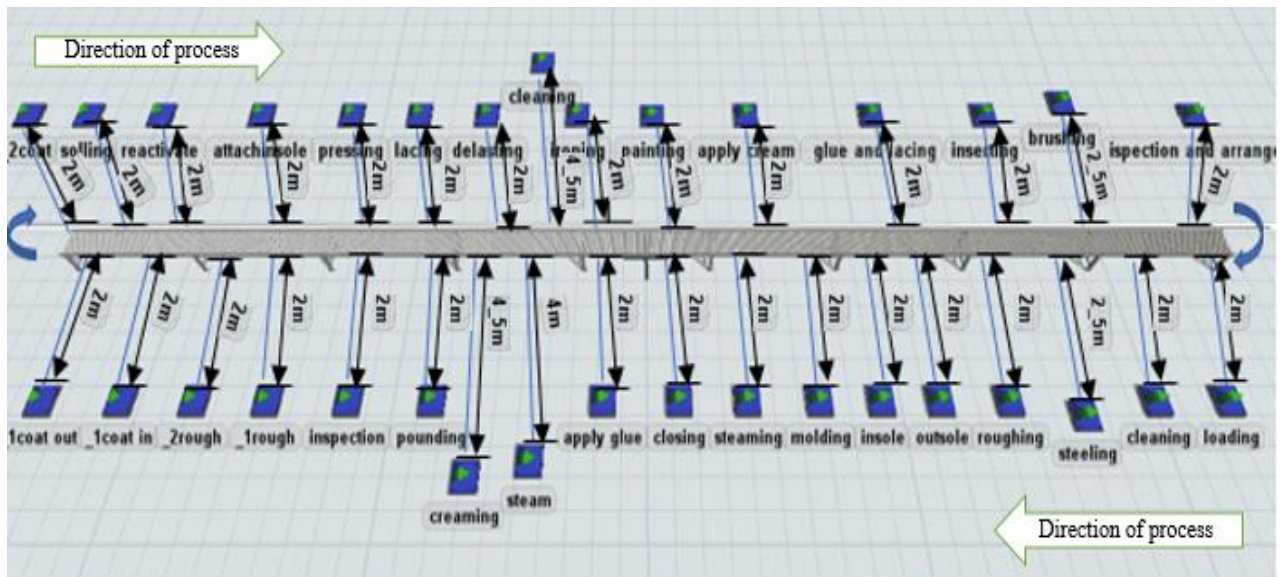


Figure 36: Improved and rearrangement of the process flow of lasting and finishing section

In the above figure, there are 33 operations (stations) after balanced and merged and then the output is store.

**6.2.3.1 Balanced and capacity output per day of lasting and finishing section**

Table 30: Capacity output, reduced bottleneck, and labor with cycle time after balanced process of lasting and finishing section

Operations	ST(sec)	Capacity	Labour	CT(sec)
last loading and insole	63.68835	904.404	2	31.844
last cleaning	32.21262	894.060	1	32.213
loading upper, toe cap steel	58.53012	984.109	2	29.265
roughing around the center of the outsole	38.9499	739.411	1	38.950
out sole cleaning	37.8972	759.951	1	37.897
attaching insole on last	32.00208	899.942	1	32.002
back part molding	58.21431	989.447	2	29.107
insert to steam	38.9499	739.411	1	38.950
insert last and side closing	69.4782	829.037	2	34.739
apply glue on the sides of the upper	38.10774	755.752	1	38.108
insert to steam	58.42485	985.882	2	29.212
creaming on upper and inserting in heat tunnel	63.89889	901.424	2	31.949
Pounding	32.10735	896.991	1	32.107
in process quality inspection	37.37085	770.654	1	37.371
first level upper roughing	36.00234	799.948	1	36.002

second level upper roughing	38.73936	743.430	1	38.739
first adhesive coating on upper	68.63604	839.209	2	34.318
first adhesive coating on outsole	38.9499	739.411	1	38.950
second adhesive coating on upper and sole	37.16031	775.020	1	37.160
sole and upper dryer	35.26545	816.663	1	35.265
sole and upper re-activator	36.8445	781.663	1	36.845
attaching sole with upper	64.53051	892.601	2	32.265
attaching sole with upper and pressing	106.11216	814.233	3	35.371
remove temporary shoe lacing	38.00247	757.845	1	38.002
de-lasting	46.95042	613.413	1	46.950
cleaning excess glue	69.68874	826.532	2	34.844
ironing to remove wrinkle	63.162	911.941	2	31.581
painting on over rough place	36.8445	781.663	1	36.845
apply cream on upper	33.47586	860.321	1	33.476
apply glue and insert sock lining and shoe lacing	117.6	734.694	3	39.200
inserting tissue paper	64.2147	896.991	2	32.107
final brushing for shine	37.26558	772.831	1	37.266
final quality inspection and arrangement and pack	81	711.111	2	40.500
<b>Total</b>	<b>1710.28</b>		<b>49</b>	<b>1169.402</b>

The total CT (sec) is 1169.402 and the total number of labour is 49 after the process is balanced.

Then reduced CT is 1286.15 second - 1169.402 second = **116.748** seconds with reduced **3** labour in the lasting and finishing section.

