Faculty of Engineering

Department of Textile Engineering

Report On

"Study on SMV and Line balancing of Garments"

Course Title: Project (Thesis)
Course Code: TE 4214

Submitted By

Name	ID
Md.Tarek Zaman	152-23-4391
Md.Shamim Imtiaz	152-23-4399
Md. Abdul Motaleb	152-23-4386

Supervised By

Mohammad Abdul Baset
Assistant Professor
Department of textile Engineering
Daffodil International University

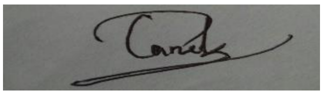
This Report Presented in Partial Fulfillment of the Requirements for the Degree of **Bachelor of Science in Textile Engineering**.

Advance in Apparel Manufacturing Technology

Date of submission: April, 2018

Declaration

We hereby declare that, this project has been done by us under the supervision of Mohammad Abdul Baset, Assistant Professor, Department of TE, and Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree. There is no part of this paper directly copy from other.



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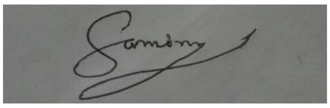
Md. Tarek Zaman

ID: 152-23-4391



………………………...

Shamim Imtiaz

ID: 152-23-4399

……………………….

Md. Abdul Motaleb

ID: 152-23-4386

LETTER OF APPROVAL

6 April 2018

To

The Head

Department of Textile Engineering

Daffodil International University

102, Shukrabad, Mirpur Road, Dhaka 1207

Subject: Approval of Project Report of B.Sc. in TE Program

Dear Sir,

I am just writing to let you know that this project report titled as **“Study on SMV and Line balancing of Garments”** has been prepared by the students bearing ID 152-23-4391 and 152-23-4399 , 152-23-4386 is completed for final evaluation. The whole report is prepared Baset on the proper investigation and interruption through critical analysis with required belongings. The student were directly involved in their project activities and the report become vital to spark of many valuable information for the readers.

Therefore it will highly appreciate if you kindly accept this project report and consider it for Final evaluation.

Yours sincerely

…………………………..

Mohammad Abdul Baset

Assistant Professor,

Department of Textile Engineering

Daffodil International University

Acknowledgement

All pleasure goes to the Almighty **Allah** to give us strength and ability to complete the Project and prepare without any completions and submit the report on time with success.

For the successful completions of this project, we must remember the person of the responsibilities who made our project work easier and helped us to enrich our knowledge. Their insight, advice and suggestion, helped us a lot. We would like to pay special thanks to the following person **Mohammad Abdul Baset,** Assistant Professor, Daffodil International University .for his proper management & guidance. His ideas and advice helped us to complete the project as well as to write the report successfully.

We express our sincere acknowledgement to our **Professor Dr. Md. Mahabubul Haque**, Head of the Department of Textile Engineering, Daffodil International University. His ideas and advice helped us to complete the project as well as to write the report successfully.

Finally, we would like to acknowledgement that we remain responsible for the inadequacies and errors, which doubtless remain in the following report.

Dedication

To our parents who brought us to the earth & who give we chance to study in Textile Engineering and support us all time.

Abstract

We completed our thesis on “Study on SMV and Line balancing of Garments”. This paper clearly explains the total operation of long sleeve shirt and SMV calculation. Total SMV of long sleeve shirt is 22.41 and we also done compare the before line balancing and after line balancing. At last we have seen this result summary that production are increasing by doing line balancing than before line balancing .To do line balancing production are increasing 21 per hours than before line balancing .

After Line balancing gain Productivity increase, Smooth work flow, balanced cycle time, Easy fault finding, reduced bottleneck, balanced line efficiency, Reduction operation breakdown, and Equal distribution of work Skilled, semiskilled & unskilled co-ordination and Easy way to supervise.

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CHAPTER 1
INTRODUCTION

1. Introduction

1. 1 Introduction of Study

As the demand for readymade garments increases rapidly across the global market, Bangladesh's position as the world's second largest readymade garment exporter continues to hold strong. The Bangladesh government just set a $37 billion export target for the 2016-17 fiscal year, of which over $30 billion will be contributed by the ready-made garment sector – the country's largest source for export earnings. According to the data from Bangladesh's Export Promotion Bureau, the garment and apparel industry in Bangladesh generated $28.09 billion exports in the fiscal year 2015-16 with a 10.21% growth from the previous year. The growth was mainly attributed to political calmness during the year, increased productivity, entrepreneurs' resilience and improvement of workers' safety standards in factories. The readymade garment (RMG) industry in Bangladesh is the largest and most renowned manufacturing sector and GDP contributor. Bangladesh exports around $30 billion readymade garments every year. The advantages of Bangladesh's readymade garment industry, including low labor cost, favorable business climate, and well established transportation facility, are pushing the industry to develop at a significant rate.

