Faculty of Engineering
Department of Textile Engineering

THESIS REPORT
ON
EFFECTIVE LINE BALANCING IMPROVING PRODUCTIVITY BY USING METHOD STUDY IN GARMENTS SEWING SECTION.

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Group A

SUPERVISING TEACHER
Md. Selim
Lecturer
Dept. of Textile Engineering
SONARGAON UNIVERSITY (SU)

Students Name	Students ID.
Kazi Ahadul Islam	Tex-1703012050
Md Al-Arafat Sabuj	Tex-1703012058
Muhammad Rahat	Tex-1703012059
Md. Asaduzzaman	Tex-1703012060
Md. Mehedi Hasan	Tex-1703012131

Submitted date: 13-03-2021

APPROVAL

Certificate that the thesis entitled "**Effective Line Balancing Improving Productivity by using Method Study in Garments Sewing Section**" is the new work carried out by **MD. ASADUZZAMAN** & his team members under our supervision and that they have fulfilled the conditions laid down in Sonargaon University (SU).

The materials included in this **Thesis** paper are the original **Thesis** work. The thesis contains no material previously published or written by another person except when due reference is make in the text of the thesis. The thesis may be considered for the degree of Bachelor of Science in Textile Engineering.

SUBMITTED TO

Supervisor

MD. SALIM

Lecturer

Department of Textile Engineering

Sonargaon University(SU)

SUBMITTED BY

Kazi Ahadul Islam
IDNo: TEX 1703012050

Md Al-Arafat Sabuj
ID No: TEX 1703012058

Muhammad Rahat
ID No: TEX 1703012059

MD. ASADUZZAMAN
ID No: TEX 1703012060

Md. MehediHasan
ID No: TEX 1703012131

DECLARATION

We hereby declare that the thesis work entitled "**Effective Line Balancing Improving Productivity by using Method Study in Garments Sewing Section**" Submitted for the **Thesis**work is our original work and the **Thesis** has not formed the basis for the award of any degree, associate ship, fellowship or any other similar titles.

Supervisor

MD. SELIM
Lecturer Department of Textile Engineering
Sonargaon University (SU)

Dedicated to

Ours Respectable Teachers

&

Parents

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MD. ASADUZZAMAN
ID No: TEX 1703012060
Department of Textile Engineering.
Sonargaon University (SU)

ABSTRACT

This thesis is based on “Effective Line Balancing Improving Productivity by using Method Study in Garments Sewing Section” through work sharing method. The objective is the increase the production by allocating work equally by removing bottleneck process. The standard minute value is calculated for every work station of a production line. Then the bottleneck process is marked and eliminated by work sharing method. No further machine allocation or new layout is needed in this method only the mobile worker or helper is used to transfer the material to the balancing work station. The table of efficiency is given before and after the balancing process to show the increase in productivity. The actual capacity and balanced capacity is shown comparing with the benchmark capacity. In this project work the productivity is improved after balancing and the efficiency and productivity is shown in the result section.

List of abbreviations

SAM: Standard Allowed Minute

ASO: Assistant Sewing Operator

AQL: Acceptable Quality Level

P/M: Plain lockstitch Machine

O/L: Over Lock machine

F/L: Flat Lock machine

T/S: Top Seam

FOA: Feed of the Arm

B/T: Bar Tack

WIP: Work In Progress

PMTS: Predetermined Motion and Time Study

SMV: Standard Minute Value

ALB: Assembly Line Balancing

MATLAB: MATrixLABoratory

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CHAPTER-ONE
GENERAL INTRODUCTION

1.1 General Introduction

Fig 1.1: Basic T-shirt

A **T-shirt** (or **T shirt**, **tee-shirt**, or **tee**) is a style of shirt. A T-shirt's defining characteristic isthe T shape made with the body and sleeves. It is normally associated with short sleeves, around neck line known as a "crew neck", and no collar.

Typically made of cotton fibers knitted in a jersey stitch, they have a distinctive soft texturecompared to woven shirts. The majority of modern versions have a body made from acontinuously woven tube, on a circular loom, so that the torso has no side seams. Themanufacture of T-shirts has become highly automated, and may include fabric cutting bylaser or water jet.

The T-shirt evolved from undergarments used in the 19th century, through cutting the onepiece"union suit" underwear into separate top and bottom garments, with the top longenough to tuck under the waistband of the bottoms. With and without buttons, they wereadopted by miners and stevedores during the late 19th century as a convenient covering forhot environments.

As slip-on garments without buttons, they originally became popular in the United Stateswhen they were issued by the U.S. Navy during or following the Spanish–American War of1898. These were a crew-necked, short-sleeved, white cotton undershirt to be worn under auniform. It became common for sailors and Marines in work parties, the early submarines,and tropical climates to remove their uniform "jacket", wearing (and soiling) only theundershirt.

They soon became popular as a bottom layer of clothing for workers in various industries,including agriculture. The T-shirt was easily fitted, easily cleaned, and in expensive and forthose reasons it became the shirt of choice for young boys. Boys' shirts were made in variouscolors and patterns. By the Great Depression, the T-shirt was often the default garment to

beworn when doing farm or ranch chores, as well as other times when modesty called for atorso covering but conditions called for light weight.
A V-neck T-shirt has a V-shaped neckline, as opposed to the round neckline of the morecommon crew neck shirt. V-necks were introduced so that the neckline of the shirt does notstand out when an outer shirt is worn over it, thus reducing or eliminating the visible clothabove the outer shirt of a crew neck shirt.

The ready-made garment (RMG) sector is the life-blood of Bangladesh economy achievinghigher export growth every year. The sector is now the largest contributor not only tooverseas trade but also to the national economy.

Bangladesh textiles and RMG industry comprises 1,55,557 units – 1,48,000 handlooms units, 3,284 mechanized primary textile units, 5150 export-oriented readymade garmentsmanufacturing units and 273 garments washing-dyeing units. The sector is a major foreignexchange earner for Bangladesh contributing 77 percent to the country's net exports. At theend of the fiscal year 2011, total export of Bangladesh garments was worth US$ 23 billion, a43 percent increase over the previous year, accounting for almost 25 percent of the GDP(gross domestic product).

A growing number of chief purchasing officers (CPOs) in European and apparel companiesare scrutinizing their sourcing strategies, as margin and supplier capacity pressure buildingover the last several years has caused them to search for the next performance improvementopportunity.

While China is starting to lose its attractiveness in this realm, the sourcing caravan is movingon to the next hot spot. With Bangladesh having developed a strong position amongEuropeans and US buyers, many companies are already eager evaluate the future potential.
However, the lure of competitive prices, available capacities and suppliers capacities offeredis being cautiously weighed against a prevailing insecurity created by the challenges inherentin Bangladesh’s Ready-Made Garments (RMG) market.

Today’s business climate for clothing manufacturers requires low inventory and quickresponse systems that turn out a wide variety of products to meet customers demand. It isespecially in the apparel industry that managers are trying to develop their current systems orlooking for new production techniques in order to keep pace with the rapid changes in thefashion industry.
Therefore, to develop a new system, good observation is needed. However to observe real manufacturing systems is very expensive and sometimes cumber some. The rapid rate at which the whole process takes place, the interaction between workers and the different transition times between workers make it increasingly more difficult for a human being to make correct decisions regarding how fast each operator should work in order to continue the process, while at the same time keeping productivity high and through put at an acceptable level. Construction of a quality garment requires a great deal of know-how, a lot of co-ordination and schedule management. Clothing manufacturing consists of a variety of product categories, materials and styling. Dealing with constantly changing styles and consumerdemands is so difficult. Furthermore, to adapt automation for the clothing system is also sohard because, beside the complex structure also it is labor intensive. Therefore, garmentproduction needs properly rationalized manufacturing technology, management and planning.

In garment production, until garment components are gathered into a finished garment,they are assembled through a sub-assembly process. The production process includes a set ofworkstations, at each of which a specific task is carried out in a restricted sequence, withhundreds of employees and thousands of bundles of sub-assemblies producing different stylessimultaneously. The joining together of components, known as the sewing process whichis the most labor intensive part of garment manufacturing, makes the structure complex as thesome works has a priority before being assembled .

Furthermore, since sewing process is labor intensive; apart from material costs, the coststructure of the sewing process is also important. Therefore, this process is of criticalimportance and needs to be planned more carefully. As a consequence, good linebalancing with small stocks in the sewing line has to be drawn up to increase the efficiencyand quality of production. An assembly line is defined as a set of distinct tasks which isassigned to a set of workstations linked together by a transport mechanism under detailedassembling sequences specifying how the assembling process flows from one station toanother. In assembly line balancing, allocation of jobs to machines is based on the objectiveof minimizing the workflow among the operators, reducing the throughput time as well as thework in progress and thus increasing the productivity. Sharing a job of work between severalpeople is called division of labor. Division of labor should be balanced equally by ensuringthe time spent at each station approximately the same. Each individual step in the assembly of product has to be analyzed carefully, and allocated to stations in a balanced way over theavailable workstations. Each operator then carries out operations properly and the work follows synchronized. In a detailed work flow, synchronized line includes short distances betweenstations, low volume of work in process, precise of planning of production times, and predictable production quantity.
Overall, the important criteria in garment production is whether assembly work will befinished on time for delivery, how machines and employees are being utilized, whether anystation in the assembly line is lagging behind the schedule and how the assembly line is doingoverall. To achieve this approach, work-time study, assembly line balancing andsimulation can be applied to apparel production line to find alternative solutions to increasethe efficiency of the sewing line. Since the late 1970s, the RMG industry started developing in Bangladesh primarily as anexport-oriented industry and the domestic market for RMG has been increasing fast due toincrease in personal disposable income and change in life style. The sector rapidly attainedhigh importance in terms of employment, foreign exchange earnings and its contribution toGDP. Since buyer comes to this region for the lowest labor price ($0.11 per shirt for
Bangladesh, $0.26 for India, $0.79 for Srilanka, the quality of the garments, efficiency andproductivity of Bangladesh RMG sector remain ignored even in the tough competitivemarket. Factories in Srilanka operate at 80% - 90% of efficiency, whereas in Bangladesh,according to some experts, productivity is between 35% and 55% of efficiency with very fewexceptions. For the RMG sector in Bangladesh, productivity alone can make a differencebetween life and death.

1.2 HISTORY OF T-SHIRT

Although the T-shirt is a staple piece of outerwear today for both genders, it originally startedout as an undergarment for men. Since then, it has undergone many transformations – fromthe tie-dyed, baggy tee to the tight fitting tank top. Additionally, the overall length, cut,fabric, and printing methods also continue to advance. Ironically, people now wear undergarments,like sports bras, underneath their T-shirts, despite the fact that it was onceused for the same purpose. After one hundred years of evolution, the appearance of the T-shirt is still constantly changing.

Early Days

The first form that the T-shirt took was called a union suit. It originated out of New York, andit was a very basic one-piece garment that was white in color and buttoned up the front. Oncethe style of long underwear started to gain popularity, the P.H. Hanes Knitting Company soonfollowed suit and released their own version in 1902; it was a two-piece men's undergarmentthat looked similar to the union suit, but lacked its length. Eventually, in 1938, which was thesame year that Nylon became popular, Sears finally introduced their own T-shirt called the"gob" shirt. It sold for 24 cents.

1950's - How the T-shirt Became Cool

Just like the Hanes Company saw potential in the union suit, Hollywood also quickly pickedup on the emerging trend. For example, James Dean's role in "Rebel Without a Cause," andMarlon Brando's acting in "A Streetcar Named Desire," only fortified the T-shirt's growingfollowing. In 1948, Governor Thomas E. Dewey's slogan was, "Dew-IT with Dewey," whichwas quickly printed on promotional T-shirts for the duration of the presidential campaign.
The Smithsonian Institute still displays the 1948 campaign shirt, and it continues to hold therecord as the oldest T-shirt with a printed slogan.

1960's - Tie-Dye and Slogans

During the 1960's, better known as the psychedelic generation, the T-shirt evolved yet again - especially whenplastic salt was invented. This was a revolutionary new type of ink that wasperfect for the daily wear and tear that most T-shirts were expected to withstand; now the inkwas durable enough to last alongside the fabric of the shirt. During this decade, bright colorsand tie-dyed patterns were very popular, and clothing was often used as a catalyst for selfexpression. For instance, anti-war slogan opposing Vietnam were often featured on shirts,along with company logos and other types of pictures. In fact, even famous music legends,like Janis Joplin and Jimi Hendrix, used to wear shirts inked with slogans and tie-dyedpatterns!

1970s and 80s - Pop Culture

During the 70's and 80's, custom T-shirts continued to grow in popularity. In turn, this meantthat methods of mass production became necessary, along with new methods of printing, likelitho-transfer. For instance, malls became a commonplace to have a custom T-shirt printed onthe spot, and corporations, along with many rock bands, started to realize how powerful T-shirtswere in terms of sales and branding. One of the most important innovations of this erawas the wrinkle-free T-shirt, which was made out of a mix of polyester and cotton.

Present Day -The Internet and Customization

Today, T-shirts still remain an integral part of the fashion industry, where they are worn inmany different styles, colors, and fabrics. People regularly have shirts custom made for adultand adolescent athletic teams, company use, self expression and as a branding tool. One ofthe most defining characteristics of the modern day T-shirt is that it can be printed almostinstantly on demand. People can custom print any type of shirt they like, with almost anykind of image, slogan or color imaginable, as long as they have access to the Internet.

Most Popular T-Shirts

Three of the most popular T-shirts that have consistently sold well and retained theirpopularity include ones with Disney characters, the Coca-Cola logo, and album art from theBeatles. Despite having started off as an undergarment, society now enjoys them as bothunder and outer pieces of clothing. In fact, they're even layered occasionally to create a trulycustom appearance for the wearer. People from many different generations wear them for casual and dress occasions, and they still continue to drastically evolve away from the onepiecelong underwear that they originated from. One of the most startling examples is thetube top. However, like its 1960's cousin, the modern day T-shirt is still a channel for self expression, artistic license and protesting political movements.

Iconic moments in the history of the T-shirt

Ever since 1913 when the T-shirt was first included as standard-issue gear in the U.S. Navy,the short-sleeved crew neck has become an essential part of the American wardrobe. Not longafter the Navy, the Army followed suit, paving the way for the T-shirt to become the go-totop for dockworkers, farmers, miners and other workers who appreciated the comfortablelightweight cotton and short sleeves. By the 1920s “T-shirt” became an official American-English word in the Merriam-Webster dictionary.
In the 100 years of its history, the T-shirt has grown up from a workwear staple to one of themost flexible garments known to mankind, an article of simple clothing that can be found injust about any clothing store for anywhere from a few dollars to a few hundred. Or a fewthousand? Indeed, last year French fashion house Hermes debuted a crocodile T-shirt with thenot-so-humble price tag of $91,500, illustrating just how far the T-shirt has come.
In celebration of the beloved classic's centennial, here are some of the more memorablemoments that mark its 100 years. Happy birthday, T-shirt!

1913: The launch

Submariners, often working in close and hot quarters, are issued T-shirts and are able to workin comfort, instead of restrictive clothing and itchy wool.

1944: Undershirt as unofficial uniform

The T-shirt is adopted as the unofficial uniform of workers across the board, from mechanicsand miners to farmers and factory workers. Here, the T-shirt as worn by a U.S. Merchant Marine oiler.