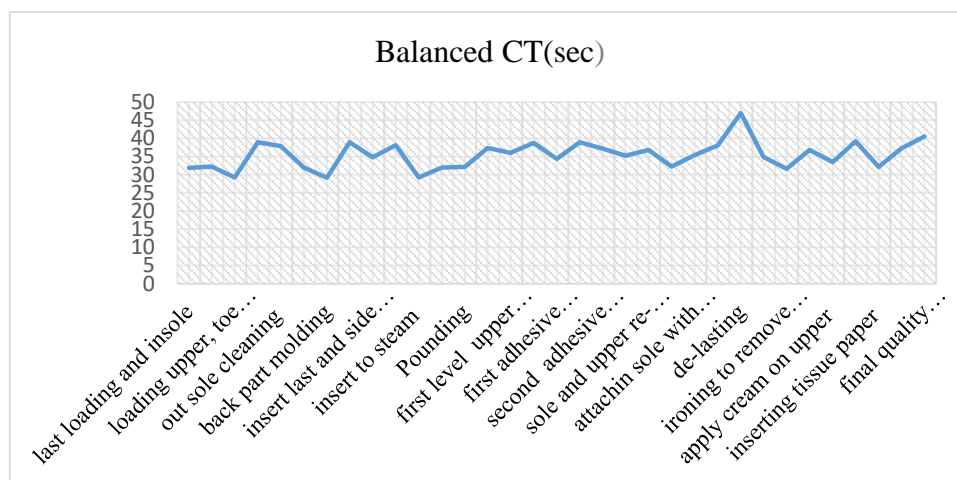


Figure 37: Balanced Cycle time of the lasting and finishing section

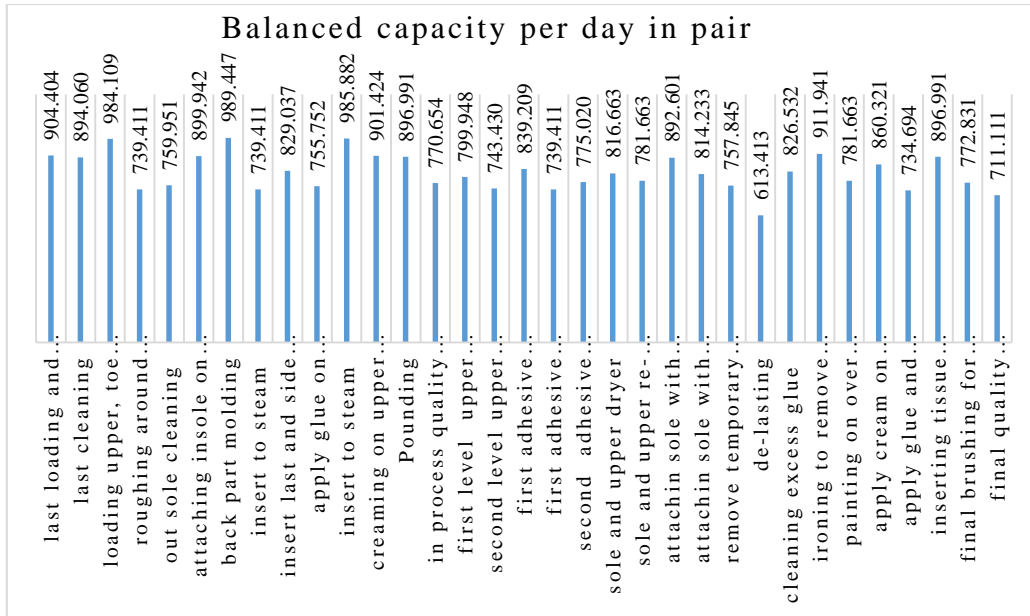


Figure 38: Balanced capacity of lasting and finishing section

After balanced it calculate the line efficiency, total output and labour productivity per day.