Readymade garments exported from Bangladesh represent around 6% of the global clothing market. Bangladesh surpassed India to become the world's second largest exporter in 2003. An increasing number of famous international fashion brands, such as Zara, H&M, Gap and Levi's, are already manufacturing and importing clothes from Bangladesh. It is expected that Bangladesh will continue to strengthen its position as the leading readymade garment exporting country.

Meanwhile, the textile and readymade garment industry in Bangladesh is also putting more effort into improving gender equality in the country and empowering women to work. The government of Bangladesh has consistently made it a point that women remain the focus area in most of their policy plans. At present, the textile industry employs around 4 million citizens, and is one industry where women are in high numbers – almost 90% of the workforce. To continue increasing the country's readymade garment exports in the global market, the

Bangladesh Garment Manufacturers and Exporters Association (BGMEA) and the Bangladesh Knitwear Manufacturers and Exporters Association (BKMEA) are focusing on further boosting and promoting the country's readymade garment sector by facilitating a healthier business environment, training more skilled workers, improving social compliance status, and improving coordination among the manufacturers, exporters and importers, with the goal of increasing Bangladesh's foreign exchange earnings. Now Bangladesh's vision is to achieve $50 billion readymade garment exports by 2021

At last Textile industry is one of the world's major industries and the garment industry is a substantial one within the supply chain of textile industry. The production process of garments is separated into four main phases.1 designing/clothing pattern generation, 2 fabrics cutting, 3 sewing, and 4 ironing/packing (Finishing). The most critical phase is the sewing phase, as it generally involves a great number of operations. The sewing line consists of a set of workstations in which a specific task in a predefined sequence is processed. In general, one to several tasks are grouped into one workstation. Tasks are assigned to operators depending on the constraints of different labor skill levels. Finally, several workstations in sequence are

Formed as a sewing line. Shop floor managers are concerned about the number of workstations. Inappropriate workstations assignment will leads to the increase of labor cost, WIP, cycle time and poor throughput. [3] These shop floor supervisors arrange tasks to workstations based on their experience in practice. As a result, the line balance performance cannot be guaranteed from one supervisor to another with different assignment preference and/or work experience.

Chapter 02

Literature Review

2. Literature Review

2.1 Line Balancing

A production line is refers to be in balance when every manpower task receive the same amount of time. Line balancing is a manufacturing-engineering function in which whole collection of production-line tasks are divided into equal part. Well-balanced lines cross off labor idealness and increasing productivity & excess capacity.

"The Line Balancing is "to design a smooth production flow by allotting processes to workers so as to allow each worker to complete the allotted workload within an even time" .It also done same amount of work to customer requirement and no one overburdened, no one waiting.

It is the allocation of sewing machine, according to style and design of the garments. It depends on what types of garments we have to produce. It is done to improve productivity.

2.2 Importance of Line Balancing

1. Line balancing helps to know about new machine need for new style.

2. As a result of line balancing are done easy distribute particular job to each operator.

3. It becomes possible to deliver goods at right time at the agreed quality for list cost.

4. Well line balancing improve the rate of production.

5. It also helps in the determination of labor requirement.

6. Well balancing reduces production time.

7. Proper line balancing given easy Profit of a factory

8. It also done reduces faults in the finished product.

2.3 Example of Line Balancing

Machine layout with actual production.

- ❖ Process@1. Production 35 pieces by 1 machine end production 35 pieces.
- ❖ Process@2. Production 45 pieces by 1 machine end production 35 pieces.
- ❖ Process@3. Production 55 pieces by 1 machine end production 35 pieces.

- ❖ Process@4. Production 70 pieces by 1 machine end production 35 pieces.
- ❖ Process@5. Production 45 pieces by 1 machine end production 35 pieces.

  Output: 35 paces/hour.

2.4 Balancing Method

The most basic methods are

- ➢ Time Study,
- ➢ Bottle Neck Process Theory
- ➢ Data Collection and Analysis.

2.5 Cycle time:

Cycle Time may be defined as the ratio between the effective time available per period and the production volume per period. Effective time available = (Time per period) X per period (%Utilization of period) the cycle time may also be interpreted in the following ways: It is the time between consecutive releases of finished assembly's frail the last station of the line.[6] It is the time between consecutive releases of semi -finished products between any two adjacent stations.