1951: The Hollywood debut

The T-shirt goes sexy when hunky Marlon Brando does it justice in "A Streetcar NamedDesire." Teens go nuts for the look, and by year's end, T-shirt sales total $180 million.

1955: Rebel chic is born

James Dean follows up on the sexy T-shirt trend in "Rebel Without a Cause."

1950s: Print happens

Miami companyTropic Togs acquires exclusive rights from Disney to print images of Mickey Mouse and pals (as well as Florida resort names) on T-shirts to promote tourism andthe Disney brand and thus, the advertising T-shirt is born.

1960s: The rock T blossoms

Album artwork like the "tongue and lips" design for The Rolling Stones, the prism design for Pink Floyd, and Grateful Dead cover art by Stanley Mouse, are emblazoned across rock andconcert T-shirts as the screen printing industry evolves.

1967: Message shirts become wearable placards

The T-shirt goes pop art and political when Warren Dayton pioneers art T-shirts featuringimages of Cesar Chavez, the Statue of Liberty, polluted lungs and other political and comicimages.

1969: Ta-da, tie-dye!

Rit dye advertising genius Don Price markets the waning-in-popularity dye as way to turnmundane shirts into psychedelic tie-dye masterpieces. Price arranges for hundreds of tie-dyedshirts to be made and distributed to attendees and performers at Woodstock in 1969, clinching the tie-dyed T-shirt's place in the hippie movement — and boosting Rit company profits at the same time.

1970s: The ironic T-shirt is formalized

The tuxedo T-shirt. Well, there's really just no explanation...

1977: The world hearts T-shirts

Advertising agency Wells Rich Greene is hired to develop a marketing campaign for New York state. Graphic designer Milton Glaser comes up with a logo including the letter "I"followed by a heart symbol and the state abbreviation. The logo is quickly adopted bysouvenir T-shirt makers, taking tourists by storm and initiating hordes of imitators.

1984: What happened in Miami, didn't stay in Miami

The T-shirt goes designer in the oh-so-1980s when Sonny Crockett (Don Johnson) sports a T-shirtas part of an ever-changing, candy-colored wardrobe on the television series "MiamiVice." The look, replete with rolled-up jacket sleeves and slip-on sockless loafers, takes offlike wildfire. To this day, the T-shirt-and-jacket combo persists.

2000s: Meme mania

The "Three Wolf Moon" T-shirt becomes an Internet sensation thanks to a humorous Amazonreview, which then spawns thousands of likewise comedic comments. Sales go through theroof for the shirt's creator, The Mountain T-shirt company, the same company responsible forthe "Big Face" animal T-shirts, which are vying for an iconic moment of their own.

2012: The message becomes the media

Although still in prototype mode, the world’s first programmable T-shirt, t-shirtOS, is acollaboration between Ballantine’s and wearable tech company CuteCircuit. Forget those oldscreen-printed classics; this high-tech T boasts an LCD screen that lets you display Facebookstatuses, tweets and even Instagram snaps.

1.3 OBJECTIVES OF THE THESIS

- To Evaluating calculate the SMV of T- shirt.
- To determine the line balancing.
- To determine operational sequence of the manufacturing process of T-shirt
- To compare the production by different type of use method study.
- To make better utilization of man, machine and materials.
- To analysis the Production, SMV, Man, Line Target, Labor Productivity & Efficiency.

CHAPTER-TOW

LITERATURE REVIEW

2.1 Overview of line balancing

From ancient times to the modern day, the concept of assembly has naturally been changed a lot. The most important milestone in assembly is the invention of assembly lines. In 1913, Henry Ford completely changed the general concept of assembly by introducing assembly lines in automobile manufacturing for the first time. He was the first to introduce a moving belt in a factory, where the workers were able to build the famous model-T cars, one piece at a time instead of one car at a time. Since then, the assembly lines concept revolutionized the way products were made while reducing the cost of production. Over the years, the design of efficient assembly lines received considerable attention from both companies and academicians. It had been found from that a well-known assembly design problem is assembly line balancing, which deals with the allocation of the tasks among workstations so that a given objective function is optimized‟. Assembly line balancing has been a focus of interest to academics in operation management for the last four decades. Mass production has saved huge costs for manufacturers in various industries for some time. NoorulHaq et al. (2005) stated that „mixed-model assembly lines are increasing in many industrial environments which deals with mixed-model assembly line balancing for n models, and uses a classical genetic algorithm approach to minimize the number of workstations‟. Scholl et al. (2006) found that „assembly line balancing problems arise whenever an assembly line is configured, redesigned or adjusted‟ [1].

An assembly line balancing problems consists of distributing the total workload for manufacturing any unit of the products to be assembled among the work stations along the line. The sequence-dependent assembly line balancing problem is an extension of the standard simple assembly line balancing problem which has significant relevance in real-world assembly line settings. Kara et al. (2006) suggested that „a successful implementation of a mixed-model U-line requires solutions for balancing and sequencing problems. The study proposes an approach for simultaneously solving the balancing and sequencing problems of mixed-model U-lines‟. The primary goal of the proposed approach is to minimize the number of workstations required on the line [2].

To meet this aim, the proposed approach uses such a methodology that enables the minimization of the absolute deviation of workloads among workstations as well. In terms of minimizing the number of workstations required on the mixed-model U-line, as well as minimizing the absolute deviation of workloads among workstations, the proposed approach is the first method in the literature dealing with the balancing and sequencing problems of mixed-model U-lines. The newly developed neighborhood generation method employed in the simulated annealing method is another significant feature of the proposed approach. Scholl et al. (2009) stated as „sequence-dependent assembly line balancing problem consist of distributing the total workload for manufacturing any unit of the products to be assembled among the work stations along a manufacturing line as used in the automotive or the electronics industries‟ [3].

Usually, it is assumed that the production process is fixed, i.e. has been determined in a preceding planning step. However, this sequential planning approach is often suboptimal because the efficiency of the production process cannot be evaluated definitely without knowing the distribution of work. Özcan and Toklu (2008) proposed „a new hybrid improvement heuristic approach to simple straight and U-type sequence-dependent assembly line balancing problem which is based on the idea of adaptive learning approach and sequence-dependent assembly‟. The proposed approach uses a weight parameter to perturb task priorities of a solution to obtain improved solutions. The weight parameters are then modified using a learning strategy [4].

The maximization of line efficiency i.e. the minimization of the number of stations and the equalization of workload among stations i.e. the minimization of the smoothness index or the minimization of the variation of workloads are considered as the performance criteria. Kilincci and Bayhan (2006) found that „simple assembly line balancing problem of type-1 aims to minimize the number of workstations for a given cycle time‟. In the relevant literature, several heuristics based on a branch-and bound procedure, Tabu search and genetic algorithms were proposed to solve simple assembly line balancing problem. In this paper, an algorithm based on the reachability analysis of Petri nets is developed for simple assembly line balancing problem [5].

The proposed algorithm searches enabled transitions or assignable tasks in the Petri net model of precedence relations between tasks, and then the task minimizing the idle time is assigned to the station under consideration. The algorithm is coded in MATLAB a fourth generation programming language, and its efficiency is tested on Talbot‟s and Hoffmann‟s benchmark datasets according to some performance measures and classifications [6].

2.2 Line balancing

A line is defined as a group of operators under the control of one production supervisor. Balancing is the technique of maintaining the same level of inventory at each and every operation at any point of time to meet the production target and to produce garments of acceptable quality. It is a function of the work study office to provide management with information to help the efficient and productive running of the factory, and part of this information is the process known as line balancing. Line balancing is a vital key in the efficient running of a line [7].

The objective of the process is to balance the workload of each operation to make sure that the flow of work is smooth, that no bottlenecks are created, and that the operators are able to work at peak performance throughout the day. This process is intended to reduce waiting time to a minimum, or in fact with the use of some work in progress to eliminate waiting time completely. The process [7] to balance the line is given below

- In operation breakdown we try to equalize the standard time.
- But still there will be the difference in the standard time which leads to work in progress.
- So, we try to set the flow through each operation to be similar as possible.
- Checking from time to time to see how things are going and then making adjustments to even out the flow again. This process is called balancing.

Needs for line balancing

Line balancing is a basic need for any garments industry. It is done on purpose it is not any unnecessary operation to perform. The need [7] of balancing are given below

- Keeping inventory cost low.
- Enabling better production planning.
- Enabling the supervisor to attend other problems.
- Enabling the operator to work at the optimal pace.
- Balancing line results in on-time shipments, low cost, and ensures reorders.

Goals for balancing

There are many goals [7] of line balancing they are given below

- Meeting production schedule.
- Avoiding the waiting time.
- Minimizing over time.
- Protecting operator earnings.

Rules for balancing

Some small rules are to be followed for balancing the production line; the rules [7] are given below in short

- Having between 3 and 5 bundles of work in process at each operation.
- Solving the problem before they become larger.
- Meeting production goals by keeping every operator working at maximum capacity and make sure he has constant feeding to ensure his capacity is high.

Process to balance the time

The balancing of the time is necessary to balance the line, so the process [7] of balancing the time is to be followed as given in the points here

- Knowing work available at the start of the day.
- Planning transfer needed to compensate for any known absenteeism.
- Checking attendance at the start of the day.
- Making additional assignments to compensate unexpected absentees.
- Making periodic checks during the day to check production.

Points to be noted when making balancing

Some points [7] are to be considered for balancing they are listed below

- Meeting production target by usage of
    - a. Regular operators,
    - b. Utility operators,
    - c. Shuttle operators.
- Work flow should be constant throughout all operations.
- Avoiding over time.
- Determining human resource.
- Checking absence daily.
- Assigning utility shuttle operators based on need.
- Updating daily production every two hours.

2.3 Balanced production system

It is a production line where the line targets are achieved in all the operations with same amount of normal work in process at all workstations, at any point of time in the day [7].

Method to keep all operations producing at the same rate

Methods are proposed or followed to keep the same rate of production, the basic of the method [7] is given here and they are needed to be improvised

- This is very difficult to achieve as the operators skill vary.
- We should balance using utility operators to cover the gaps in production.
- We should keep operators at the expected level of production, or higher if possible.

Process to start balancing the production line

The two processes [7] to start the balancing is given before to perfectly establish balanced lines

- Allocating operators based on the planned efficiency.
- Determining the amount of work in process required to ensuring smooth flow.

Reasons to balance the line

Nothing is done in a factory without a reason, so line balancing has its own reason to perform in the assembly line; the reasons [7] are given below

- To keep inventory cost low results in higher income.
- To keep the normal inventory levels let the operator work consistently.
- To free the supervisors to concentrate on other areas.
- To keep the production cost low will increase the profits, which in turn will make the facility more competitive.

Steps to balance the line

The method of line balancing can vary from factory to factory and depends on the garments manufactured; but at any instance, line balancing concerns itself with two distinct applications: “Opening the line” and “Operating the line” [7].

Opening the line

Opening the line means the operations that are done to obtain a basic of the line or the collection or establishment of a semi balanced line before final balancing. The processes [7] of opening the line are given here

- Calculation of labor requirements.
- Operation breakdown.
- Opening the line Theoretical operation balance.
- Initial balance.
- Balance control.

Operating the line

Operating the line means the successful running of the line to always keep the balance in progress of the production [7].

- Operating the line.

Opening the line and operating the line is significant steps to balance the line for any further production in a single or multiple production lines. Though it varies from different production system the application signifies to balance properly.

Calculation of labor requirement

Before a new style comes onto a line, it is necessary to establish the operation sequence, the time, the type of equipment and the attachments required to manufacture the order. Management must have this information before the commencement of the order, so that the line can be balanced and laid out in such a way as to maximize productivity [7].

There are two methods which can be used to set up a line

Two methods are followed to set up a balanced line; the methods [7] are shortly given below before further advancement

- Method 1 calculating how many operators will be necessary to achieve a given production rate per hour.
- Method 2 Calculating how many garments can be produced by a given number of operators.

One should know the total: work content of garment, standard time, estimated production per day, efficiency of operator.

Pieces per machine = 480 min/SAM.

Labor required = Estimated production per day / pieces per machine

Operation breakdown

Using either technique, there is certain information [7] required before commencing the calculations

- The number of operators in the line.
- Sequential list of operations by method study.
- The standard minute values for each operation.
- Output required form a given group of operators

Addition information required for calculation

Some other information [7] is required for the proper calculation of minute value or the efficiency of the line they are given below

- The size of the group, an operation sequence, the standard time for each operation, the total standard time for the garment
- Type of machine.
- Machine attachments
- Process name/code
- Work aids

2.4 Initial balance

From the skill inventory chart, choosing the right operator whose efficiency matches the target output mentioned in the man/machine chart of theoretical operation balance sheet [8]. Floaters used to balance the time due to absenteeism and imbalance. The method [8] of calculating the line balance is as follows:

- Adding up the operation time for the whole of the style.
- Establishing what percentage each operation is of the total time.
- Working out what the theoretical balance is by using each operations percentage of the total number of operators on the line.
- Rounding the theoretical balance to the nearest half an operators on the line.
- Listing the type of equipment required for each operation at the side of our rounded figure.
- Where we have “half” operators, combine similar equipment to get “full” operators.
- If we have an odd “half” operator, this obviously will be rounded we can now calculate the number of garments that would be produced per hour on each operation by multiplying the number of operators through each operation.
- Using knowledge of the skill levels of each operator to establish which operators will give us the best possible by 60 minutes and dividing by the total minutes for the style. This will give us the theoretical number of garments that will be produced output per operation.

Line imbalance

The line imbalance is need to be carefully noticed to efficiently solve the balancing problem information [8] is given about line imbalance

- When operating a line, supervisor will be concerned with eliminating any problems which arise throughout the day; as even with the most carefully planned style and best organized production floor, it is impossible to balance the production from operator to operator.
- Due to factors such as machine breakdown, absenteeism, different performance levels between operators, the supervisor have to constantly to re-assess the balance between operations and this is one of the supervisor‟s most important functions.
- The experienced supervisor will know there is a problem on the line, by the variances in the work in progress levels; but there are certain factors which the supervisor can look for to help the balancing of the line.

Balance control

The way and technique to balance and to hold the balanced system is an important issue. The discussion [7] about the balance control is briefly given below

- There should be a reasonable level of work in progress. A recommended level is between 30 minutes to 1 hour between operations. Anything below 30 minutes will not give the supervisor sufficient time to react to a breakdown. Anything above 1 hours supply is unnecessary.
- Work in progress should always be kept in good order and full view.
- Have a number of additional machinists trained on many operations so that they can be used, wherever necessary, to cover for absenteeism. Therefore if absenteeism is 5%, a squad of skilled operator would be required to cover this amount.
- Space should be made available within the line for spare machines in case of a breakdown.
- Ensure that the mechanics keep the machines regularly serviced.
- If a bottle-neck keeps occurring at a particular place in the line, improve the method to eliminate the bottle neck.

- Supervisors must know the capabilities and skills of the operators under their control.
- Supervisors must learn that the amount of work waiting for each operation will increase or decrease over a period of time, and must plan when to take appropriate action.
- The supervisor should have in mind a minimum and maximum number of bundles that should be at each operation, and what action to take if the level drops or rises.
- Supervision could carry out „balancing duty" regularly at 2-hour intervals, checking every operation on the line to ensure that the work in- progress level is within the correct limits.
- Balancing duties should be carried out on time irrespective of what else the supervisor is doing.
- The supervisor should be able to make up his/her mind about what to do if the levels are not correct, and not have to wait for the manager to make the decision for him/her.