$$\text{Total ST (sec)} = 1710.2772$$

$$\text{Total CT (sec)} = 1169.402$$

$$\text{Number of labour} = 49$$

$$\text{Number of operation (station)} = 33$$

$$\text{Available time per day} = 28800 \text{ second}$$

$$\text{Maximum CT (sec)} = 46.950$$

$$\text{Line efficiency} = [(1169.402)/(33*46.950)] * 100$$

$$=[1169.402/1549.35] * 100$$

$$[0.755] * 100 = \underline{\underline{75.5\%}}$$

$$\text{Total output per day} = (0.755*49*28800)/ 1710.2772$$

$$= \underline{\underline{623 \text{ pair per day}}}$$

$$\text{Labour output per day} = 623\text{pair} /49$$

$$= \underline{\underline{12.7 \text{ pair per day per labour}}}$$

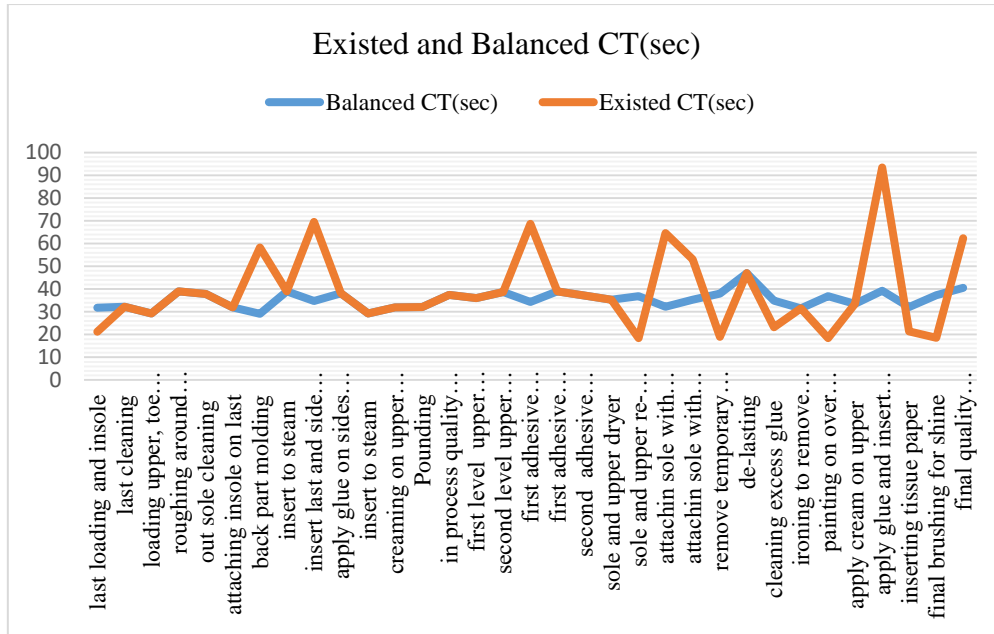


Figure 39: Comparison of existed and balanced Cycle time of lasting and finishing section

**6.2.4 Management and workers responsibility and relationship.**

Management and workers relationship is paly a great role on the enhancement of the productivity of the company and both have their responsibility. When managers and workers fully participated in their responsibility, then the relationship between them also increased.

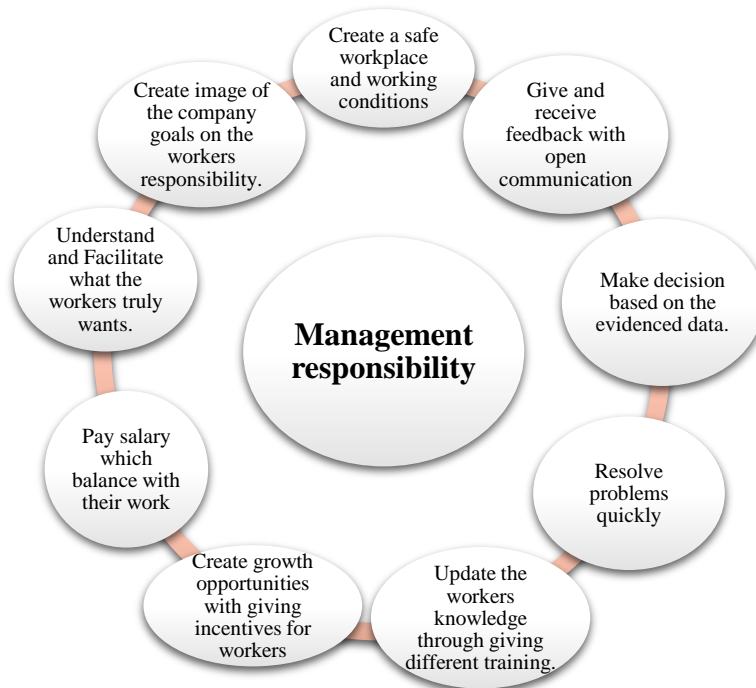


Figure 40: Management responsibility for enhancing productivity.

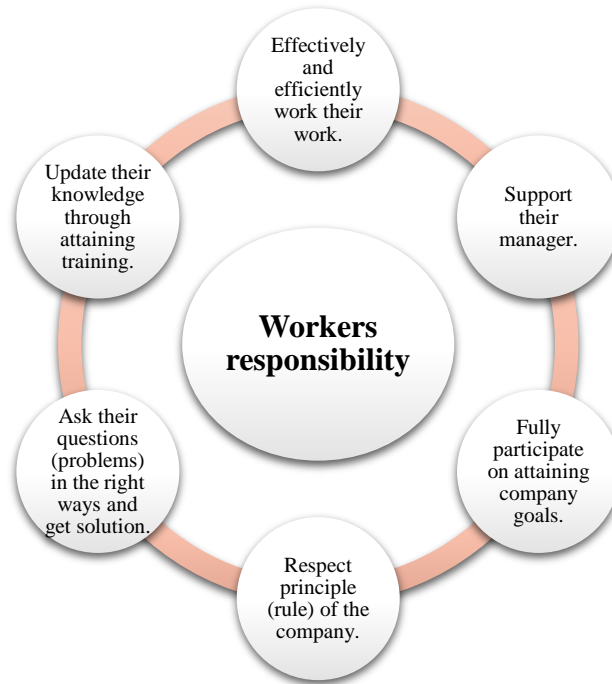


Figure 41: workers responsibility to enhancing the productivity of the company

### 6.3 Generalize the overall compression of existed and proposed result

By this study, there is an improved result in the different directions to enhance the productivity of the ASSC through work measurement and line balancing applications. Then, the overall summary of the existed and proposed conditions of the ASSC in this study is on the bellow tables.