2.6. Operational sequence of a short pant

Fig 2.1 short pant

Front Part

Ironing (Fusing)

Single fly over lock

Double fly over lock

Front part over lock with single fly & two F. part joint

Front pocket joint (Plain)

Front facing, body & pocket joint (Plain)

Front pocket rolling (2 needle plain)

Front pocket facing close (Plain)

Side tack (Plain)

Front pocket over lock

Front pocket ¼ stitch (Plain)

Single fly top seam & zipper joint with single fly (Plain)

Double fl joint with zipper (Plain)

Care label attach (plain)

Back PART

Back part dark mark & stitch (Plain)

Back part fusing with Iron

Back part top seam (Velcro m/c)

Back pocket tack (Plain)

Back pocket bone making (APW)

Back pocket bone top seam (Plain)

Back pocket facing joint (Plain)

Back pocket over lock

Back pocket ¼ stitch (Plain)

Back pocket top seam (Plain)

Main label attach (Plain)

ASSEMBLY

Front & back part matching

Side seam over locking

Inseam over locking

Back raise top seam (Plain)

Belt loop joint (Plain)

Waist belt joint (Plain)

↓

Label attaching

↓

Waist belt mouth closing (Plain)

↓

Waist belt tack (Plain)

↓

Waist belt joint (Kansai)

↓

Bottom hem joint (2 needle plain)

↓

Loop Bartech (bone, front rise side pocket Bartech)

↓

Loop Bartech (Loop upper & lower)

2.7 Operational sequence of a long pant

Fig: 2.2 long pant

Front part

Ironing (Fusing)

↓

Single fly joint with front part (Over lock)

↓

Single fly top seam (Plain)

↓

Zipper joint (Plain)

↓

Front part tack (Plain)

↓

Zipper joint with D/fly & front part (Plain)

↓

High joint & j stitch at single fly (Plain)

↓

Front pocket joint

Front pocket rolling ¼ stitch (Plain)

Front pocket facing top seam (Plain)

Front pocket tack (Plain)

Front pocket over lock

Pocket ¼ stitch (Plain)

Back part

Back part dark mark

Back part tack (Plain)

Back part fusing with Iron

Back pocket tack (Plain)

Back pocket bone making (APW)

Back pocket bone top seam (Plain)

Back pocket facing joint (Plain)

Back pocket over lock

Back pocket ¼ stitch (Plain)

Back pocket top seam & mouth close of back pocket

Iron
ing for keeping bone straight

Assembly

Front & back part matching

Side top seam (Plain)

Attach care label

Side seam over locking

Inseam over locking

Back rise over lock

Back rise top seam (Plain)

Belt loop joint (Plain)

Waist belt joint (Plain)

Label attaching

Waist belt mouth closing (Plain)

Waist belt tack (Plain)

↓

Waist belt joint (Kansai)

↓

Loop Bartech (bone, front rise side pocket Bartech)

↓

Loop Bartech (Loop upper & lower)

↓

Bottom hem joint (2 needle plain)

Fig.2.3 Line view of Short pant

2.8 Required types of sewing machines:

Basically in the case of both short & long pant almost same types of sewing machines are required. But according to buyer requirement for the different design purpose very few machine can be changed. However if anyone need can complete a short or long pant by lock stitch machine. In our experiment we have seen that almost same types of sewing machine are used in both short & long pant. Here the lists of required types of sewing machine including figure & application areas are given.

1. Single needle lock stitch.
2. Double needle lock stitch.
3. Over lock.
4. Feed of the arm.
5. Kansai.
6. Bartacking m/c
7. Chain stitch
8. APW
9. Velcro attaching m/c

2.9 SMV

SMV: Standard Minute Value. Or SAM: Standard Allowed Minute.

Defining Standard Time: Standard Time {also referred to as the "Standard Allowed Minute (SAM)" or "Standard Minute Value (SMV)"}, is the time required for a qualified worker working at "Standard Performance" to perform a given task. The SAM or SMV includes

Additional contingencies allowances to recover the lost time due to personal needs, fatigue and unavoidable delays.

SMV= Basic time + Allowance. [5]

Basic Time:

The basic time for the operation is found by applying concept of rating to relate the observed to that of a standard place of working. Calculated as follows.

Basic time = observed time * observed rating / 100

Example..

Rating

50 75 100 125

Observed time 1.3, 0.8, 0.6, 0.5

Basic Time = 1.3*50 /100 0.8*75 /100 0.6*100/100 0.5*125/100

= 0.6 0.6 0.6 0.6

2.10 Standard Time

Basic steps to calculate standard time:

1. Define the task to be studied, and inform the worker(s) who will be studied.
2. Determine the number of cycles to be observed.
3. Time the job and rate the performance
4. Compute the standard time

2.11 SAM of Woven shirt part

operation	SAM
Collar make	0.50
Front part fêting	0.32
Pocket rolling	0.24
Bk yoke join	0.45
Collar join	0.46
Slv join	0.92

Table: 2.1 SAM of Woven shirt part

2.11.1 What Types of Sewing Machine Required for Shirt Manufacturing?

1. Edge neatening or over lock sewing machine,

2. Plain or lock stitch sewing machine,

3. Button holing machine,

4. Feed of the arm sewing machine,

5. Flat lock sewing machine,

6. Button attaching machine.

7. Bartack machine

8. Kansai special machine

Fig 2.4 see operation in different parts of woven shirt

2.12 Some Important formula

Line Labor Productivity:

$$\text{Line Labor Productivity} = \frac{\text{Total number of output per day per line}}{\text{Number of worker worked}}$$