Use of the daily production sheet in line balancing

The daily production report plays an important role in balancing the production line, with the report the efficiency and SMV can be calculated as a result the balancing can be done simply with a little observation [7]

- The using of a daily production sheet will also assist the supervisor in the balancing of the line, as it shows where problems exist due to the difference in production levels between operations.
- The output of each operation and each operator is recorded hourly, thus giving hourly production figures throughout the day. If the production rate drops below the target, the supervisor can identify the problem and help to redress the balance.
- The advantages of using the production sheet are that the supervisor can address any problems hourly as they occur. This, done in conjunction with the balancing form, will stop the situation getting out of hand.

Efficiency

Efficiency is another way of expressing productivity, although efficiency figures are more useful and meaningful. Efficiency figures tell us how we perform against a target which has been set by scientific means. As the target is expressed as a time per garment or a required level of production, the efficiency is quite easy to calculate. Targets are normally set at a performance level of 100%, and therefore if an operator reaches his/her target production, then his/her efficiency would be 100% Likewise, should an operator only produce 75% of his/her target, and then his/her efficiency would be 75% [7]. The formulae for calculating efficiencies are as follows [7]

Efficiency% = (Time allowed) / (Time taken) X 100%

Where time allowed = (Quantity produced) X (time per unit)

Time taken = (Attended minutes) – (Lost time)

Efficiency% = (Achieved production) / (Target production) X 100%

Productivity and efficiency improvement are keys to job security, better wages and lower price.

Cycle checks

A cycle check is a brief time study with the purpose of setting a target quickly, or checking whether an operator is capable of achieving a standard time [7].

The cycle time is the time taken by the operator to perform one cycle of the operation, i.e., time between pick-up and dispose.

Conducting a cycle check according to the following steps [7]:

- Selecting the operation/s to be studied and enter the details on an appropriate form.
- Watching five cycles of each operation, noting the time for each complete cycle.
- Calculating the average cycle time for each operation.
- Comparing cycle time to the issued basic time.

Lost time

Lost time is the time an operator loses which is outside of his/her control. This time will affect the efficiency of an operator unless it is taken into consideration. Categories [7] of lost time are below

- Waiting for work,
- Machine trouble,
- Doing other peoples repairs,
- Doing samples,
- Power failures,
- Meetings.

Since the above points cannot be controlled by the operator, the time spent is subtracted from the attended minutes of the operator.

Balancing tools

There are four line balancing tools [7] to be studied for application the suitable one to the balancing process in lines they are below

1. Balancing matrix.
2. Operation-wise hourly production monitoring report.
3. Bi-hourly production board.
4. Daily line inventory report.

Balancing matrix

The chart shown gives the clear idea to make a balancing decision based on the work in progress and capacity. Our balancing will be done on the basis of this balancing matrix method [7].

Operation-wise hourly production monitoring report

From the hourly production report for each and every process so that the monitoring and balancing has been done with these data. The report gives the entry level WIP and closing WIP to plan for the day and the next day too [7].

Bi-hourly production board

The bi-hourly production report where the production details of each and every section noted for every 2 hours. This is vital information to conduct bi-hourly meeting with all the department staffs to ensure the line in balance. This report has the loading details and WIP details to make the balancing decision [7].

Daily line inventory report

The daily line inventory report gives the overall performance of the line for the day. The feeding and production details give the remaining inventory in the line for each and every section and also the efficiency of the sections recorded. These details are used for the next day planning and balancing [7].

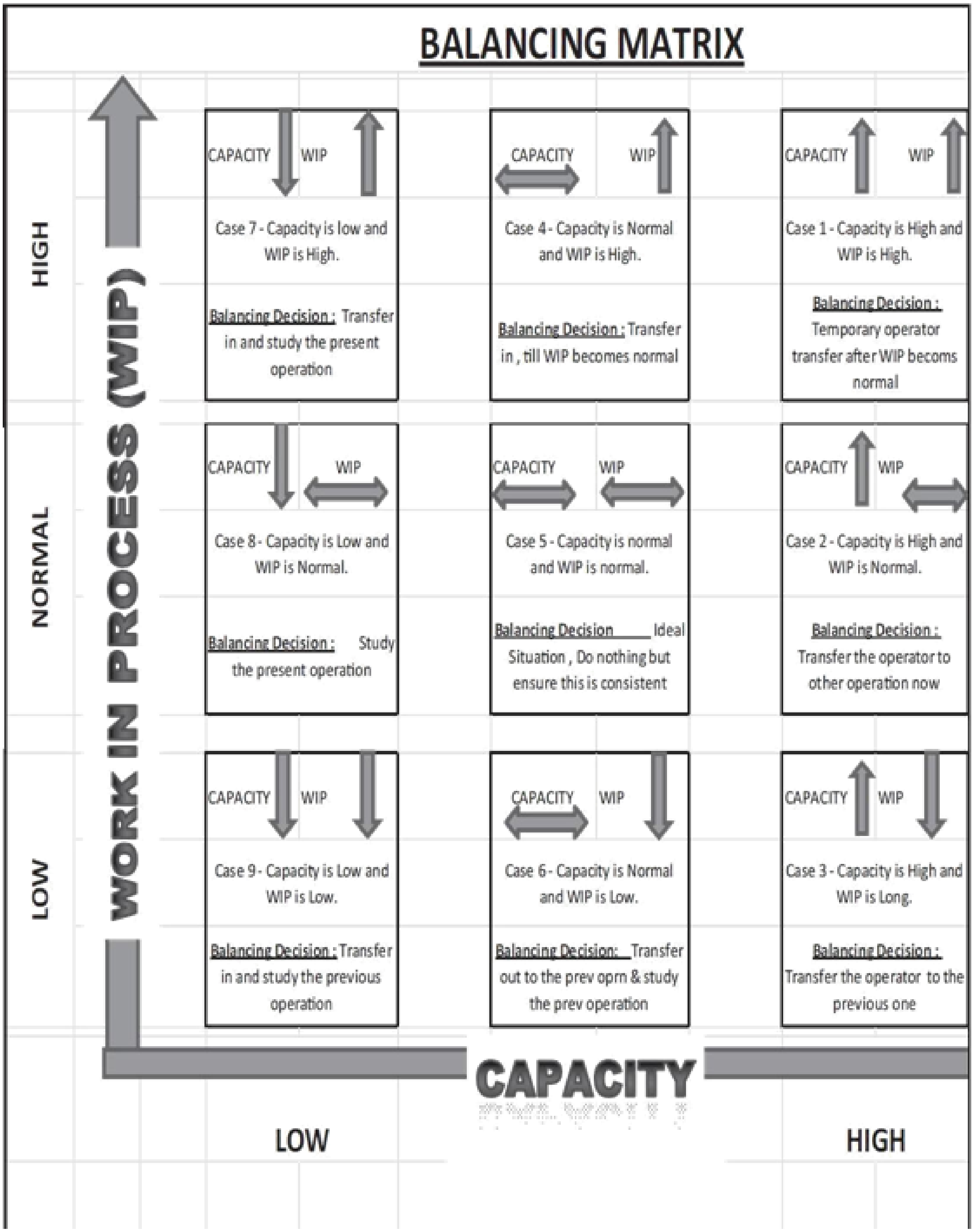


Figure 2.1: Balance matrix

2.5 Progressive bundle straight line system – batch system

As the name suggests, this system is based on a synchronized flow of work through each stage of producing a garment. Time-synchronization is the most important factor of this system because the flow of work cannot be synchronized if there are considerable variations in the standard times allowed for all the operations performed on the line. For example, if one operation has a value of 1.5 minutes then all the other operations in the line must have the same, or a very close, value. The manipulation required to balance the standard time for each operator can sometimes lead to illogical combinations of whole or part operations which are not always conducive to the overall efficiency of individual operators. The synchronized system by its very nature is rigid and particularly vulnerable to absenteeism and machine breakdowns. At all times reserve operators and machines must be available to fill the gaps. In addition, this system requires a sufficient volume of the same type of garment to keep the line in continuous operation [9].

To be effective, this system requires [9]

- Volume production.
- Accurate line balancing.
- Skilled supervision.
- Reserve operators.
- Reserve machinery and equipment.

Advantages

There are advantages [9] of bundle system they are given below for better understanding the line of production

- Laborers of all levels, i.e., unskilled, skilled, semi-skilled laborers, are involved in this system where the operations are broken into small simple operation. Hence the cost of labor is very cheap.
- Here the quantity of each component is checked during the individual operation itself, so the quality is good.
- The components are moved in bundles from one operation to next operation, so there is less chance for confusion like, lot mix-up, shade variation, size variation, etc.
- Specialization and rhythm of operation increases productivity.
- As the WIP is high in this system, it is a stable system. Because of the buffer, the breakdown, absenteeism, balancing of line, change of style can be easily managed.
- An effective production control system and quality control system can be implemented.

  (a) Time study, method study techniques;

  (b) Operator training program;

  (c) Use of material handling equipment, such as Centre table, chute, conveyor, trolley, bins, etc.
- Bundle tracking is possible, so identifying and solving the problems becomes easy.

Disadvantages

The disadvantages [9] of the progressive bundle system should also be kept in mind before line balancing so they are given below in the simplest way

- Balancing the line is difficult and this problem is solved by effective supervisor.
- Proper maintenance of equipment and machinery is needed.
- Proper planning is required for each batch and for each style, which takes lot of time.
- Improper planning causes labor turnover, poor quality, less production, etc.
- Increase in WIP in each section increases the inventory cost.
- Planned and proper layout should be made to make the system effective, i.e. smooth flow of material.
- Variety of styles, less quantity is not effective in this system. 8. Shuttle operators and utility operators are needed in every batch to balance the line effectively

Our balancing carried on this type of production system.

Standard Allowed Minute (SAM)

Standard time is the total time in which a job should be completed at the standard performance. The unit that measures the amount of work to be done by an operator in an operation by the number of minutes it should be completed. The time required by a worker with standard experience to complete a given task when working at a pace sustainable for an entire workday under normal working conditions and work methods thus comprises the following components [10].

Uses for standard time

Modern management techniques [10] are highly dependent upon time. The "time" factor can be used as follows.

- Developing a rational plan
- A reference point for considering product delivery
- A tool for developing a production plan
- Setting an appropriate product price
- A reference point for negotiating the cost of labor
- Another factor in profit/loss calculations
- Improving productivity
- Discovering problems and places for improvement in the work flow, including bottlenecks and tasks with lots of waste, irrational procedures, and inconsistencies.
- Comparing the time required and movements of two or more operators performing the same task to discover places for improvement.
- Checking the effects of work improvements based on the time required.
- As the time data for process design
- To determine operator skill levels.

Mechanisms in arriving at SAM

There are specific ways [10] to determine the SAM of a work. So for the study they are given below in the list

- Guess work
- Past experience
- Stop watch and time study
- PMTS(Predetermined motion and time study)

It is the time taken by a normal worker for a specific job, working under moderate conditions and including other allowances such as fatigue (20%), setting of tool and job (5%), personal (5%) and repairing of tool and checking of job, etc. [10].

Ways to determine the standard time

The standard time can be determined by various methods. The most common method used in sewing factories is the stopwatch method, which is described below [10].

2.6 Stop-watch measurements

Cautions on measurements by stopwatch

When using a stopwatch some points [8] are to be noted on mind to exactly make the best use of the equipment and perfectly measure the time or SMV

- Carefully explaining the purpose of the time measurements so that the operators understand the purpose of being timed.
- The position of the person taking the measurements should make it easy for the observer to watch the operator but should not be distracting to the operator.
- A position diagonally behind or in front of the operator is usually best.
- Before measuring the time, record the component tasks in the task column of the time measurement sheet after observing the job to be measured.
- The points when recordings are taken must be consistently defined and followed for greater accuracy and to prevent confusion during the timing process.

The component tasks should be recorded as the smallest measurable task unit.

Job	Component tasks and when to record		
Sewing machine work	Taking the work piece (bodice, other) and placing under presser	Sewing by machine	Placing (on holding table)
When to record	Start of needle movement Start of pulley turning	When needle stops When pulley stops	When hand is taken from the work piece
Ironing	Taking and placing the work piece (bodice, other)	Ironing	Placing (on holding table)
When to record	When iron is picked up	When iron is returned to position	When hand is taken from the work piece

Figure 2.2: Component task classification and when to record

Other time measurement considerations

There are some other considerations [8] in time measurement they are given below

- For time measurements, keeping our eyes, the stopwatch, and the operator in line so that we will keep an eye on the clock and hand movements. When there will be a succession of short component tasks, sound can also be used effectively. Starting the stopwatch at the start of the time measurement, and leaving it running until the number of required measurements has been completed.
- Recording the stopwatch reading at the designated reading point on the time measurement sheet. For short repetitive operations requiring 2–3s each, such as chained stitching and stacked thread trimming, record the time required to complete a known number (between 10 and 20) of operations. Unexpected actions or changes in the work procedure may occur even during repetitive tasks if the work procedure is not sufficiently standardized.

Number of measurements

The number of measurements taken will vary with the purpose for which the results will be used. If for defining the standard time or improving work methods, measurements should, in principle, be taken ten times (five or more times for repetitive tasks performed at a steady rhythm) [8].

Record working conditions

Work movements and work time are obtained as the results of various work conditions, and can therefore be used as reference for similar jobs and component tasks. It is important in this case to record the time measurements so that other people can understand the conditions under which the readings were obtained [8].

Calculating and organizing time measurements

The calculation and organize of the calculated data is very essential in line balancing so this need to be precisely described and understood for proper line balancing and to hold the condition of the balance. The need of measurement [8] given below

- When time measurements are completed, writing the time for each component task in red pencil on the bottom row of the measurements. The time is used to calculate the difference between measurements.
- Circle times (indicated with a V) that are clearly abnormal, and we will not include these values when calculating the average time.
- In the averages column of the time measurement sheet, recording the average times to one decimal point.
- Totaling the times in the component task averages column, and recording to the totals column. When there are two pieces per garment, e.g. pockets, and the time measurement was for only one pocket, multiply the measurement by two to obtain the actual time per garment for both pieces.

- For short repetitive operations requiring 2–3 s each, such as chained stitching and stacked thread trimming operations, divide the measured time by the number of operations per garment to obtain the time per garment, and record this figure in the actual time column.
- Determining and recording an allowance factor.
- Calculation of the standard time as: Standard time = actual time (Basic time) + allowance time
- Standard time is not constant and unchanging. It is necessary to periodically reassess the standard time to accurately reflect the current work conditions as workplace improvements and the introduction of new equipment rationalize work procedures.

Allowances

Before it is possible to complete and issue that standard time for a job, it is necessary to add to the basic time certain allowances. The reason for adding these allowances is that the work study engineer has only been considering the productive work of the operator and has not taken into account the periods of rest that are required by the operator to enable the operator to recover from the energy expended, nor the time that he/she needs to allow attention to personal needs. There are certain special allowances for cleaning or re-threading machines which must be taken into account or the work study officer will not be issuing accurate times [11].

2.7 Reason to add allowances to the basic time

Allowances are basic need of whether it is a machine or a worker operating. So the need [11] for adding allowances are given below in the list

- When a worker works for a long duration, there is no consistency in her pace. Also she requires some attention to personal needs, time is required for fixing needle in case of needle breakage, rethreading the needle in case of thread breakage, time lapsed due to machine breakdown, etc.
- The standard time is arrived at by adding up some allowances to the basic time. This will be a correct measure to set daily targets which are more practical or reliable.
- To get the standard time, a proper allowance must be added consisting the working conditions. While deciding the quantum (generally in terms of percentage) of allowance to be added to the normal time, following types of allowance are considered.