Table 31: Generalize the overall compression of existed and proposed result

Section		Existed	Proposed
Cutting	Line efficiency	61.10%	80.76%
	Output per day in pair	563	714
	Number of labour	25	21
	Labour productivity in pair	22.5	34
	operation (station)	19	17
	Cycle time (CT)in sec	625.906	562.435
	distance movement (m)	60	48
	movement time (sec)	240	192
Stitching	Line efficiency	50.50%	76.80%
	Output per day in pair	427	625.3
	Number of labour	53	51

	Labour productivity in pair	8.1	12.3
	operation (station)	37	33
	Cycle time (CT)in sec	1499.56	1181.59
	distance movement (m)	83.5	70.5
	movement time (sec)	334	282
lasting and finishing	Line efficiency	52.89%	75.50%
	Output per day in pair	463	623
	Number of labour	52	49
	Labour productivity	8.9	12.7
	operation (station)	35	33
	Cycle time (CT)in sec	1286.15	1169.4
	Distance movement (m)	83	74
	Movement time (sec)	332	296

Table 32: Reduced materials after balanced in each section

Types of materials	Cutting section	Stitching section	Lasting and finishing section
Tables	2	2	1
Machine	0	2 (PBSN M/C)	0

The reduced table and machine are it will use for future as a maintenance spare part or as reserve materials.

## 6.4 Recommended and implementation of the proposed result.

To implement the proposed systems it needs to identify the major activity and its sequence uses of the activities. All activities are implemented on the working day of the company through self-adjustment of the stakeholders through identify the implementer requirement from each position.

### 6.4.1 Budget for implementation proposed result

For implementers budget as overtime is 5% of their salary level per day and the salary of the top management is 20,000 ETB, the department head is 8200 ETB, Supervisors is 5,506 ETB and Helpers from workers (Skilled, semiskilled and unskilled) is 3000, 2200 and 1, 180 ETB.

Table 33: Selected implementer of the proposed activity

Selected implementer	Number	Budget per day in ETB
From tom management	1	1000
From production management	1	410
Super visors (from each section)	3	$275*3 = 825$
Helpers from workers	3	$150+110+59 = 319$
Total	8	<b>2,554 ETB per day</b>

The implementation of the proposed result takes 14 days (lists shows in table 33), then the total implementation budget needed is  $2,554 \text{ ETB} * 14 \text{ days} = 35,756 \text{ ETB}$ .

Table 34: Major activities and sequence of implementation

Order of activity	Activity	The time it takes in a day.
A	Advise the top management and supervisors aim an result of the study	1
B	show the types and areas of the problem that need improvement in each section	3
C	Identify the unwanted activity, distance movement, number of labour, CT, and capacity per day of the selected operation	3
D	identify types of operation those by manual or machine	1
E	Assess the skill of the labour on the requirement operation	1
F	Identify the number of the implementer of the activity (from Top and production management, supervisor, and low-level workers)	1
G	Prepare criteria to reduce the labour and add on the operation (skill, experience, etc.)	1
H	select the reduce and add labour on the operation	1
I	select and merge the operation	1
J	overall arrange and check	1
	Total	14

The total time it takes to implement is 14 days and it showed below their sequence by using QM for windows.

Table 35: The recorded sequence of activities with their time

Order of activity		
Activity	Activity time	Predecessor 1
A	1	
B	3	A
C	3	B
D	1	C
E	1	D
F	1	E
G	1	F
H	1	G
I	1	H
J	1	I

Table 36: Total time with starting and finishing of each activity

Order of activity solution					
Activity	Activity time	Early Start	Early Finish	Late Start	Late Finish
Project	14				
A	1	0	1	0	1
B	3	1	4	1	4
C	3	4	7	4	7
D	1	7	8	7	8
E	1	8	9	8	9
F	1	9	10	9	10
G	1	10	11	10	11
H	1	11	12	11	12
I	1	12	13	12	13
J	1	13	14	13	14