Line Machine Productivity:

$$\text{Line Machine Productivity} = \frac{\text{Total number of output per day per line}}{\text{Number of machines used}}$$

Line Efficiency:

$$\text{Line Efficiency} = \frac{\text{Total output per day per line} * \text{SAM}}{\text{Total manpwer per line} * \text{total working minutes per day}} * 100\%$$

Theoretical Manpower:

$$\text{Theoretical Manpower} = \frac{\text{Target per houre}}{\text{Process capacity per houre}}$$

Target:

$$\text{Target} = \frac{\text{Total manpower per line} * \text{Total working minute pewr day}}{\text{S.A.M}} * 100\%$$

Standard Pitch Time (S.P.T) = Basic Pitch Time (B.P.T) + Allowances (%)

SMV

SMV = Basic time + (Basic time * Allowance)

Basic time

Basic time = Observed time * Rating

Observed time

Observed time = Total Cycle time / No of cycle

Earn minute

Earn minute = No of Pc's (Production) * Garments SMV

Available minute

Available minute = Work hour * Manpower

Factory capacity

Factory capacity = (Work hour / SMV) * Total worker * Working day * Efficiency

Efficiency
Efficiency = (Earn minute * Available minute) * 100

2.13 Productivity

According to Marsh, Brush (2002) in his article Journal of industrial technology, productivity is a measure of the efficiency and effectiveness to which organizational resources (inputs) are utilized for the creation of products and/or services (outputs). Productivity measurement is both a measure of input utilization and an assessment as to whether or not input utilization is growing faster than output.

2.14 Bottleneck

A bottleneck is a point of congestion in a production system that occurs when workloads arrive too quickly for the production process to handle. It is a metaphorical scene of obstruction of production sector. It is an extreme point in a production sector where production is hampered from normal flow of production. In a production sector bottleneck means lost production and lost profit e.g. the lowest capacity of production.

2.15 The assembly line balancing

The classical assembly line balancing problem (ALBP) considers the assignment of tasks to the workstations. Main concern of the assignment is the minimization of the total assembly cost while satisfying the demands and some restrictions like precedence relations among tasks and some system specific constraints. [6]

2.15.1 Classifications of assembly line system

Assembly lines can be classified as single-model, mixed-model, and multi-model systems according to the number of models that are present on the line.

Single-Model assembly line:

Single-Model Assembly lines have been used in single type or model production only. There are large quantities of the products, which have the same physical design on the line. Here, operators who work at a workstation execute the same amount of work when a sequence of products goes past them at a constant speed.

Mixed-Model assembly line:

Mixed-Model Assembly lines are usually used to assemble two or more different models of the same product simultaneously. On the line, the produced items keep changing from model to model continuously.

Multi-Model assembly line:

Multi-Model Assembly lines. Several (similar) products are manufactured on one or several assembly lines. Because of significant differences in the production processes, rearrangements of the line equipment are required when product changes occur. Consequently, the products are assembled in separate batches in order to minimize set-up inefficiencies. While enlarging batch sizes reduces set-up costs, inventory costs are increased.[7]

2.16 Problems in line balancing

Nowadays assembly lines move towards cellular manufacturing in terms of variety of production. As a result of this, usage of special equipment and/or professional workers, which are able to perform more than one process, is increasing. In order to benefit from continuous productions advantages, these equipment and workers must be added to the line in a way by which high efficiency measures (maximum usage, minimum number of stations) can be achieved.

This theory is supported by Barbers (1986), he stated that while designing the line, the list of task to be done, task times required to perform each task and the precedence relations between them are analyzed. While tasks are being grouped into stations based on this analysis, the following goals are regarded:

1. Minimization of the number of workstations for a given cycle time. 2. Minimization of cycle time for a given number of work stations.

Nicosia et.al (2002) studied the problem of assigning operations to an ordered sequence of non-identical workstations, which also took precedence relationships and cycle time restrictions into consideration.[8] The aim of the study was to minimize the cost of workstations. They used a dynamic programming algorithm, and introduced several fathoming rules to reduce the number of states in the dynamic program.

Falkenauer (2000) listed a few of the difficulties that must be tackled in a line balancing tool in order to be applicable in the industry. Those difficulties are: Workstation cannot be eliminated. Since each work-station has their own identities, it is obvious that the workstations cannot be eliminated unless the workstations were in front or at the end of the line. The elimination of any workstation at the middle will create a gap or holes in the assembly line.