The allowances [11] are given below

- Machine allowances
- Relaxation allowance
- Interference allowance
- Process allowance
- Contingency allowance
- Special allowance

Machine allowances

One of the important allowances is machine allowance [12] this covers the following

- Thread cone or tube change
- Thread and needle breakage
- Adjusting tension
- Small problems in machine

Type of machine Allowance Type of machine Allowance [12]

- Single needle lock stitch 12.5%
- Multi-needle chain stitch 16%
- Double needle lock stitch 14%
- Safety stitch (5TOL/FL) 18%
- Single needle chain stitch 13%
- Bar tack stitch 12%
- Overlock stitch 12%

Relaxation allowance

People are not machines and they need to go the toilet, scratch, blow their nose, etc. Relaxation and fatigue allowances are provided to give the operator/ worker the opportunity to recover from the effort of doing his/her work, and to allow for attention to personal needs. The relaxation and fatigue allowance is given to every operation [12].

Recommended allowances for personal and fatigue allowances in the sewing trade are set at 11% for sitting jobs and 13% for standing. Relaxation allowance is an addition to the basic time intended to provide the worker with the opportunity to recover from the physiological and psychological effects of carrying out specified work under specified conditions and to allow attention to personal needs. The amount of this allowance depends upon the nature of the job and includes the following two categories [12].

Personal need allowance

It provides for the necessity to go away from the work place to attend the personal needs such as washing, going to lavatory, getting a drink, etc. It is commonly taken as 5% for male and 7% for female worker [12].

2.27.1.4 Fatigue allowance

Fatigue allowance is provided to recover a worker, from the physical efforts of carrying out work. It consists [12] of

- A constant portion (the minimum or basic fatigue allowance) which must be adequate for a worker who carries out the job while seating, engaged on light work in an ideal working conditions. This is generally considered as 4% for both men and women.
- A variable portion is added when the working conditions are severe. It is based on factors which vary with the working conditions. These factors are as follows [12]
    - Standing or other abnormal position (2%)
    - Use of force (10–20%)
    - Light
    - Atmospheric condition (10–20%)
    - Visual strain (4–8%)
    - Manual strain
    - Mental strain
    - Loud noise
    - Vibration

Interference allowance

When one worker is attending more than one machine, then interference is the time for which one or more machine units remain idle while the operator is occupied with the work on other machine units. The allowance provided to compensate this idleness due to interference is known as interference allowance [12].

Process allowance

This is an allowance provided to compensate for enforced idleness during a process. This includes [12] loss of time due to

- No work
- Power failure
- Faulty material
- Faulty tools or equipment

Contingency allowance

A contingency allowance should not be greater than 5% and should only be given in cases where the work study officer is absolutely satisfied that they are justified. The contingency allowances should be expressed as a percentage of the basic time. This is an allowance of time to meet legitimate, irregular and infrequent items of works or delays which cannot economically be measured correctly. It is usually taken as less than 5% [12].

Special allowance

These allowances are decided as a policy matter of management. These are allowed for activities which are normally not a part of the operation cycle bur are essential for satisfactory performance of work. These include [12] for the following items

- Start up
- Cleaning
- Shut down
- Set up
- Dismantling allowance
- Change over
- Reject allowance
- Excess work allowance
- Learning allowance
- Training allowance
- Implementation allowance
- Small batch allowance
- Tool changing and regrinding
- Bundle handling allowance

Bundle handling can, if required, be expressed as a percentage and added as an allowance [12].

CHAPTER-THREE
THEORITICAL BACKGROUND

3.1 Equations to balance the production line

These equations are needed to calculate the data required for the balancing of production line for further improvement

Standard minute value (SMV) = (average cycle time X allowance) in minute

Takt time=

Target= X 100%

Theoretical manpower=

Labor productivity=

Line efficiency= X 100%

3.2 Balancing the line

The first step of line balancing is to breakdown the operation into sequential logical order. The breakdown is done to better understand and implement the sequential order of product processing steps.

Taking cycle time for each operation is done manually and SMV is calculated from the average time with suitable allowance. Adding total SMV we can obtain target/hour. In this case 90% efficiency is the desired output level per hour.

The number of operator remains same to keep the SMV same before and after the line balancing.

Table 3.1: Process name with sequence, machine type, SMV and actual capacity

SI NO	Process	M/C Type	No. of Operator	SMV	Total capacity
1	Back and Front matching	ASO	1	.29	207
2	Shoulder join	O/L	1	.25	240
3	Thread cut & fold	ASO	1		
4	Neck rib make & cut	P/M	1	.28	214
5	Neck rib join with body	O/L	1	.28	214
6	Main label attach with body	P/M	2	.26	220
7	Back tape join and cut	F/L	1	.28	214
8	Front neck top seam	F/L	1	.25	240
9	Trim and mark label top seam	ASO	1		
10	Back tape close with label	P/M	2	.50	240
11	Sleeve hem	F/L	1	.25	240
12	Trim and pair	ASO	1	.25	240
13	Sleeve match with body	ASO	1	.29	207
14	Sleeve join with body	O/L	2	.50	240
15	Trimming thread	ASO	1		
16	Side seam with care label	O/L	3	.95	189
17	Thread cut & sticker remove	ASO	1		
18	Sleeve open and press tuck	P/M	2	.58	212
19	Thread cut & body fold	ASO	1		
20	Body bottom hem	F/L	1	.29	207
21	Thread cut	ASO	1		

Table 3.2: Bench mark Target, Labor productivity and Line Efficiency before balancing line

Total output per day	1320
Total manpower	27
Working time	480
SMV	5.50
Take time (min)	207
Target/hour	236 (efficiency 100%)
Target/hour	212(efficiency 90%)
Target/hour	188(efficiency 80%)
Target/hour (actual)	165 (efficiency 70%)
Labor productivity	49
Line efficiency	56%

Process wise capacity of each work station has been shown in table 4.1 where Standard minute value has been calculated by taking average cycle time for each process and considering allowances.

Table 4.2 shows the target per hour for the line calculating total 27 manpower worked on that line for 480 minutes with a SMV value of 5.50.

We have standardized the Bench mark target of 212 pieces of garment at 90% efficiency.

Observation before balancing the line has been reflected as labor productivity is 49, line efficiency is 56%.

Table 3.3: Balancing Process to equalize the bottleneck process

SI NO	Bottleneck process				Balancing process			
1	Process name	Process No	Capacity /hour	Balanced capacity	Process Name	Process No	Capacity /hour	Balanced capacity
	Side seam	16	189	212	Sleeve join with body	14	240	212

Remarks Process # 14 can work for 52 min. and share work with process # 16 for at least 8 min.

That increases the production from 189 pieces to 212 pieces noticeably increasing the efficiency and eliminating the bottleneck process.

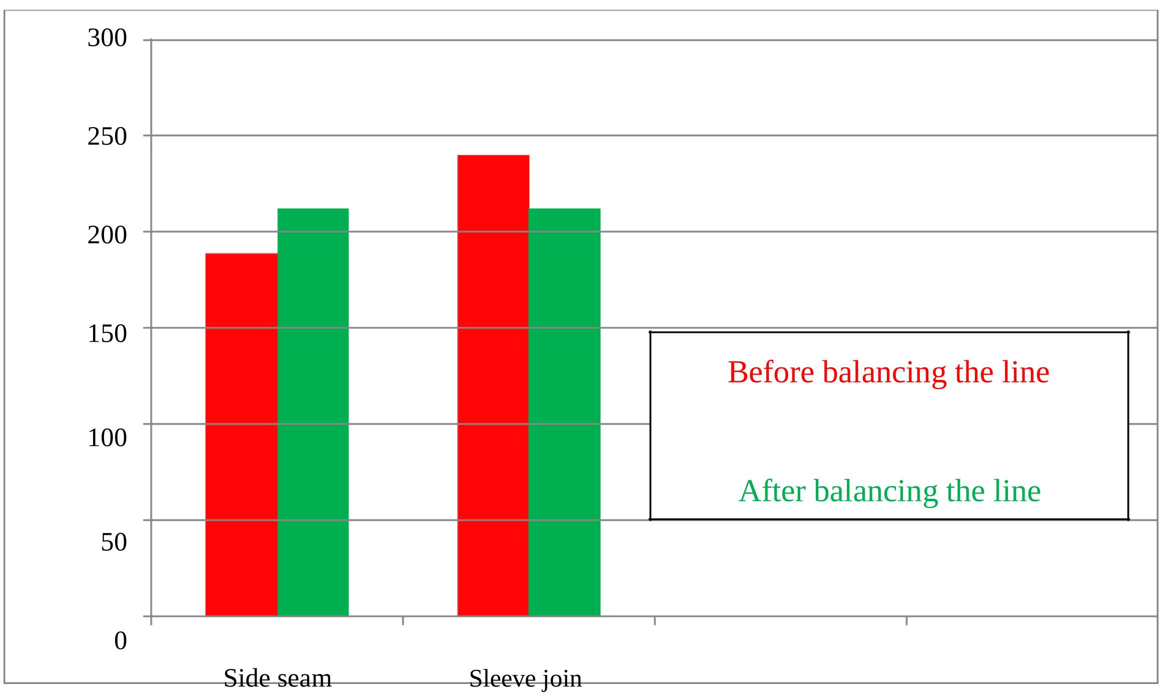


Figure 3.1: Change of productivity in process no. 16 and process no.14

SI NO	Bottleneck process				Balancing process			
2	Process name	Process No	Capacity /hour	Balanced capacity	Process name	Process no	Capacity /hour	Balanced Capacity
	Bottom hem	20	207	220	Sleeve hem	11	240	225

Remarks Process # 11 can work for 55 min. and share work with process # 20 for at least 5 min.

That increases the production from 207 pieces to 220 pieces noticeably increasing the efficiency and eliminating the bottleneck process.

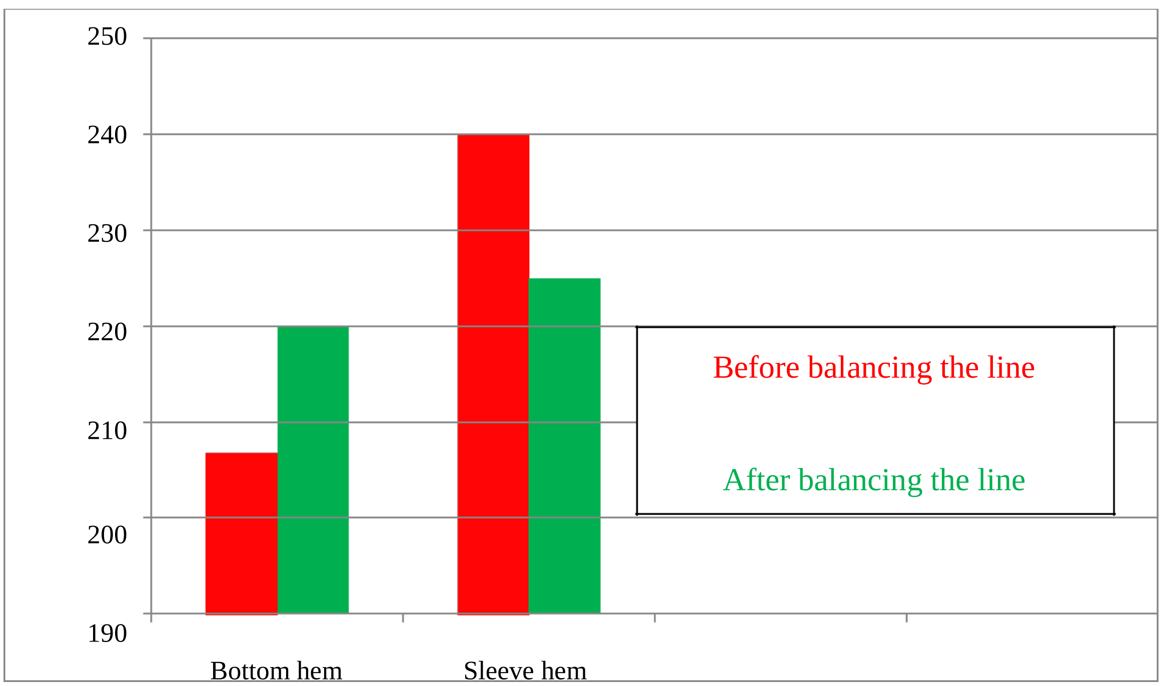


Figure 3.2: Change of productivity in process no. 20 and process no.11

SI NO	Bottleneck process				Balancing process			
3	Process name	Process No	Capacity /hour	Balanced capacity	Process name	Process no	Capacity /hour	Balanced capacity
	Back and front part match	1	207	212	Trim and pair	12	240	225
	Match sleeve with body	13	207	212	Trim and pair	12	240	225

Remarks Process #12 can work for 55 min. and share work with process # 1 and #13 for at least 5 min.

That increases the production from 207 pieces to 212 pieces noticeably increasing the efficiency and eliminating the bottleneck process.