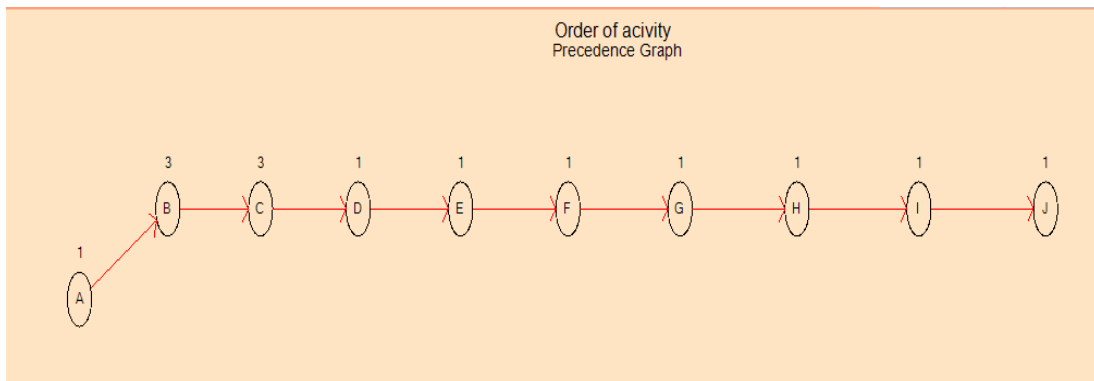


Figure 42: order of activity precedence graph with the required time

## **CHAPTER SEVEN**

### **CONCLUSION, RECOMMENDATION, AND FUTURE RESEARCH WORK**

#### **7.1 Conclusion**

The existed productivity competitiveness of the ASSC is lower than their competitor's companies, because of the existed ineffective process time, low-efficiency line, less labour productivity, bottleneck process and less output per day. In this study, those major factors are reduced through the work measurement and line balance application and it enhanced the productivity of the ASSC. The result of the study is reduced total of unwanted movement distance with a time, cycle time, number of operation (station), and number of the labour from the existed is 34m with 136 seconds, 498.19second, 8 number operations, and 9 labour respectively and also it increased line efficiency of the cutting, stitching and lasting and finishing section to 80.76%, 76.805 and 75.50% and output per day in pair is to 714, 625.3 and 623 with the increased labour productivity per day in pair to 34, 12.3 and 12.7 respectively. Generally, ASSC enhanced productivity of finished footwear output is to 623 pairs per day with an additional output of 160 pairs of shoes per day and the actual finished shoe output performance of the company is increased by 23%. The recommended implementation of the study result was proposed with different activities and it takes 14 days and 8 implementers with an implementation budget of 35,756 ETB.

## **7.2 Recommendation**

- ❖ It is highly recommended to fully implement work measurement and line balance in all shoe models
- ❖ Give training and update the skill of the employers, because through competition it requires a new and updated skill on the shoe production process.
- ❖ Increase the labour and management relationship, because it is used for the overall benefit of the company.
- ❖ It focussed on the balanced profit with customer's satisfaction, because customers are the backbone of the company.

## **7.3 Future research work**

- ✚ Develop a way to increase the interconnection of footwear industries with manually shoe processed small shops.

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## Appendices

### Appendix A: Prepared the major questioners for respondents and analyzed data

Table 37 A-1: Prepared questionnaires' with purpose

Questions for respondents	Purpose of the question
Do you know factors that affect the productivity of the company?	It understands and identifies the major factors that affect the productivity of the company.
Is there a supply-demand gap on the product?	To know the existed supply-demand gap on the footwear of the company.
Did the customer satisfaction with the company product?	To know the causes of customers dissatisfaction
The current amount of the finished product on the market is enough?	To assess the interests of the customers for the product of the company on the current level.
Do you know which model is the basis for others and factors that affect the overall productivity of the company?	Assess which model has the basic operation for others and also the factors of that model affect the productivity of the company.
Are there repetitive motion tasks?	To identify the existence of the repetitive motion of the workers throughout the working hours.
Is there ineffective process time in the production process?	To assess and identify the ineffective time in each production process of the company.
Distance movement of the workers exists in the production process?	To assess the distance movement of the workers throughout their working hours.
Absenteeism of the workers exist in the company?	To know the causes of the absenteeism of the workers
Do employers have a good working interest in the company production process?	To assess the level of the employer's motivation on the company productivity.
Is there multi-operation by a single operator?	Assess the types of operation operated/worked by a single worker.
Is there waiting time due to unbalance of each consecutive process/operation, machine break down, or bottleneck in the process?	To assess and identify the operation which has more waiting and affects the next operation in the production process.

Table 38 A- 2: Interested and selected respondents

Section	Total labor	Interested
Cutting	25	17
Stitching	53	39
Lasting and finishing	52	40
Total respondents		96

Table 39 A-3: Analyzed questioners' data

Questions	Res pons es	Cutting Section		Stitching Section		Lasting finishing Section &	
		Frequ ency	Perce ntage	Frequ ency	Perce ntage	Frequ ency	Percentage
Is there a supply-demand gap on the product?	YES	12	71%	24	61.5%	25	62.5%
	NO	5	29%	15	38.5%	15	37.5%
Did the customer satisfaction for the company product?	YES	9	53%	27	69%	31	77.5%
	NO	8	47%	12	31%	9	22.5%
The current amount of the finished product on the market is enough?	YES	4	24%	13	33%	9	22.5%
	NO	13	76%	26	67%	31	77.5%
Do you know factors that affect the productivity of the company?	YES	3	18%	11	28%	8	20%
	NO	14	82%	28	72%	32	80%
Are there repetitive motion tasks?	YES	15	88%	29	74%	22	55%
	NO	2	12%	10	26%	18	45%
Is there ineffective process time in the production process?	YES	13	76%	24	61.5%	24	60%
	NO	4	24%	15	38.5%	16	40%
Distance movement of the workers exists in the production process?	YES	14	82%	22	56%	21	52.5%
	NO	3	18%	17	44%	19	47.5%
Absenteeism of the workers exist in the company?	YES	11	65%	28	72%	26	65%
	NO	6	35%	11	28%	14	35%
Do employers have a good working interest in the company production process?	YES	7	41%	13	33%	8	20%
	NO	10	59%	26	67%	32	80%
Is there multi-operation by a single operator?	YES	12	71%	22	56%	23	59%
	NO	5	29%	18	46%	17	41%
Is there waiting time due to unbalance of each consecutive process/operation, improper process flow, unbalanced labour, machine break down, or bottleneck in the process?	YES	12	70.5%	24	61.5%	23	57.5%
	NO	5	29.5%	15	38.5%	17	42.5%