- The load needs to be equalized. A small increase in the maximum lead time may yield a substantial reduction in load misbalanced. Tact time is normally set by the company's marketing that sets production target. The cycle time must not exceed the given Tact time. But, it is normally useless to reduce the line's cycle time below that value. Minimizing the cycle time is only required as long as it exceeds the Tact Time. Once, the objective is met, equalization of workload should be pursued instead.
- Multiple operators. Once a workstation features more than one operator, the workstation's lead time ceases to be a simple sum of durations of all operations assigned to it. Firstly, the whole workstation need to have time equal to the "slowest" operator to complete all operations assigned to the workstation. Since different workstation has different workload, hence it is surely not equal to the sum of durations divided by the number of operator. The precedence constraint that nearly exists among the workstations may introduce idle (waiting) time between operations. This idle time reduces efficiency of the workstation and must be reduced as much as possible [8]

Chapter 03

Experimental Details

3. Methodology

3.1 SAM and worker efficiency calculation of long sleeve Men’s shirt, line A

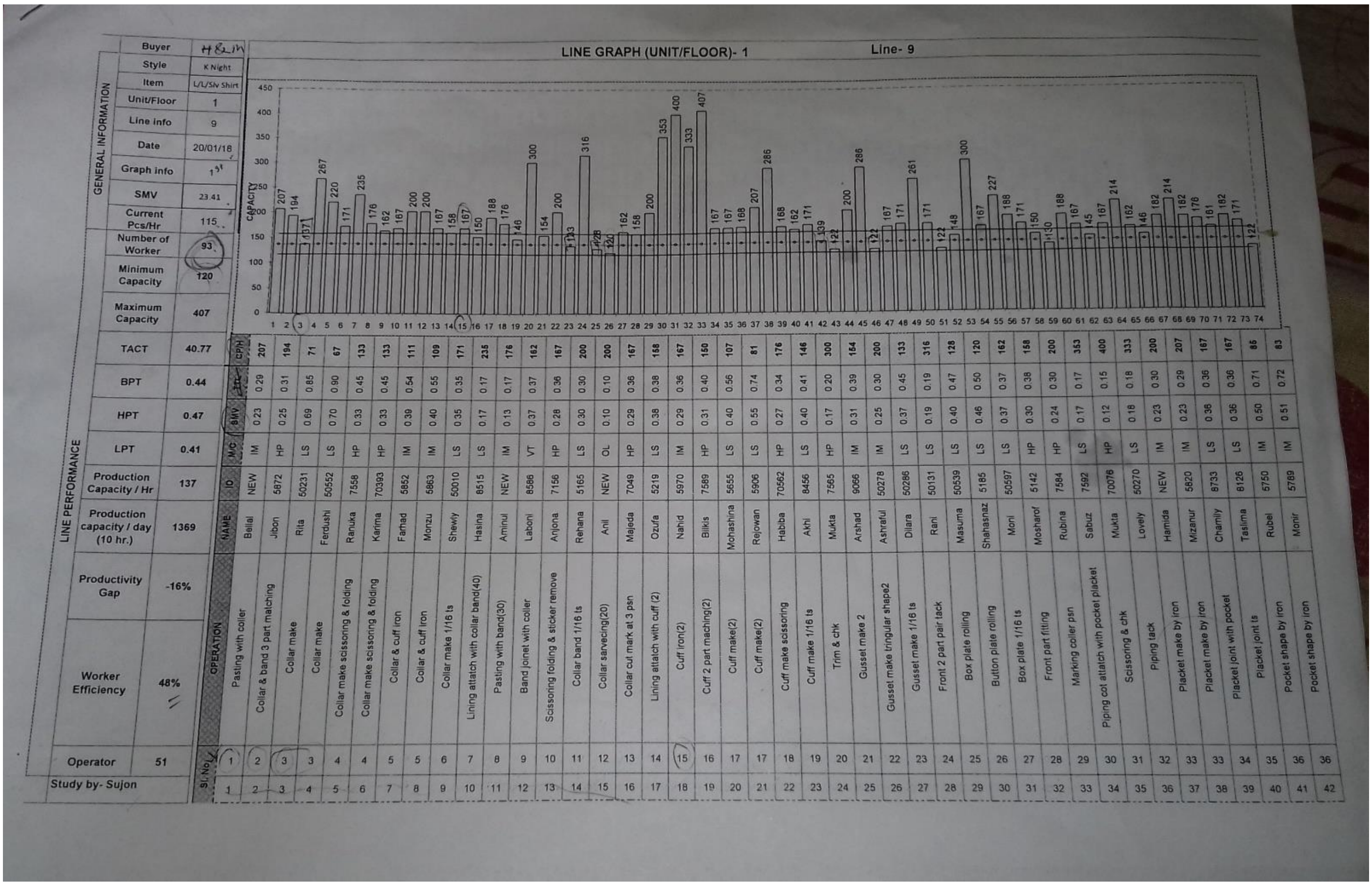

Fig: 3.1 SAM and worker efficiency calculation of long sleeve Men’s shirt

From this figures we see the operation of long sleeve shirt and we calculation the SAM of different parts. At first start the operation pasting with caller, caller make then at last done button attatch at 11 pieces. Then final trim and check. Total operation are done 56 this shirt .The following the operation and know the SMV of make full shirt done 23.41 min .And we calculate the worker efficiency and productivity of line. Productivity gap is 16 %. Current pcs/hr. is 115. And the production 10 hour is 1150. Productivity is 84% this line.