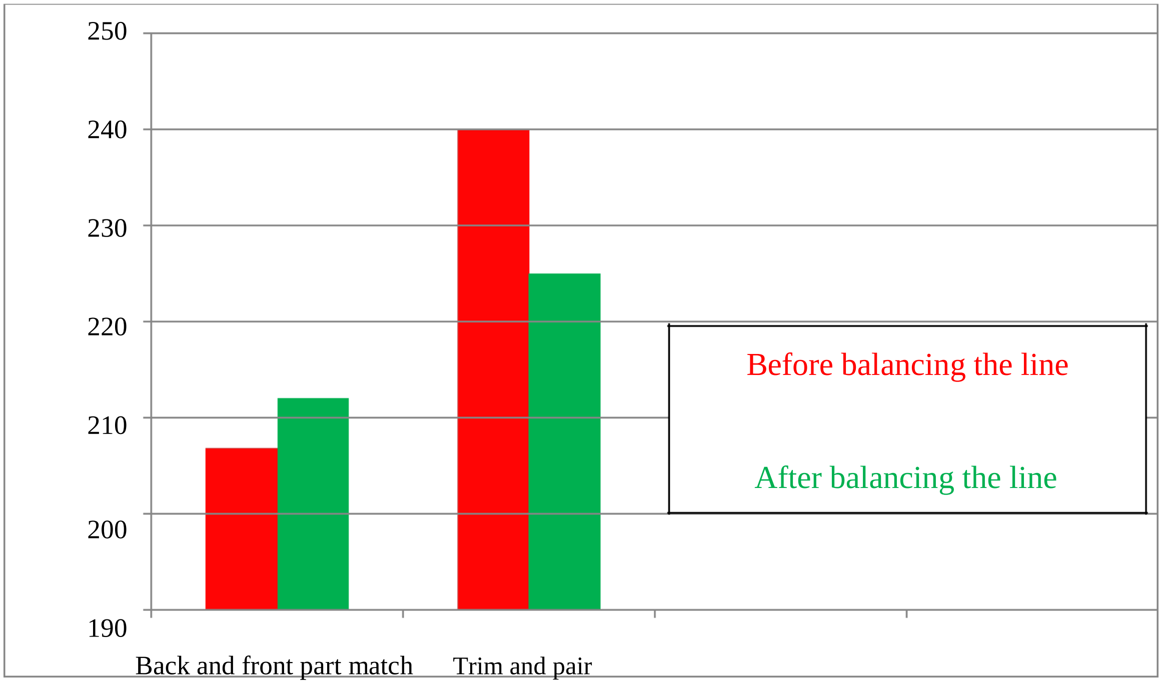


Figure 3.3: Change of productivity in process no. 1 and process no.12

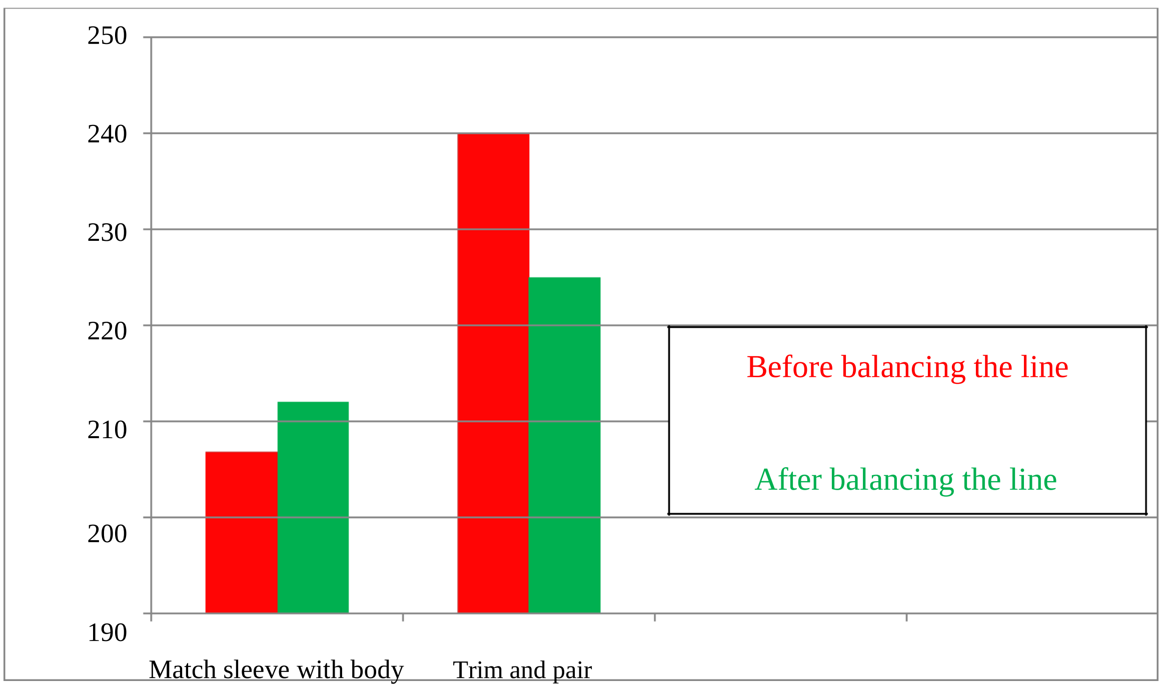


Figure 3.4: Change of productivity in process no. 13 and process no.12

3.3 Bottleneck processes

We have identified some variations in process capacity from the bench mark target and the lower capacity from the bench mark target is the bottleneck process as production flow would stuck on the bottleneck point. Comparing total capacity of each process to the 90% bench mark target, we have identified the bottleneck process named Side seam with care label attaching, Body hem.

Total production has been blocked in these seven work stations and large work in process (WIP) has been stuck in that bottleneck process.

3.4 Balancing Processes

Balancing method is very essential to make the production flow almost smoother compare to the previous layout. Considering working distance, type of machines and efficiency, workers who have extra time to work after completing their works, have been shared their work to complete the bottleneck processes.

Previously identified bottleneck process has been plotted in the left side of the Table 4.3. Side seam and Sleeve join with body both have been made by over lock machine and these have been shared by two over lock machine processes. Operator who work in Process no. 14 Sleeve join with body, have been worked for 52 minutes per hour in first process, capacity 240 pieces and then have been worked in the process no. 16 Side seam for last 8 minutes to make additional 23 pieces for overall capacity of 212 pieces on process no. 16.

Again identified bottleneck process has been plotted in the left side of the Table 4.3. Bottom hem and Sleeve hem both have been made by flat lock machine and these have been shared by flat lock machine processes. Operator who work in Process no. 11 Sleeve hem, have been worked for 55 minutes per hour in first process, capacity 240 pieces and then have been worked in the process no. 20 bottom hem for last 5 minutes to make additional 13 pieces for overall capacity of 220 pieces on process no. 20.

Again identified bottleneck process has been plotted in the left side of the Table 4.3. Back and front match, Trim and pair and Match sleeve with body have been done by the assistant sewing operator. Operator who work in Process no. 12, have been worked for 55 minutes per hour in first process, capacity 240 pieces and then have been worked in the process no. 1 and 13 for last 5 minutes to make additional 10 pieces for overall capacity of 212 pieces on process no. 1 and 13.

Table 3.4: Process wise revised capacity and manpower distribution

SI NO	Process	M/C Type	No. of operators	SMV	Total capacity	Total capacity revised	Target (90%)
1	Back and Front matching	ASO	1	.29	**207**	**212**	212
2	Shoulder join	O/L	1	.25	240	240	212
3	Thread cut & fold	ASO	1				
4	Neck rib make & cut	P/M	1	.28	214	214	212
5	Neck rib join with body	O/L	1	.28	214	214	212
6	Main label attach with Body	P/M	2	.26	220	220	212
7	Back tape join and cut	F/L	1	.28	214	214	212
8	Front neck top seam	F/L	1	.25	240	240	212
9	Trim and mark label top Seam	ASO	1				
10	Back tape close with label	P/M	2	.50	240	240	212
11	Sleeve hem	F/L	1	.25	**240**	**225**	212
12	Trim and pair	ASO	1	.25	**240**	**225**	212
13	Sleeve match with body	ASO	1	.29	**207**	**212**	212
14	Sleeve join with body	O/L	2	.50	**240**	**212**	212
15	Trimming thread	ASO	1				
16	Side seam with care label	O/L	3	.95	**189**	**212**	212
17	Thread cut & sticker Remove	ASO	1				
18	Sleeve open and press tuck	P/M	2	.58	212	212	212
19	Thread cut & body fold	ASO	1				
20	Body bottom hem	F/L	1	.29	**207**	**220**	212
21	Thread cut	ASO	1				

CHAPTER-FOUR
MATERIALS AND METHODS

4.1 Introduction

In sewing section there are various types of product are produced such as T-shirt, polo shirt,Tank top, Hollywood style, jeeps top, jacket, hoodyjacket, under wear, trouser, sportswear,swimming wear and so on To produce these types of garments different type of materials areused such as-

Material used:

- ✓ single jersey (lycra)(Hundred percent cotton)
- ✓ Pattern paper
- ✓ Measuring Tape
- ✓ Scissor
- ✓ Pencil
- ✓ Eraser
- ✓ Curve Ruler

4.2 METHOD OF MAKING T-SHIRT:

I am getting a lot of visits from people goggling "how to make a t-shirt" so I thought I'doblige you.
First off, you need a pattern. You can trace one from an existing shirt, but I'm not coveringthat step in this tutorial. I'm using the size 4 t-shirt pattern from my beloved vintage Sew forToddler. All the patterns for this book are on a large pattern sheet and you have to trace offthe size you want. I usually trace my patterns onto freezer paper. If you look closely you cansee I traced the wrong size first; I don't remember what happened there but it was one of twotracings I have of this pattern. My pattern has 4 pieces: front, back, sleeve, and neckband.
I have a pretty big piece of this fabric, so to waste the least amount of fabric and also be ableto manage the whole thing, I cut out one pattern piece at a time. I'm starting with the front--the center front edge needs to be on placed on the fold of the fabric. I look closely at thefabric and make sure the tiny knit stitches are running straight (not at an angle) with myfoldline. Also, the stretch of this fabric is going up and down in the photo, or across the bodyof the t-shirt front and back pattern pieces. You want to cut your knits out with the stretchgoing the right way.

Then I do the same with the back. First I cut off the small amount of scrap from cutting thefront and then I refold the fabric wide enough to do the back. Here you can see my cutepattern weights. I don't pin my patterns--I use pattern weights and rotary cut around the edges of my patterns. You can use scissors if you don't have a rotary cutter. I need to sharpen my scissors *and* get a new rotary blade--cutting this out wasn't as easy and fun as it should have been.The sleeve. Again I refold so I have enough width to lay out the sleeve pattern. See that long straight line? It's the pattern grain line and should line up with the grain of the fabric. In other words, line up with straight up and down lines of knitted stitches in the fabric. If you've ever had a t-shirt that twisted around your body when you were wearing it, it was cut offgrain. It's not hard to make sure your fabric and patterns are on grain when you're cutting.Neckline ribbing. This fabric is laid out with the stretch going left to right. The pattern piece islaid on the fold. I used a cotton/lycra rib knit for this piece. If your main shirt fabric is ribbedor fairly stretchy, you can use the same fabric for the neckline. This shirt fabric is a jerseythat's not really stretchy enough to go over my boy's head and not have stitches pop rightaway.

4.3 SEWING:

Sewing step 1: Place front and back pieces together with right sides facing. Match the piecesup at the shoulder and pin them if you want.Here they are surged together. Before I had aserge I would sew the seam, then zigzag the edges together because I don't like unfinishededges.

Sewing step 2: Pin the top center of the sleeve to the shoulder seam.
Pin the front and back edges of the sleeve seam. This is kind of difficult to show in a photo

Sewing step 3: Fold the shirt so the front and back line up and the sleeve edges line up.
Starting at the sleeve hem edge, and all at once, sew the sleeve edges together, then the frontand back together at the sides. Do both sides

Sewing step 4: Sewing the neckband on is explained here in T-shirt

Sewing step 5: Fold the sleeve edges and bottom edge up once and stitch in place. I have awhy you don't need a free arm to sew hems of small sleeves".

4.4 MACHINE SEQUENCE OF T-SHIRT MANUFACTURE PROCESS:

Number matching front to back part (back on part on upper side)
Shoulder joining by over lock m/c)
Interlining by fusing
Over locking of lining by over lock m/c
Piping (with collar piped) by over lock m/c
Join edge of the pipe by plain m/c
Neck joint by plain m/c
Neck over locking by over lock m/c)
Neck piping round the neck by flat lock m/c
Round neck finished cut by plain m/c
Main label attaching by plain m/c
Sleeve hem by flat lock m/c
Sleeve Joint by over lock m/c)
Side Seam by over lock m/c)
Care label joining by plain m/c
Side top stitch by flat lock m/c
Side tuck cuff by plain m/c
Neck top stitch by flat m/c
Bottom hem by flat lock m/c
Inspection.

4.5 LINE BALANCING OF T-SHIRT MANUFACTURING PROCESS FOR 180 PIECES PER HOUR:

Number of m/c

Shoulder joining-(O/L) = 1
Over locking of lining-(O/L) = 1
Piping- (O/L) = 1
Neck joining-(O/L) = 1
Neck overlocking-(O/L) = 1
Sleeve hem-(F/L) = 1
Sleeve joining-(O/L) = 2
Side joining-(O/L) = 3
Side top stitch-(F/L) = 2
Side tuck cuff-(SNLS) = 1
Neck top stitch-(F/L) = 1
Bottom hem join(F/L) = 1

Table 4.1SMV study for a T-shirt

No.	Operation	Average Cycle Time(sec)	Estimated SMV
01	SMV for shoulder joining	13.09	0.30
02	SMV for over locking of lining	10.90	0.25
03	SMV for piping	13.09	0.30
04	SMV for neck joining	15.27	0.35
05	SMV for over locking	13.09	0.30
06	SMV for sleeve hem	13.96	0.32
07	SMV for sleeve joining	26.18	0.60
08	SMV for side joining	34.90	0.80
09	SMV for side top stitch	26.18	0.60
10	SMV for side tuck cuff	26.18	0.60
11	SMV for neck top stitch	15.27	0.35
12	SMV for bottom hem Joining	15.27	0.35
TOTAL SMV			5.12

3.7 APPENDIX

1. **SMV for shoulder joining**

= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [13.09/(60 x 80/100)] + Allowance%
= 0.272 + [(10 x 0.272)/100]
= 0.272+0.0272
= 0.30 Minute

2. SMV for over locking of lining
= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [10.90/(60 x 80/100)] + Allowance%
= 0.227 + [(10 x 0.227)/100]
= 0.227+0.0227
= 0.25 Minute

3. SMV for piping
= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [13.09/(60 x 80/100)] + Allowance%
= 0.272 + [(10 x 0.272)/100]
= 0.272+0.0272
= 0.30 Minute

4. SMV for neck joining
= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [15.27/(60 x 80/100)] + Allowance%
= 0.318 + [(10 x 0.318)/100]
= 0.318+0.0318
= 0.35 Minute

5. SMV for neck overclocking

= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [13.09/(60 x 80/100)] + Allowance%
= 0.272 + [(10 x 0.272)/100]
= 0.272+0.0272
= 0.30 Minute

6. SMV for sleeve hem

= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [13.96/(60 x 80/100)] + Allowance%
= 0.29 + [(10 x 0.29)/100]
= 0.29+0.029
= 0.32 Minute

7. SMV for sleeve joining

= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [26.18/(60 x 80/100)] + Allowance%
= 0.545 + [(10 x 0.545)/100]
= 0.545+0.0545
= 0.60 Minute

8. SMV for side joining

= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [34.90/(60 x 80/100)] + Allowance%
= 0.727 + [(10 x 0.727)/100]
= 0.727+0.0727
= 0.80 Minute

9. SMV for side top stitch

= Normal or Basic time + Allowance%

= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %

= [26.18/(60 x 80/100)] + Allowance%

= 0.545 + [(10 x 0.545)/100]= 0.545+0.0545= 0.60 Minute

10. SMV for side tuck cuff

= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [26.18/(60 x 80/100)] + Allowance%
= 0.545 + [(10 x 0.545)/100]
= 0.545+0.0545
= 0.60 Minute

11. SMV for neck top stitch
= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [15.27/(60 x 80/100)] + Allowance%
= 0.318 + [(10 x 0.318)/100]
= 0.318+0.0318
= 0.35 Minute

12. SMV for bottom hem
= Normal or Basic time + Allowance%
= [Cycle time (Second) /(60 x Performance rating%)] +Allowance %
= [15.27/(60 x 80/100)] + Allowance%
= 0.318 + [(10 x 0.318)/100]
= 0.318+0.0318
= 0.35 Minute

CHAPTER-FIVE
RESULT & DISCUSSION

5.1Result &Discussion:

Essentially, a "waste" is anything that the customer is not willing to pay for. Typically the types of waste considered in a lean manufacturing systeminclude: [8].