Table 40 A -4: Identified major existed problems

Major problems	Cutting Section	Stitching Section	Lasting Section
Repetitive motion tasks	88%	74%	55%
Ineffective process time	76%	61.5%	60%
Distance movement	82%	56%	52.5%
Absenteeism	65%	72%	65%
Less working interest (motivation)	59%	67%	80%
Multi operation by a single operator	71%	56%	59%
waiting time due to unbalance of each consecutive process/operations, unbalanced labour, improper flow process, machine break down, or bottleneck in the process	70.5%	61.5%	57.5%

### Appendix B: Major competitors output per year

Table 41 B-1: Major competitors finished shoe analyzed data

Major Competitors	Averagely Produced/ year	Output per labour per year
Kangaroo shoe factory	158,400 pair	3,046
Ras Dashen shoe factory	172,800 pair	3323
Wallia shoe factory	164,160 pair	3,156
Anbessa SSC	127,680 pair	2,455

Collected from production and marketing department of each company recorded in 2012 E.C

### Appendix C: Analysed output data per year of ASSC

Table 42C-1: Analyzed data of plan and actual product output

Sections plan & Actual output		Output per year in pairs		
		2010 E.C	2011E.C	2012E.C
Cutting	Plan	216,000	216,000	216,000
	Actual	152,640	158,400	141,120
Stitching	Plan	201,600	201,600	201,600
	Actual	118,080	120,960	112,320
Lasting & finishing	Plan	201,600	201,600	201,600
	Actual	129,600	135,360	118,080

Reported data from production department of ASSC, 2012 E.C.

## Appendix D: Overall recorded and analyzed time of each section.

Table 43D-1: Cutting section

Operations	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Av.OT(sec)	PR	NT(sec)= OT*PR	AF= NT*22%	ST(sec)= NT+AF	ST (min)	O/P(min)	number labor	CT(ST/LB)sec
upper raw material preparation	48	47	47	49	48	49	47	48	49	48	48.0	92.0%	44.16	9.72	53.88	0.90	534.57	1	53.875
pre-cutting operation	54	56	55	55	55	56	54	54	56	57	55.2	92.0%	50.78	11.17	61.96	1.03	929.68	2	30.978
back box skiving	37	39	37	38	38	39	36	38	38	40	38.0	92.0%	34.96	7.69	42.65	0.71	1350.49	2	21.326
stamping	54	54	56	55	55	56	54	55	55	56	55.0	92.0%	50.60	11.13	61.73	1.03	933.07	2	30.866
Upper collect	38	37	39	38	38	38	37	38	39	39	38.1	92.0%	35.05	7.71	42.76	0.71	673.47	1	42.763
upper arrange and dispatch	56	58	57	60	59	58	56	59	58	59	58.0	92.0%	53.36	11.74	65.10	1.08	884.80	2	32.550
insole material preparation	29	29	30	30	31	31	29	30	30	32	30.1	92.0%	27.69	6.09	33.78	0.56	852.47	1	33.784
cutting texn board	29	28	31	30	31	31	30	29	30	31	30.0	92.0%	27.60	6.07	33.67	0.56	855.31	1	33.672
cutting shank board	28	28	30	29	30	31	28	29	30	29	29.2	92.0%	26.86	5.91	32.77	0.55	878.74	1	32.774
shank grooving	27	27	29	28	29	29	27	29	28	29	28.2	92.0%	25.94	5.71	31.65	0.53	909.90	1	31.652
shank skiving	31	30	32	31	32	32	31	31	31	32	31.3	92.0%	28.80	6.34	35.13	0.59	819.79	1	35.131
attaching shank	24	25	27	26	26	26	24	26	27	26	25.7	92.0%	23.64	5.20	28.85	0.48	998.42	1	28.846
apply glue	31	30	30	32	31	32	31	30	32	31	31.0	92.0%	28.52	6.27	34.79	0.58	827.72	1	34.794
molding	28	28	29	30	29	29	29	28	28	30	28.8	92.0%	26.50	5.83	32.33	0.54	890.95	1	32.325
beveling	24	25	24	26	26	27	24	26	25	26	25.3	92.0%	23.28	5.12	28.40	0.47	2028.40	2	14.198
Insole collect	44	44	44	45	46	46	43	44	46	46	44.8	92.0%	41.22	9.07	50.28	0.84	1145.50	2	25.142
insole arrange and dispatch	35	35	37	36	36	36	35	35	36	37	35.8	92.0%	32.94	7.25	40.18	0.67	716.74	1	40.182
count and overall dispatch	28	29	27	28	28	30	27	29	28	26	28.0	92.0%	25.76	5.67	31.43	0.52	916.40	1	31.427
overall inspection	35	34	35	36	36	36	36	34	35	36	35.3	92.0%	32.48	7.14	39.62	0.66	726.89	1	39.621
													640.136	140.82992	780.97	13.02	940.70	25	625.906