3.1.1 SAM and worker efficiency calculation of long sleeve Men's shirt data

Buyer- H&M

Order No. PETE-BD (256826)

Style / Item- L SLV men's shirt

Line No.-09

Order quantity- 5k

Factory-New age garments ltd

S/No	Operation Description	SAM
1	Pasting with caller	0.23
2	Collar 3 Part match & Mark	0.25
3	Collar Make	0.69
4	Scissoring After Collar Make	0.28
5	Collar Turning	0.2
6	Iron At Collar	0.18
7	Collar Make1/4 Ts	0.4
8	Band 3 Part Match & Match With Collar	0.3
9	Band Join With Collar	0.46
10	Scissoring After join 2 End Psn	0.32
11	Band Rolling	0.24
12	Regular Label Attach At Band	0.36
13	Band Join 1/16 T/s	0.29
14	Collar BTM Cut & Cut Mark At 3 PSN	0.3
15	Iron At Cuff	0.32
16	Cuff Make	0.6
17	Scissoring After Cuff Make Turn Over	0.32
18	Front Part Pair Tack & Care Label Attach	0.2
19	Box Plate Rolling	0.26
20	BTN Plate Rolling	0.38
21	Neck & Pocket Mark	0.3
22	Front Part Feeting	0.32

23	Pocket Rolling PSN Shape By Iron	0.18
24	Pocket Rolling	0.24
25	Iron At Pocket	0.3
26	Pocket Extra Part Scessoring	0.41
27	Pocket Attach	0.67
28	BK Part Ticken Make	0.2
29	Flag Label Attach With Main Label& Main Label Attach At Bk Yoke PSN	0.4
30	BK Yoke Join	0.45
31	BK Yoke Join 1/16 T/S	0.26
32	Bk & Fornt Part Match	0.32
33	Shoulder Join & Trim	0.53
34	Shoulder Join 1/16 T/S	0.26
35	Collar Mark & Match	0.36
36	Collar Join	0.46
37	Collar join 1/16 T/S With Size Label Attach	0.75
38	Gumble Binding	0.4
39	SLV Gumble Binding Tack	0.34
40	PLKT Shape By Iron	0.8
41	SLV Plkt attach both	0.74
42	Slv plkt attach exta part scissoring & mark for cuff join	0.37
43	Slv and body match	0.3
44	Slv join	0.92
45	Trim and check	0.31
46	Arm hole ¼ t/s	0.75
47	Bottom Hem acissoring	0.4
48	Bottom hem rolling	0.5
49	Side join both	0.75
50	Trim at check	0.4
51	Cuff tikken mark and match with body	0.43
52	Cuff join (to)	0.75
53	Hole at 11 psn	0.7
54	BTN attach mark at 9 psn	0.26
55	BTN attach at 15 psn	1
56	Final trim	0.3
	Total operation = 56	Total SAM = 23.41
Total worker efficiency =48%		

Table: 3.1 long sleeve Men’s shirt operation and SAM

long sleeve Men’s shirt make total SAM = 23.41 min

Total worker efficiency =48%

Total operation = 56

Section	OP	HP	IM	Total
Make	15	7	4	26
Body	44	18	5	62
Total	59	25	9	93

Table: 3.2 Total man power

3.2 SAM and line capacity calculation of long sleeve Men’s shirt , line B

NEWAGE GROUP

LAYOUT SHEET	Hours Per Day	Unit:	Floor/Line	Order No.	Style/Item	Buyer	Plan Productivity /Day 45%	Potential Productivity /Day 50%	Potential Productivity /Day 55%	Potential Productivity /Day 100%	Pre Line Balancing %	1st Day Output	2nd Day Output	3rd Day Output
	10	NGL-2	ND Line-01,02,0	PETE-BD(256826)	L Slv Mens Shirt	H&M	539	598	658	1197	131.93%	10th Day Output	11th Day Output	12th Day Output
		PPM Date:	Delivery Date:			Acc to MP	163	181	200	363	434.97%			