Overproduction: to produce more than demanded or produce it before it is needed. It is visible as storage of material. It is the result of producing to speculative demand. Overproduction means making more than is required by the next process, making earlier than is required by the next process, or making faster than is required by the next process. Causes for overproduction waste include:

- Just-in-caselogic
- Misuseofautomation
- Long processsetup
- Unlevelscheduling
- Unbalancedworkload
- Overengineered
- Redundantinspections

Figure 5.1:Overproduction

Waiting: for a machine to process should be eliminated. The principle is to maximize the utilization/efficiency of the worker instead of maximizing the utilization of the machines. Causes of waiting waste include:

- Unbalancedworkload • Unplannedmaintenance
- Long processset-uptimes • Misuses ofautomation
- Upstreamqualityproblems • Unleveledscheduling

Figure 5.2: Waiting

Excess Inventory: is material between operations due to large lot production or processes with long cycle times. Causes of excess inventory include:

- Protecting the company from inefficiencies and unexpectedproblems
- Productcomplexity • Unleveledscheduling • Poormarketforecast• Unbalancedworkload
- Unreliable shipmentsbysuppliers • Misunderstoodcommunications • Rewardsystems

Figure 5.3: Excess Inventory

Over Processing: should be minimized by asking why a specific processing step is needed and why a specific product is produced. All unnecessary processing steps should be eliminated. Causes for processing waste include:

- Product changes withoutprocesschanges • Just-in-caselogic
- True customer requirementsundefined
- Over processing toaccommodatedowntime • Lack of communications
- Redundantapprovals
- Extra copies/excessiveinformationFigure

5.4: Over Processing

Excess Transportation: does not add any value to the product. Instead of improving the transportation, it should be minimized or eliminated (e.g. forming cells). A cause of transportation waste includes:

- Poor plantlayout
- Poor understanding of the process flow for production
- Large batch sizes, long lead times, and large storageareas

Figure 5.5: Excess Transportation

Excess Motion: of the workers, machines, and transport (e.g. due to the inappropriate location of tools and parts) is waste. Instead of automatingwasted motion, the operation itself should be improved. Causes of motion wasteinclude:

- Poorpeople/machineeffectiveness• Inconsistent workmethods
- Unfavorable facility orcelllayout • Poor workplace organizationand Housekeeping
- Extra "busy" movements whilewaiting

Figure 5.6: Excess Motion

Rework: is pure waste. Prevent the occurrence of defects instead of finding and repairing defects. Causes of processing waste include:

- Weak processcontrol
- Unbalanced inventorylevel
- Deficientplannedmaintenance • Productdesign
- Customer needs notunderstood
- Inadequateeducation/training/work instructions

Figure 5.7: Rework

Underutilizing People: Losing time, ideas, skills, improvements, and learning opportunitiesby not engaging or listening to the employees. Causes of people waste include: [ ]

- Old guard thinking, politics, thebusinessculture
- Poor hiringpractices
- Low or no investment intraining
- Low pay, high turnoverstrategy

Nearly every waste in the production process can fit into at least one of these categories. Those that understand the concept deeply view waste as the singular enemy that greatly limits business performance and threatens prosperity unless it is relentlessly eliminated over time. Lean manufacturing is an approach that eliminates waste by reducing costs in the overall production process, in operations within that process, and in the utilization of productionlabor.

5.2 Workstudy:

Work study is a systematic technique of method analysis work measurement and setting of time standard that can be ensure the highest productivity by the optimum use of man power, equipment andmaterial.

5.3 MethodStudyforgarmentoperations:

Method study is more of a systematic approach to job design than a set of techniques. It is defined as the systematic recording and critical examination of existing and proposed methods of doing work, as a means of developing and applying easier and more effective methods and reducing costs. The method involves systematically following sixsteps:

1. Selection of work to be studied: Most operations consist of many discrete jobs or activities. The first stage is to select those jobs to be studied that will give the best returns for the time spent. For example, activities with the best scopes for improvement, those causing delays or bottlenecks or those resulting in highcosts.

2. Recording of all relevant facts of current method: Method study uses formal techniques to record the sequence of activities, the time relationship between different tasks, the movement of materials, and the movement of staff. There are many techniques used in methodstudy.

3. Criticalexaminationofthosefacts: Thisisthemostimportantstageinmethodstudy.
It is used to critically examine the current method by seeking answers to questions:

- The purpose of eachelement
- Theplace
- Thesequence
- Theperson
- Themeans

4.Development of the most practical, economic and effective method: This stage is used to develop a new and better method of executing the task, by taking into account the results of critical examination. The new method is developed by a combination of entirely eliminating some activities, combining some parts, changing the sequence of some activities and by simplifying the content ofothers.

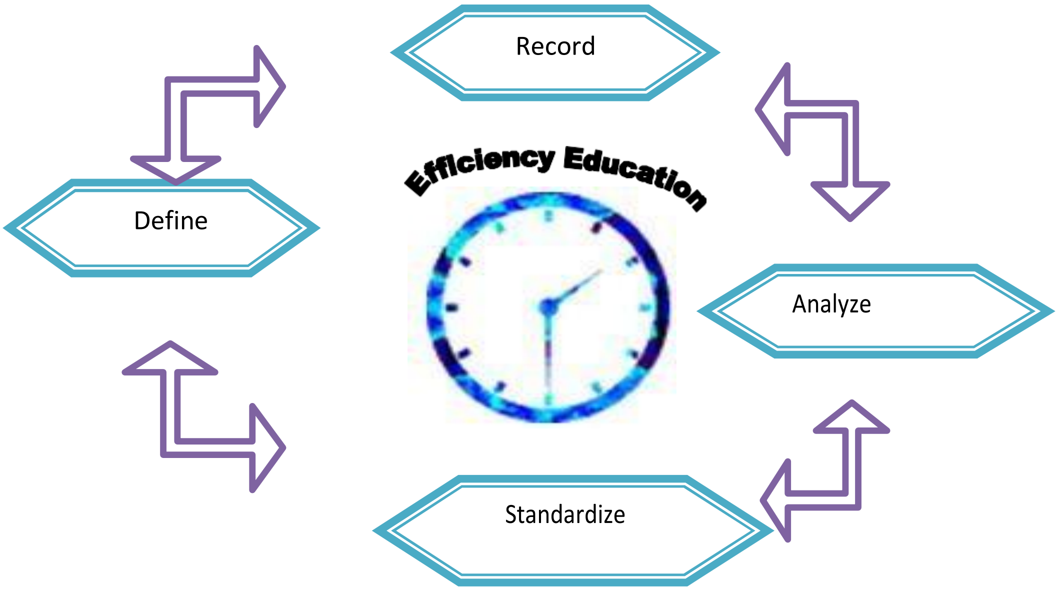
5. Installation of new method: This step involves project managing the changes and ensuring that everybody involved understands the changes involved. In other words they understand the new method, which is doing what, the differences compared to the old method and crucially the reason for the changes. Training is an important part of this stage particularly if the new method involves radical changes. Providing modified equipment, components and layouts may also beinvolved.

6. Maintenance of new method and periodic checking: Monitoring of how effective the new method is and how personnel have adapted is very important. One aspect that is sometimes overlooked is to check what effect the new method has on other activities. For instance, it may be that whilst the new method is successful in eliminating a bottleneck in a particular area, the bottleneck has moved elsewhere in the process. By periodic checking the new method and its effects, management can ensure that overall efficiency is improving rather thandeteriorating.

5.4 TimeStudyforgarmentOperations:

Time study is very important analysis for the find out of SMV condition of time study: Before making the time study officer ensure that conditions on the job are normal.

1. The work flow into the operation isnormal
2. Amount of work in the section isnormal
3. The size of the work available arenormal



5.8Figure: Time study system

5.5 Techniques of timestudy:

1. Asses the performance of theworker
2. Understand the flow ofwork
3. Time study person should not disturb theoperator
4. Should inform to the operator that he is going to do sometimesstudy
5. Enter every detail on study papers by a pen as it can'tdelete.

5.6Time study tools:

- ✓ A stopwatch
- ✓ Time study format
- ✓ One pen orpencil

5.9 Figure: stop watch

5.7Layout:

Layout means to distribute/allocate elements (Sequentially) to the individual operator in the line by considering total worker, worker experience, total machine, types of machine & mainly the estimated SMV of allocated/distributed elements in a broken down garments. A good layout is that physical arrangements which permits the product to be produced with minimum unit cost in the shortesttime.

5.8Benefit of Layout:

1. The line will be quiteequivalent
2. Usually a great type of bottle neck will not be found inline
3. No operator will be idle
4. Target will be achieved easily.

5.9Linebalance:

Line balance means the better allocation of the necessary tasks between the operators, which reduces waiting time.

For line balance we have to know some data and some calculating information those are as follows:-

1) How manyoperators.
2) Operation.
3) SMV.
4) Performance.
5) Potential production /hour.
6) Hours to achievetarget.
7) Capacity.
8) Target.

5.10Capacitystudy:

When we make a capacity study on an operator, we are measuring the performance she should attain if she continues to work at the same pace and use the same method as observed during the study. This means that at the end of the study we can say that operator has the capacity to be a 120 % performer, or whatever performance level the studyindicates.

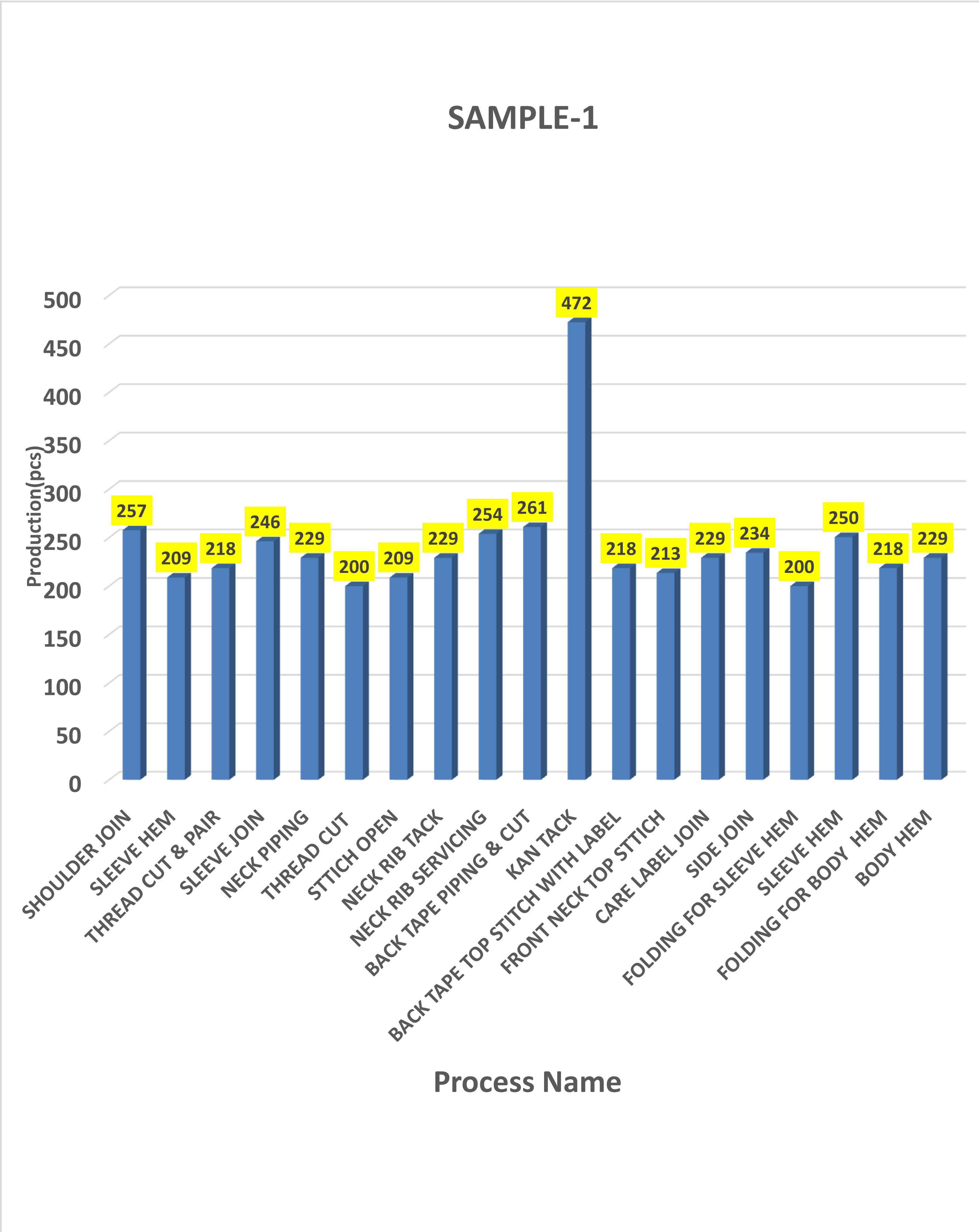
What exactly do we mean by capacity? Well, it means the same as capability. It means that the operator is capable of achieving the performance measured by the study.

AMAZING FASHIONS LTD
10,Dagerchala,Gazipur.
Capacity Study

Target HR :	200
Production :	

Line :	A	STYLE :	HOUTE	DATE:	18-3-19
Section:	Sewing	ITEM :	T-SHIRT	COLOR:	

SL NO:	Operator Name	Operation name	Machine Name	Cycle Time 1st	2nd	3rd	TTL Time	Avg. Tim	Allow Tim	SMV	Capacity	TTL Capacity	NEED M/C	REMARKS
1	SANTA	SHOULDER JOIN	O/L	20	25	30	75	25	3.8	0.48	125	257		
2	LUNA		O/L	25	20	26	71	24	3.6	0.45	132			
3	HENA	SLEEVE HEM	O/L	14	15	16	45	15	2.3	0.29	209	209		
7	BITHY	THREAD CUT & PAIR	H/P	12	15	16	43	14	2.2	0.27	218	218		
	SANTU	SLEEVE JOIN	O/L	25	30	18	73	24	3.7	0.47	129	246		
	SATHI		O/L	30	32	18	80	27	4	0.51	117			
5	SURJI	NECK PIPING	O/L	12	15	14	41	14	2.1	0.26	229	229		
6	HELENA	THREAD CUT	H/P	15	18	14	47	16	2.4	0.30	200	200		
7	BITHY	STTICH OPEN	H/P	14	15	16	45	15	2.3	0.29	209	209		
8	ETI	NECK RIB TACK	P/M	12	14	15	41	14	2.1	0.26	229	229		
9	SANTA	CK RIB SERVICI	P/M	12	13	12	37	12	1.9	0.24	254	254		
10	TASLIMA	BACK TAPE PIPING & CUT	F/L	10	12	14	36	12	1.8	0.23	261	261		
11	LIPI	KAN TACK	P/M	15	12	10	37	12	1.9	0.24	254	472		
12	HELENA	BACK TAPE TOP STITCH	P/M	16	12	15	43	14	2.2	0.27	218	218		
15	SATHI	NT NECK TOP ST	P/M	14	15	15	44	15	2.2	0.28	213	213		
16	REHENA	CARE LABEL JOI	P/M	12	15	14	41	14	2.1	0.26	229	229		
17	SABINA	SIDE JOIN	O/L	35	35	38	108	36	5.4	0.69	87	234		
18	JOHIRUL		O/L	40	50	40	130	43	6.5	0.83	72			
19	MORJINA		O/L	40	45	40	125	42	6.3	0.80	75			
#	HATEM	FOLDING FOR SLEEVE HEM	H/P	20	12	15	47	16	2.4	0.30	200	200		
21	SHUMI	SLEEVE HEM	O/L	20	25	30	75	25	3.8	0.48	125	250		
#	FULJHORI		O/L	20	25	30	75	25	3.8	0.48	125			
#	AFROZA	FOLDING FOR BODY HEM	H/P	12	15	16	43	14	2.2	0.27	218	218		
#	HOSNA	BODY HEM	P/M	12	15	14	41	14	2.1	0.26	229	229		
	TOTAL									9.22				