Table 44D - 2: stitching section

Operations	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	AV.OT	PR	NT = OT*PR	AF= NT*22%	ST= NT+AF	O/P inpair	labor	CT=ST/labor	
loading	57	56	56	57	57	58	56	56	57	58	56.8	0.87	49.416	10.87	60.288	477.71	1	60.288	
marking	71	70	71	71	72	71	69	71	72	72	71	0.87	61.77	13.59	75.359	382.17	1	75.359	
skiving and quarter lining	55	55	57	56	57	57	55	55	57	57	56.1	0.87	48.807	10.74	59.545	483.67	1	59.545	
attach nylon and reinforcement	51	51	53	52	53	52	53	52	53	54	52.4	0.87	45.588	10.03	55.617	1035.65	2	27.809	
attach textile adhesive	31	33	32	32	33	33	31	32	32	33	32.2	0.87	28.014	6.16	34.177	1685.34	2	17.089	
decorative stitch on quarter	45	46	47	47	47	48	46	46	47	48	46.7	0.87	40.629	8.94	49.567	1162.05	2	24.784	
stitch back count lining	42	42	44	44	45	44	43	42	45	44	43.5	0.87	37.845	8.33	46.171	1247.54	2	23.085	
stitch mudguard lining and counter	35	34	36	36	37	36	34	35	37	36	35.6	0.87	30.972	6.81	37.786	762.19	1	37.786	
apply glue and attach apron	74	75	75	77	76	76	74	75	75	78	75.5	0.87	65.685	14.45	80.136	359.39	1	80.136	
apply glue and attach mudguard	74	74	76	75	76	76	75	74	76	76	75.2	0.87	65.424	14.39	79.817	360.82	1	79.817	
re-cut apron and mudguard	37	36	36	35	38	37	36	35	37	38	36.5	0.87	31.755	6.99	38.741	743.40	1	38.741	
marking mudguard	31	31	30	32	31	32	32	31	30	32	31.2	0.87	27.144	5.97	33.116	869.68	1	33.116	
skiving vamp with its lining	37	36	38	37	39	38	36	37	39	38	37.5	0.87	32.625	7.18	39.803	723.57	1	39.803	
stitch mudguard with mudguard lining	27	27	28	29	28	28	29	29	28	30	28.3	0.87	24.621	5.42	30.038	1917.60	2	15.019	
stitch apron with its lining	30	30	31	31	32	32	31	30	31	32	31	0.87	26.97	5.93	32.903	875.29	1	32.903	
apply glue and attach back count	74	74	76	75	76	76	74	75	75	76	75.1	0.87	65.337	14.37	79.711	361.30	1	79.711	
stitch back count with quarter	31	30	31	32	32	33	31	32	31	32	31.5	0.87	27.405	6.03	33.434	861.40	1	33.434	
stitch complete quarter and quarter lining	53	55	55	54	56	57	54	54	55	57	55	0.87	47.85	10.53	58.377	493.34	1	58.377	
insert collar foam by applying glue	48	48	51	50	51	51	48	49	51	51	49.8	0.87	43.326	9.53	52.858	544.86	1	52.858	
turning	50	50	52	52	52	53	51	50	52	53	51.5	0.87	44.805	9.86	54.662	1053.75	2	27.331	
hammering around collar	29	31	30	32	32	32	29	31	32	32	31	0.87	26.97	5.93	32.903	1750.58	2	16.452	
in process quality inspection	29	29	31	30	32	32	30	29	31	32	30.5	0.87	26.535	5.84	32.373	889.64	1	32.373	
stitch around eye stay and collar	54	55	54	57	56	58	56	55	55	57	55.7	0.87	48.459	10.66	59.120	974.29	2	29.560	
trimming around eye stay and apron	35	37	35	36	37	37	35	36	36	38	36.2	0.87	31.494	6.93	38.423	1499.11	2	19.211	
skiving 45 degree for mudguard	34	34	36	35	35	36	35	34	36	35	35	0.87	30.45	6.70	37.149	1550.51	2	18.575	
punch eyelet place	54	53	55	57	55	56	54	55	55	57	55.1	0.87	47.937	10.55	58.483	492.45	1	58.483	
apply glue and attach quarter	73	75	74	76	76	76	75	74	76	75	75	0.87	65.25	14.36	79.605	361.79	1	79.605	
stitch quarter over mudguard	43	44	44	43	45	44	43	44	44	45	43.9	0.87	38.193	8.40	46.595	1854.26	3	15.532	
trimming around quarter lining	32	34	35	33	34	36	32	34	35	35	34	0.87	29.58	6.51	36.088	798.06	1	36.088	
stitch quarter lining bottom	33	31	32	32	30	34	32	31	32	33	32	0.87	27.84	6.12	33.965	847.94	1	33.965	
punch closed hole	37	39	41	40	38	39	37	39	40	40	39	0.87	33.93	7.46	41.395	695.74	1	41.395	
insert counter stiffener by applying glue	40	40	42	41	42	42	40	41	42	42	41.2	0.87	35.844	7.89	43.730	1975.77	3	14.577	
cutting and cleaning excess thread	74	75	75	77	76	76	75	75	77	75.6	0.87	65.772	14.47	80.242	358.91	1	80.242		
burning the excess thread	35	34	36	35	35	35	34	35	36	37	35	0.87	30.45	6.70	37.149	775.26	1	37.149	
temporary shoe lacing	34	36	37	37	36	36	36	36	35	37	36	0.87	31.32	6.89	38.210	753.72	1	38.210	
final QC	35	35	37	36	37	37	36	35	37	37	36.2	0.87	31.494	6.93	38.423	749.56	1	38.423	
Collect and arranging pairwise	35	36	35	36	37	37	36	36	35	37	36	0.87	31.32	6.89	38.210	2261.16	3	12.737	
Total																	945.66	53	1499.56