S/NO	M/C TYPE & HP	OPERATION DESCRIPTION	SAM	TOTAL TIME	NAME	HOURLY POTENTIAL @ 100%	HOURLY POTENTIAL @70%	DAILY POTENTIAL 100%	Daily Plan@0.45	Daily Potential@0.5	Daily Potential@0.55	Manning Required	Target/Hr @ 100%	Target/Hr @ 70%	Manning	Attachment (E/M)	REMARKS
1	HP	COLLAR 3 PART MATCH & MARK	0.18	0.18		333	233	3333									
2	SNLS	COLLAR MAKE	0.50	0.50		120	84	1200				0.4					
3	HP	SCISSORING AFTER COLLAR MAKE	0.24	0.24		250	175	2500	810	900	990	1.0	180	126	1.5		
4	IM	COLLAR TURNING	0.20	0.20		300	210	3000				0.5					
5	IM	IRON AT COLLAR	0.18	0.18		333	233	3333				0.4					
6	SNLS	COLLAR MAKE 1/4 T/S	0.40	0.40		150	105	1500				0.4					
7	HP	BAND 3 PART MATCH & MATCH WITH COLLAR	0.30	0.30		200	140	2000	1013	1125	1238	0.8	225	158	1.5		
8	VT	BAND JOIN WITH COLLAR	0.46	0.46		130	91	1304				0.6					
9	HP	SCESSORING AFTER BAND JOIN 2 END PSN	0.32	0.32		188	131	1875	880	978	1076	0.9	196	137	1.5		
10	SNLS	BAND ROLLING	0.24	0.24		250	175	2500				0.6					
11	SNLS	REGULAR LABEL ATTACH AT BAND	0.36	0.36		167	117	1667	900	1000	1100	0.5	200	140	0.8		
12	SNLS	BAND JOIN 1/16 T/S	0.29	0.29		207	145	2069	750	833	917	0.7	167	117	1		
13	HP	COLLAR BTM CUT & CUT MARK AT 3 PSN	0.30	0.30		200	140	2000	931	1034	1138	0.6	207	145	1		
14	IM	IRON AT CUFF	0.32	0.32		188	131	1875				0.6					
15	VT	CUFF MAKE	0.60	0.60		100	70	1000				0.6					
16	HP	SCISSORING AFTER CUFF MAKE TURN OVER	0.32	0.32		188	131	1875	900	1000	1100	1.2	200	140	2		
17	SNLS	FRONT PART PAIR TACK & CARE LABEL ATTACH	0.20	0.20		300	210	3000				0.6					
18	KAN	BOX PLATE ROLLING	0.26	0.26		231	162	2308	1080	1200	1320	0.4	240	168	0.8		
19	SNLS	BTN PLATE ROLLING	0.38	0.38		158	111	1579	831	923	1015	0.5	185	129	0.8		
20	HP	NECK & POCKET MARK	0.30	0.30		200	140	2000	711	789	868	0.8	158	111	1		
21	HP	FRONT PART FEETING	0.32	0.32		188	131	1875				0.6					
22	IM	POCKET ROLLING PSN SHAPE BY IRON	0.18	0.18		333	233	3333				0.6					
23	SNLS	POCKET ROLLING	0.24	0.24		250	175	2500	900	1000	1100	0.4	200	140	0.8		

Manager / Officer IE   Incharge Mechanic   Manager / Incharge Quality   Supervisor / Line Chief / Incharge(Make) / Incharge / Manager / FM / DGM Sewing Section

Fig.3.2 SAM and line capacity calculation of long sleeve Men’s shirt.

We compare the line and line 1. The different of two line SMV and productivity. We can see the operation of long sleeve shirt and we calculation the SAM of different parts is 22.81 but line 9 SMV is 23.41 .At first start the coller 3 parts match and make , caller make then at last done button attatch at 15 pieces. Then final trim and check. Total operation are done 55 this shirt .The following the operation and know the SMV of make full shirt done 22.81 min. And we calculate the Line capacity is 1447 pcs. Productivity is 86% and Productivity gap is 14%.

3.2.1 SAM and worker line capacity calculation of long sleeve Men's shirt data

Buyer- H&M

Order No. PETE-BD (256826)

Style / Item- L SLV Menes shirt

Line No.-01

Order quantity- 5k

Factory-New age garments ltd

S/No	Operation Description	SAM
1	Collar 3 Part match & Mark	0.25
2	Collar Make	0.50
3	Scissoring After Collar Make	0.24
4	Collar Turning	0.20
5	Iron At Collar	0.18
6	Collar Make1/4 Ts	0.4
7	Band 3 Part Match & Match With Collar	0.3
8	Band Join With Collar	0.46
9	Scessoring After join 2 End Psn	0.32
10	Band Rolling	0.24
11	Regular Label Attach At Band	0.36
12	Band Join 1/16 T/s	0.29
13	Collar BTM Cut & Cut Mark At 3 PSN	0.3
14	Iron At Cuff	0.32
15	Cuff Make	0.6
16	Scissoring After Cuff Make Turn Over	0.32
17	Front Part Pair Tack & Care Label Attach	0.2