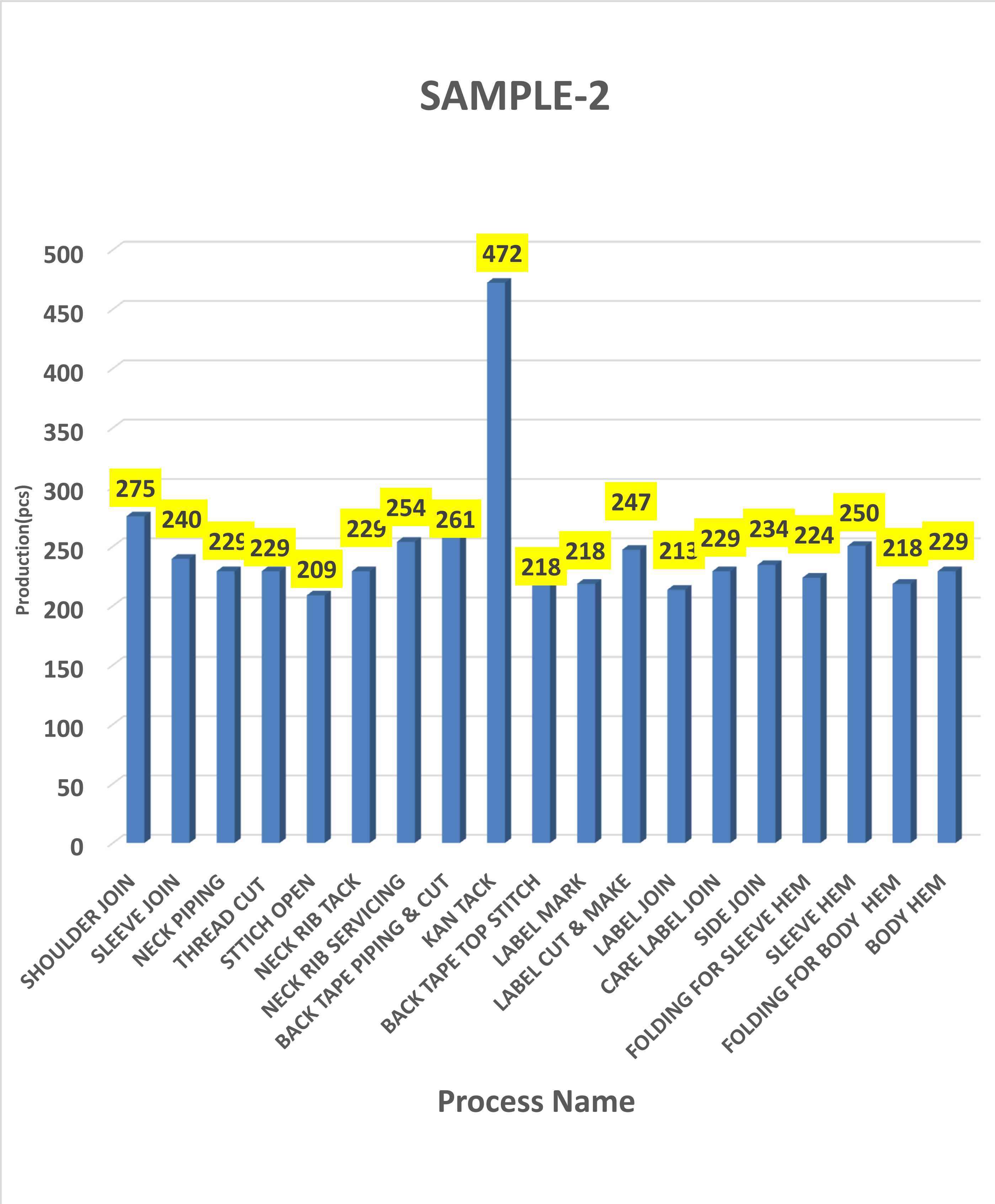
SAMPLE-1
Production(pcs)
500
450
400
350
300
250
200
150
100
50
0
257
209
218
246
229
200
209
229
254
261
472
218
213
229
234
200
250
218
229
SHOULDER JOIN
SLEEVE HEM
THREAD CUT & PAIR
SLEEVE JOIN
NECK PIPING
THREAD CUT
STTICH OPEN
NECK RIB TACK
NECK RIB SERVICING
BACK TAPE PIPING & CUT
KAN TACK
BACK TAPE TOP STITCH WITH LABEL
FRONT NECK TOP STTICH
CARE LABEL JOIN
SIDE JOIN
FOLDING FOR SLEEVE HEM
SLEEVE HEM
FOLDING FOR BODY HEM
BODY HEM
Process Name

AMAZING FASHIONS LTD
10,Dagerchala,Gazipur.
Capacity Study

Target HR :	250
Production :	213

Line :	B	STYLE :	AFTS-23	DATE:	18-5-19
Section:	Sewing	ITEM :	T-SHIRT	COLOR:	

SL NO:	Operator Name	Operation name	Machine Name	Cycle Time 1st	2nd	3rd	TTL Time	Avg. Time	Allow Time	SMV	Capacity	TTL Capacity	NEED M/C	REMARKS
1	MARIUM	SHOULDER JOIN	O/L	18	25	30	73	24	3.7	0.47	129	275		
2	LUNA		O/L	20	18	26	64	21	3.2	0.41	147			
3	HENA	SLEEVE JOIN	O/L	24	22	30	76	25	3.8	0.49	124	240		
4	KULSUM		O/L	23	28	30	81	27	4.1	0.52	116			
5	SURJI	NECK PIPING	O/L	12	15	14	41	14	2.1	0.26	229	229		
6	HELENA	THREAD CUT	H/P	15	12	14	41	14	2.1	0.26	229	229		
7	BITHY	STTICH OPEN	H/P	14	15	16	45	15	2.3	0.29	209	209		
8	ETI	NECK RIB TACK	P/M	12	14	15	41	14	2.1	0.26	229	229		
9	SANTA	CK RIB SERVICI	P/M	12	13	12	37	12	1.9	0.24	254	254		
10	TASLIMA	BACK TAPE PIPING & CUT	F/L	10	12	14	36	12	1.8	0.23	261	261		
11	LIPI	KAN TACK	P/M	15	12	10	37	12	1.9	0.24	254	472		
12	HELENA	K TAPE TOP STI	P/M	16	12	15	43	14	2.2	0.27	218	218		
13	SATHI	LABEL MARK	H/P	12	15	16	43	14	2.2	0.27	218	218		
14	HAI	ABEL CUT & MAK	P/M	12	12	14	38	13	1.9	0.24	247	247		
15	SATHI	LABEL JOIN	P/M	14	15	15	44	15	2.2	0.28	213	213		
16	REHENA	CARE LABEL JOI	P/M	12	15	14	41	14	2.1	0.26	229	229		
17	SABINA	SIDE JOIN	O/L	35	35	38	108	36	5.4	0.69	87	234		
18	JOHIRUL		O/L	40	50	40	130	43	6.5	0.83	72			
19	MORJINA		O/L	40	45	40	125	42	6.3	0.80	75			
#	HATEM	FOLDING FOR SLEEVE HEM	H/P	16	12	14	42	14	2.1	0.27	224	224		
21	SHUMI	SLEEVE HEM	O/L	20	25	30	75	25	3.8	0.48	125	250		
#	FULJHORI		O/L	20	25	30	75	25	3.8	0.48	125			
#	AFROZA	FOLDING FOR BODY HEM	H/P	12	15	16	43	14	2.2	0.27	218	218		
#	HOSNA	BODY HEM	P/M	12	15	14	41	14	2.1	0.26	229	229		
TOTAL										9.07				



SAMPLE-2
Production(pcs)
500
450
400
350
300
250
200
150
100
50
0
275
240
229
229
209
229
254
261
472
218
218
247
213
229
234
224
250
218
229
SHOULDER JOIN
SLEEVE JOIN
NECK PIPING
THREAD CUT
STTICH OPEN
NECK RIB TACK
NECK RIB SERVICING
BACK TAPE PIPING & CUT
KAN TACK
BACK TAPE TOP STITCH
LABEL MARK
LABEL CUT & MAKE
LABEL JOIN
CARE LABEL JOIN
SIDE JOIN
FOLDING FOR SLEEVE HEM
SLEEVE HEM
FOLDING FOR BODY HEM
BODY HEM
Process Name

AMAZING FASHIONS LTD

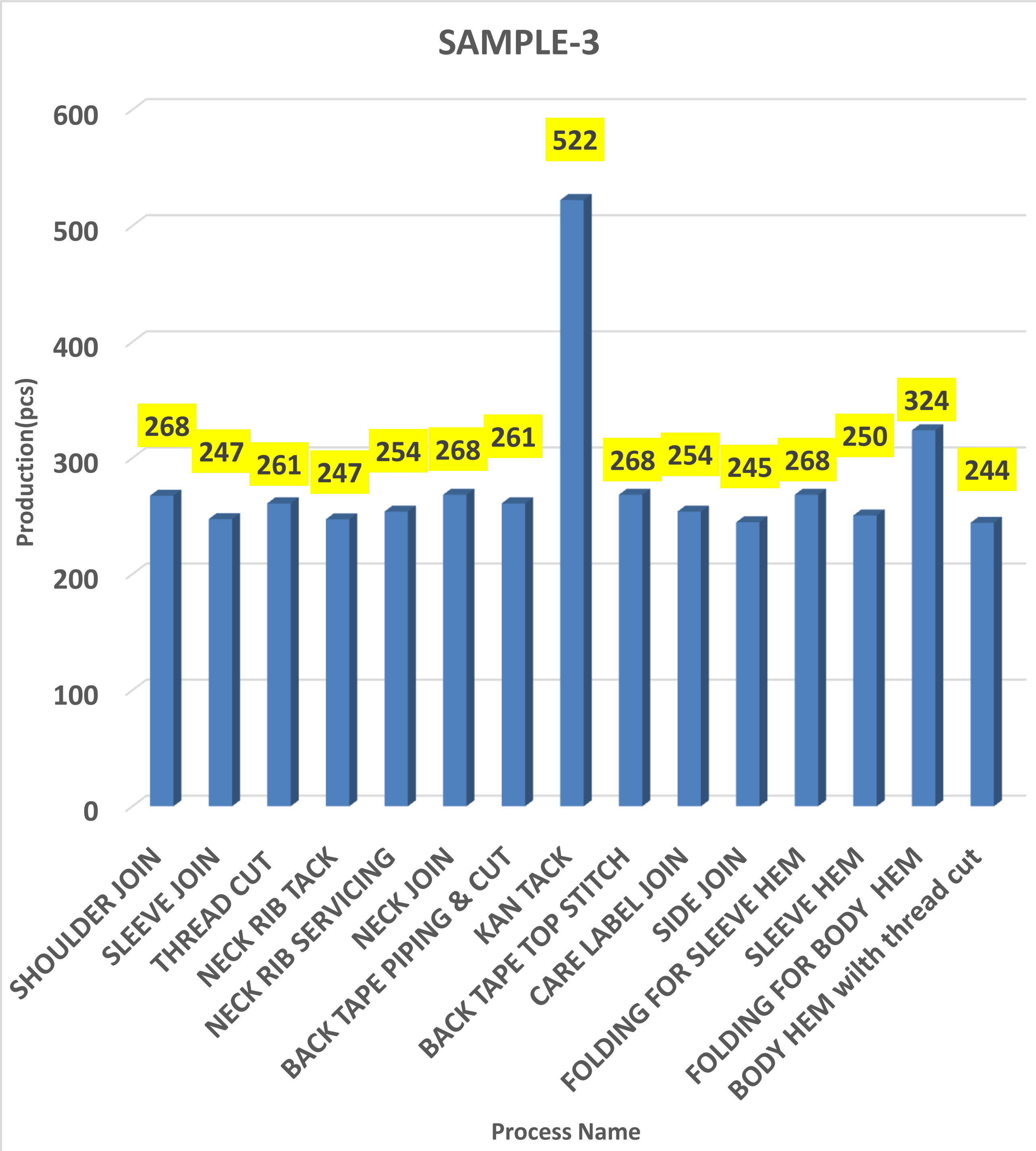
10,Dagerchala,Gazipur.

Capacity Study

Target HR :	280
Production :	244

Line :	A	STYLE :	GROSSO-289	DATE:	18-9-19
section:	sewing	ITEM :	T-SHIRT	COLOR:	

SL NO :	Operator Name	Operation name	Machine Name	Cycle Time 1st	Cycle Time 2nd	Cycle Time 3rd	TTL Time	Avg. Time	Allow Time	SMV	Capacity	TTL Capacity	NEED M/C	REMARKS
1	BITHE	SHOULDER JOIN	O/L	20	25	30	75	25	3.75	0.48	125	268		
2	SATHI		O/L	18	20	28	66	22	3.3	0.42	142			
3	TANIA	SLEEVE JOIN	O/L	25	22	27	74	24.67	3.7	0.47	127	247		
4	KULSUM		O/L	23	25	30	78	26	3.9	0.50	120			
5	HELENA	THREAD CUT	H/P	12	11	13	36	12	1.8	0.23	261	261		
6	ETI	NECK RIB TACK	P/M	12	14	12	38	12.67	1.9	0.24	247	247		
7	SANTA	NECK RIB SERVICING	P/M	12	13	12	37	12.33	1.85	0.24	254	254		
8	SURJI	NECK JOIN	O/L	12	13	10	35	11.67	1.75	0.22	268	268		
9	TASLIMA	BACK TAPE PIPING & CUT	F/L	10	12	14	36	12	1.8	0.23	261	261		
10	LIPI	KAN TACK	P/M	15	12	10	37	12.33	1.85	0.24	254	522		
11	HELENA	BACK TAPE TOP STITCH	P/M	10	12	13	35	11.67	1.75	0.22	268	268		
12	REHENA	CARE LABEL JOIN	P/M	13	10	14	37	12.33	1.85	0.24	254	254		
13	SABINA	SIDE JOIN	O/L	40	35	46	121	40.33	6.05	0.77	78	245		
14	JOHIRUL		O/L	37	36	40	113	37.67	5.65	0.72	83			
15	MORJINA		O/L	35	37	40	112	37.33	5.6	0.72	84			
16	HATEM	FOLDING FOR SLEEVE HEM	H/P	12	10	13	35	11.67	1.75	0.22	268	268		
17	SHUMI	SLEEVE HEM	O/L	20	25	30	75	25	3.75	0.48	125	250		
18	FULHORI		O/L	20	25	30	75	25	3.75	0.48	125			
19	AFROZA	FOLDING FOR BODY HEM	H/P	8	12	9	29	9.667	1.45	0.19	324	324		Support thread cut
20	HOSNA	ODY HEM wilth thread c	P/M	17	15	19	51	17	2.55	0.33	184	244		↓
TOTAL										7.63				


SAMPLE-3
600
500
400
300
200
100
0
Production(pcs)
268
247
261
247
254
268
261
522
268
254
245
268
250
324
244
SHOULDER JOIN
SLEEVE JOIN
THREAD CUT
NECK RIB TACK
NECK RIB SERVICING
NECK JOIN
BACK TAPE PIPING & CUT
KAN TACK
BACK TAPE TOP STITCH
CARE LABEL JOIN
SIDE JOIN
FOLDING FOR SLEEVE HEM
SLEEVE HEM
FOLDING FOR BODY HEM
BODY HEM wilth thread cut
Process Name

5.10 Fig: Comparison between above 3 styles

Calculation:

- Avg. Time = Total time / Total number of reading(3)
- SMV = Basic time + (basic time x 15% allowance)/60
- Basic time = avg. Cycle time x rating (here rating = 0.75)
- Capacity/Hr = Hr (3600) / avg. Times peroperation

Analysis of capacity Study:

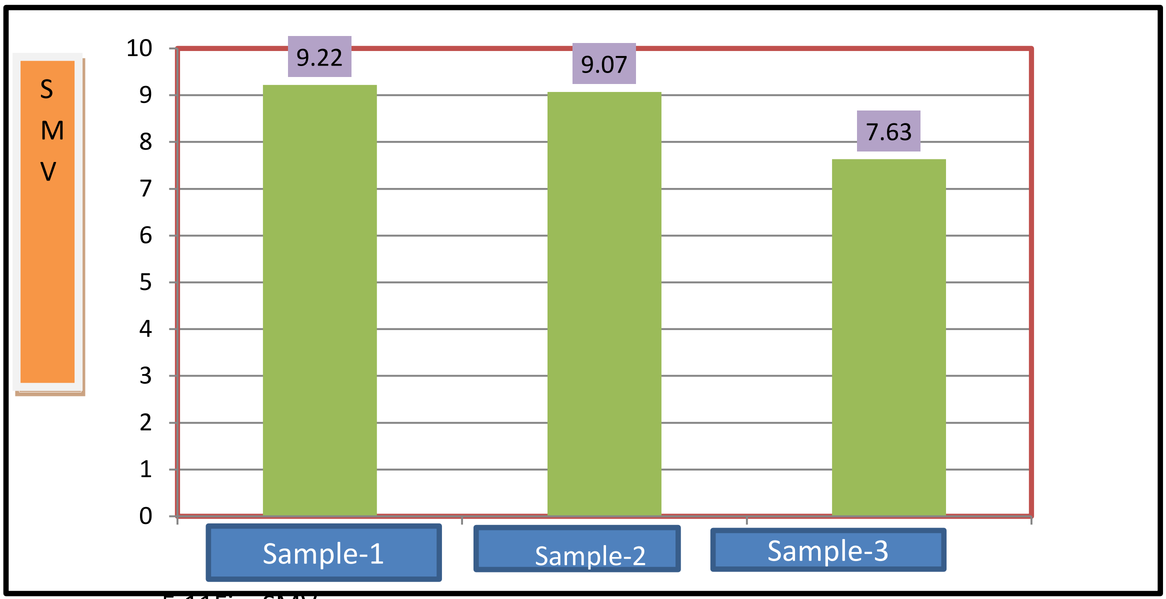
- ✓ To calculate capacity study, first we have to take at least five readings of each worker of allprocess.
- ✓ Then we have to calculate the average value of these fivereadings
- ✓ After then, the average value is divided by 3600 to get actual capacity perhour.
- ✓ Capacity study shows the worker capacity perhour.
- ✓ It helps for line balancing and maintains process layout of sewingoperation.

1. SMV:

SMV of the Sample-1 is 9.22

SMV of the Sample-2 is 9.07

SMV of the Sample-3 is 7.63



5.11Fig: SMV

Comments: 1. Sample-3 has more skilled operator but less skill operator is on other two Sample.

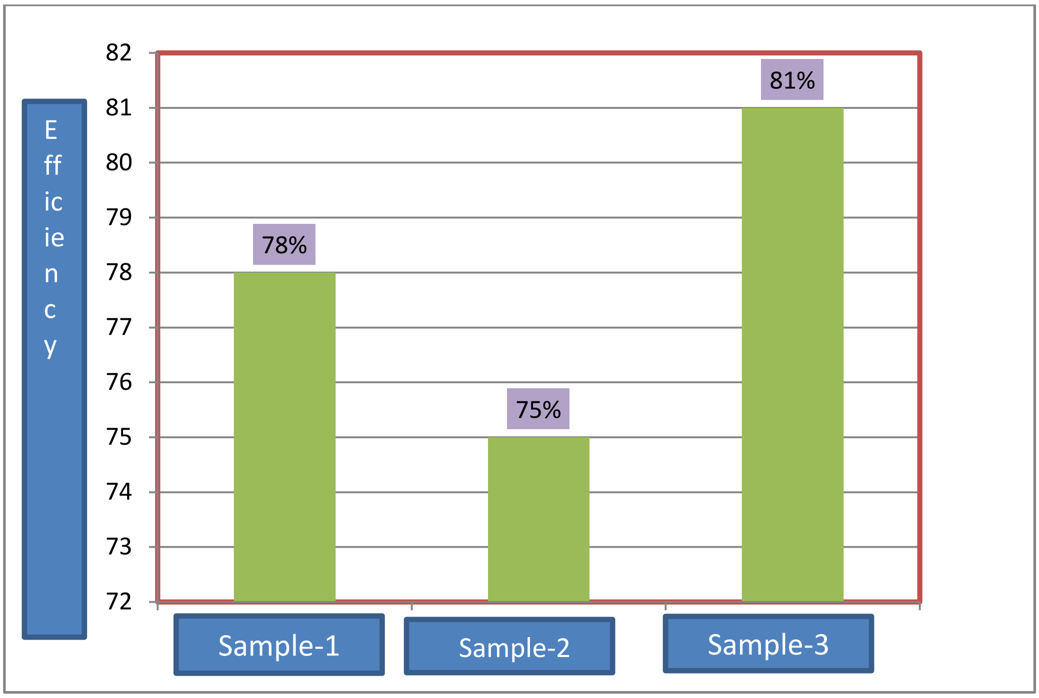
2. Sample-3 has less quality problem but more on other twoSample.

2. **Line Efficiency:**

Line Efficiency of the Sample-1is 78%

Line Efficiency of the Sample-1is 75%

Line Efficiency of the Sample-1is 81%



5.12 Fig: Line Efficiency

Comments:1.Less machine breakdown at Sample-3 but more machine breakdown of other two.

2. Sample-3 has good balance line but not so good in othertwo.

3. Good quality at Sample-3 but less quality in othertwo.

4. Sample-3 has more skill operator but has less skill operator in other two.

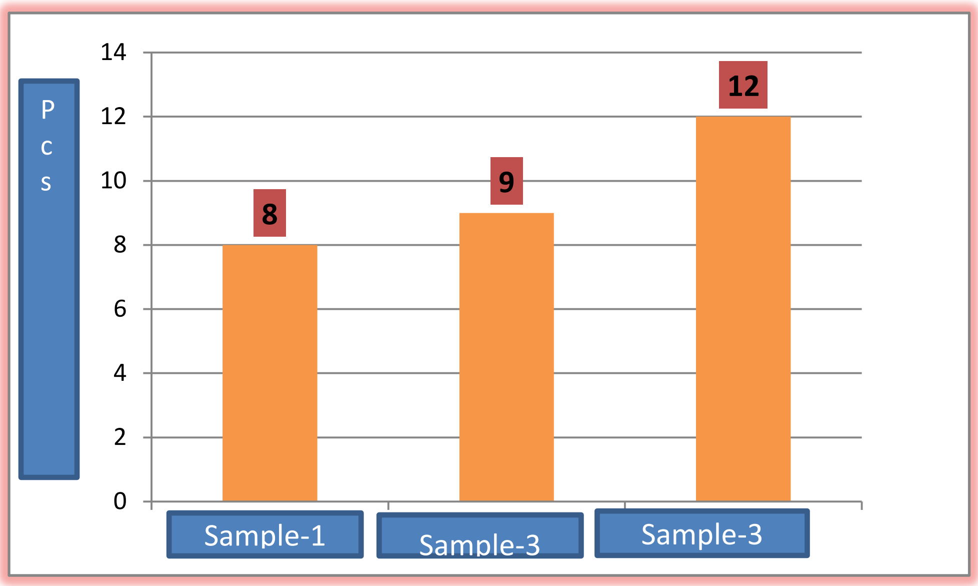
5. Sample-3 has good plant layout but other two plan layout not so good.

3. LaborProductivity:

Labor Productivity of Sample-1 is 8 Pcs.

Labor Productivity of Sample-2 is 9 Pcs

Labor Productivity of Sample-3 is 12 Pcs



5.13Fig**:** LaborProductivity

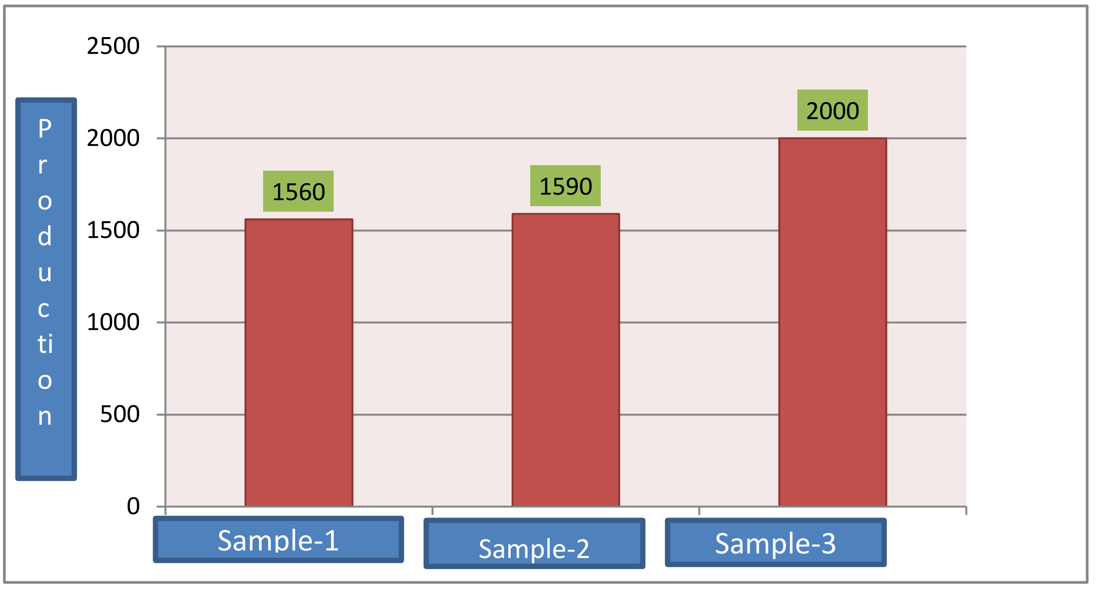
Comments: 1. Worker of Sample-1 is more attentive on their task but less attentive in other two.

4. LineTarget:

Line target of Sample-1 is 1560 pieces

Line target of Sample-2 is 1590 pieces

Line target of Sample-3 is 2000 pieces



5.14 Fig:LineTarget

Comments: 1. Sample-1 has good plan layout but not so good plant layout at other two.

2. Sufficient input in Sample-1 but insufficient at other two.

3. Another important parameter is skill operator at Sample-1.

CHAPTER-SIX

CONCLUSION
AND
RECOMMENDATIONS

6.1 Conclusion:

This thesis has come to termination finally after lots of thinking discussion and weuninterrupted trying. We really have worked hard to complete this thesis well ahead. We wouldlike to make it as a replica of production so that it provides a complete knowledge about T-shirt.
Through there where some limitation like shortages of time that compelled me to completed the thesis as soon as possible, even then we have tried to give my best. As we are found that SMV for a T-shirt is 6.14.we have found during my thesis that SMV of a T-shirt increased in terms of decorative garments and there is a decrease of productivity. On the other hand SMV decreased on the less decorative garments as a result productivity of garments is increased. Above discussion it is clear that correct SMV calculation is the key factor for garments productivity.

6.2 Recommendation:

When we look into the processes and operations during ourthesis work in Amazing Fashion Ltd.We have found improvement potential is there in the factory. But, there are few points that mightbe taken into consideration for improving the productivity.

✓ Efficiency as well as productivity would have been better if we would have takensome large quantity e.g. 25,000 pieces order.

✓ Balancing the process is highly related to the type of machines as machine utilizedin bottleneck and balancing process should be similar.

✓ Skilled operators should be in right place. If, it not happens then after couple ofhours, high skilled operators start sitting idle and low skilled operators stuck withtheir work. Thus line becomes imbalanced and lot of productive time is lost asoperators sit idle. On this occasion, skilled workers are eligible for the productionprocesses and proper training and supervision is essential to achieve the optimumimprovements on productivity and efficiency.

✓ They should use pitch diagram method to find bottlenecks inside the line and alsohave to minimize bottleneck operations by balancing operations.

✓ A straight assembly line with center table at left side is good for a product that hasno preparatory work and individual operation SAM is nearby the pitch time. Whena style includes lot of preparatory work (for garment parts), it is better to makegarment parts in sections and assemble them later. If possible use overheadtransportation system.

✓ Raw materials input should be available as per operators' efficiency.

✓ There are some kinds of time saving devises such as folders, guides,attachments,correct pressure foots etc. that facilitate operators' to perform their work effectivelywith less effort.

✓ Instead of giving equal target to all operators working in a line, give individualtarget as per operators’ skill level and capacity.

✓ Operators’ will is the most crucial part in productivity improvement. If they aremotivated, they will put enough efforts on the work. Employee motivationgenerally depends on various factors like working atmosphere, HR policies andbonus on extra effort or achieving target.

6.3REFERENCE

References

1. RahmanMizanur, (Thursday, 06 December 2012). RMG sector: Secret of success and causes of unrest, senior vice- p resident (IBBL).

2. Berg Achim, November 2011,Principal, McKinsey's Frankfurt, Co-coordinator, McKinsey's Apparels, Apparel, Fashion & Luxury Practice,

3. Mücella G. Güner, Can Ünal, Department of Textile Engineering, Faculty of Engineering, University of Ege, Izmir, Turkey, Line Balancing in the Apparel industry Using Simulation Techniques, FIBRES & TEXTILES in Eastern Europe April / June 2008, Vol. 16, No. 2 (67), p-75.

4. Glock, R. E. & Kunz, G. I. (1995). Apparel Manufacturing-Sewn Product Analysis, Prentice Hall ,New Jersey, p:4
Oxford, pp. 60-63.

5.Cooklin, G. (1991). Introduction to Clothing Manufacturing, Blackwell Science, Oxford, p.104.

6 A. NoorulHaq, K. Rengarajan, J. Jayaprakash, "A hybrid genetic algorithm approach to mixed-model assembly line balancing", The International Journal of Advanced Manufacturing Technology, vol. 28, no. 3–4, pp.337–341, 2005.

7. Y. Kara, U. Ozcan, A. Peker, "An approach for balancing and sequencing mixed-model JIT U-lines", The International Journal of Advanced Manufacturing Technology, vol. 32, no. 11–12, pp.1218–1231, 2006.

8.A. Scholl, N. Boysen, M. Fliedner, "Optimally solving the alternative sub graphs assembly line balancing problem", Annals of Operations Research, vol. 172, no. 1, pp.243– 258, 2009.

9. Hui, C. & Ng, S. (1999). A study of the effect of time variations for assembly linebalancingin the clothing industry International Journal of Clothing Science and Technology, Vol.11, pp. 181-188.

10. Kursun, S. &Kalaoglu, F. (2009). Simulation of Production Line Balancing in Apparel Manufacturing, FIBRES & TEXTILES in Eastern Europe Vol. 17, No. 4 (75), pp.68-71.

11. Labor Management in Development Journal, 2001, Vol.2 Number 7 P.5.

14. Stuart D, 2011. Calculation of SAM Through Time Study, http://www.onlineclothingstudy.com/2011/02/how-to-calculate-sam-ofb

THANKS…