Table 45D -3: Lasting and finishing section

Operations	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	AV.OT	PR	NT (sec)= OT*P	AF(sec)= NT*21%	ST = NT+AF	O/P /day	labor	CT(sec)
last loading and insole	58	60	59	62	62	62	60	60	59	63	60.5	87%	52.635	11.05	63.69	1356.61	3	21.229
last cleaning	29	29	31	32	31	32	30	29	31	32	30.6	87%	26.622	5.59	32.21	894.06	1	32.213
loading upper, toe cap steel	54	55	55	57	56	57	56	55	55	56	55.6	87%	48.372	10.16	58.53	984.11	2	29.265
roughing around center of out sole	37	36	37	37	38	37	37	36	37	38	37	87%	32.19	6.76	38.95	739.41	1	38.950
out sole cleaning	35	35	36	36	37	37	36	35	36	37	36	87%	31.32	6.58	37.90	759.95	1	37.897
attaching insole on last	29	30	29	31	31	32	30	31	30	31	30.4	87%	26.448	5.55	32.00	899.94	1	32.002
back part molding	55	54	54	55	57	56	56	54	57	55	55.3	87%	48.111	10.10	58.21	494.72	1	58.214
insert to steam	36	37	36	38	37	38	36	37	37	38	37	87%	32.19	6.76	38.95	739.41	1	38.950
insert last and side closing	66	65	65	66	67	67	66	65	67	66	66	87%	57.42	12.06	69.48	414.52	1	69.478
apply glue on sides of the upper	35	37	36	35	37	37	35	37	36	37	36.2	87%	31.494	6.61	38.11	755.75	1	38.108
insert to steam	54	56	55	56	56	56	55	56	55	56	55.5	87%	48.285	10.14	58.42	985.88	2	29.212
creaming on upper and inserting in heat tunnel	59	58	61	61	62	63	60	60	62	61	60.7	87%	52.809	11.09	63.90	901.42	2	31.949
pounding	30	31	30	30	31	31	30	31	30	31	30.5	87%	26.535	5.57	32.11	896.99	1	32.107
in process quality inspection	34	36	35	35	36	36	35	36	35	37	35.5	87%	30.885	6.49	37.37	770.65	1	37.371
first level upper roughing	33	33	34	35	35	35	35	33	34	35	34.2	87%	29.754	6.25	36.00	799.95	1	36.002
second level upper roughing	36	35	38	37	37	38	36	36	38	37	36.8	87%	32.016	6.72	38.74	743.43	1	38.739
first adhesive coating on upper	64	65	65	66	65	66	65	64	65	67	65.2	87%	56.724	11.91	68.64	419.60	1	68.636
first adhesive coating on out sole	36	36	37	38	37	38	37	36	37	38	37	87%	32.19	6.76	38.95	739.41	1	38.950
second adhesive coating on upper and sole	33	36	34	35	37	37	35	36	35	35	35.3	87%	30.711	6.45	37.16	775.02	1	37.160
sole and upper dryer	32	32	33	34	34	36	33	32	34	35	33.5	87%	29.145	6.12	35.27	816.66	1	35.265
sole and upper re-activator	34	35	35	34	36	36	34	35	35	36	35	87%	30.45	6.39	36.84	1563.33	2	18.422
attachin sole with upper	61	60	61	61	63	62	61	60	62	62	61.3	87%	53.331	11.20	64.53	446.30	1	64.531
attachin sole with upper and pressing	101	100	101	101	102	102	100	99	100	102	100.8	87%	87.696	18.42	106.11	542.82	2	53.056
remove temporary shoe lacing	36	35	35	37	36	35	37	36	37	37	36.1	87%	31.407	6.60	38.00	1515.69	2	19.001
de-lasting	44	43	46	45	44	45	46	46	43	44	44.6	87%	38.802	8.15	46.95	613.41	1	46.950
cleaning excess glue	66	66	67	65	67	68	66	64	65	68	66.2	87%	57.594	12.09	69.69	1239.80	3	23.230
ironing to remove wrinkle	59	61	60	61	58	59	61	62	58	61	60	87%	52.2	10.96	63.16	911.94	2	31.581
painting on over rough place	35	34	35	35	35	36	35	34	36	35	35	87%	30.45	6.39	36.84	1563.33	2	18.422
apply cream on upper	32	31	31	33	32	32	31	33	31	31	31.8	87%	27.666	5.81	33.48	860.32	1	33.476
apply glue and insert sock lining	45	45	46	45	46	46	46	45	46	45	45.5	87%	39.585	8.31	47.90	1202.56	2	23.949
shoe lacing	65	66	65	67	66	67	65	66	65	68	66	87%	57.42	12.06	69.48	414.52	1	69.478
inserting tissue paper	61	61	60	62	61	61	62	59	62	61	61	87%	53.07	11.14	64.21	1345.49	3	21.405
final brushing for shine	36	35	35	37	34	36	35	34	37	35	35.4	87%	30.798	6.47	37.27	1545.66	2	18.633
final quality inspection	40	40	42	41	42	42	41	40	42	42	41.2	87%	35.844	7.53	43.37	664.03	1	43.371
arrangement and pack	35	36	36	37	36	36	36	35	36	37	36	87%	31.32	6.58	37.90	1519.90	2	18.949
															1710.32	909.62	52.00	1286.15