18	Box Plate Rolling	0.26
19	BTN Plate Rolling	0.38
20	Neck & Pocket Mark	0.3
21	Front Part Feeting	0.32
22	Pocket Rolling PSN Shape By Iron	0.18
23	Pocket Rolling	0.24
24	Iron At Pocket	0.3
25	Pocket Extra Part Scessoring	0.36
26	Pocket Attach	0.67
27	BK Part Ticken Make	0.20
28	Flag Label Attach With Main Label& Main Label Attach At Bk Yoke PSN	0.4
29	BK Yoke Join	0.45
30	BK Yoke Join 1/16 T/S	0.26
31	Bk & Fornt Part Match	0.32
32	Shoulder Join & Trim	0.53
33	Shoulder Join 1/16 T/S	0.26
34	Collar Mark & Match	0.36
35	Collar Join	0.46
36	Collar join 1/16 T/S With Size Label Attach	0.75
37	Gumble Binding	0.4
38	SLV Gumble Binding Tack	0.34
39	PLKT Shape By Iron	0.8
40	SLV Plkt attach both	0.74
41	Slv plkt attach exta part scissoring & mark for cuff join	0.37
42	Slv and body match	0.3
43	Slv join	0.92
44	Trim and check	0.28
45	Arm hole ¼ t/s	0.75
46	Bottom Hem acissoring	0.4
47	Bottom hem rolling	0.5
48	Side join both	0.75
49	Trim at check	0.4
50	Cuff tikken mark and match with body	0.43
51	Cuff join (to)	0.75
52	Hole at 11 psn	0.7
53	BTN attach mark at 9 psn	0.26
54	BTN attach at 15 psn	1
55	Final trim	0.3
	Total operation = 55	Total SAM = 22.81

Table: 3.2 long sleeve Men’s shirt line capacity, operation and SAM

Line capacity=(Total manpower *work hour*60) / SMV

= (55*10*60) / 22.81

=1447 pcs

Productivity = 86%

Productivity gap =14%

3.3 Data Analysis before balancing

Goldtex Garments ltd.

Buyer- PVH
Style- 437892
Item- Short pant

Data Analysis before balancing

S.L	FR PART	M/C	Basic time	SMV	Cycle time	Capacity /hr	Target/ hr	Production/ Hr
1	Ironing	Iron	12.6	14	20.12	257.14	180	176
2	Single fly over lock	O/L	9	10	14.3	360	252	248
3	double fly over lock	O/L	13.5	15	21.2	240	168	164
4	front part over lock with s/fly & 2 F. part join	O/L	18	20	29.1	180	126	122
5	Front pocket joint	SND	26.1	29	42.04	124.13	87	83
6	Front facing, body & pocket joint	SND	31.5	35	50.12	102.85	72	68
7	Front pocket rolling	DND	41.4	46	66.3	78.2	55	51
8	Front pocket facing close	SND	18	20	29.2	180	126	122
9	Side tack	SND	29.7	33	47.1	109	77	72
10	Front pocket over lock	O/L	34.2	38	56.04	94.73	66	62
11	Front pocket ¼ stitch	SND	26.1	29	42.2	124.13	87	83
12	Single fly top seam & zipper joint with single fly	SND	19.8	22	32.12	163.63	115	111
13	Double fl joint with zipper	SND	26.1	29	42.09	124.13	87	83
14	Care label attach	SND	30.6	34	49.1	105.88	74	70
	Back Part							
15	Back part dark mark & stitch	SND	9	10	14.13	360	252	248
16	Back part fusing with Iron	Iron	10.8	12	17.2	300	210	206
17	Back part top seam	Velcro	42.3	47	67.04	76.59	54	50
18	Back pocket tack	SND	12.6	14	20.5	257.14	180	176
19	Back pocket bone making	APW	18	20	29.2	180	126	122
20	Back pocket bone top seam	SND	31.5	35	50.2	102.85	72	68
21	Back pocket facing joint	SND	10.8	12	17.1	300	210	206
22	Back pocket over lock	O/L	36.9	41	59.2	87.8	61	58
23	Back pocket ¼ stitch	SND	35.1	39	55.13	92.3	65	60
24	Back pocket top seam	SND	29.7	33	47.14	109	76	72
25	Main label attach	SND	16.2	18	26.19	200	140	136
	ASSEMBLY							
26	Front & back part matching	H/W	18	20	29.31	180	126	122
27	Side seam over locking	O/L	31.5	35	50.2	102.85	72	68
28	Side top seam	F/arm	27	30	43.34	120	84	80
29	Inseam over locking	O/L	24.3	27	38.32	133.33	94	89
30	Back raise top seam	SND	26.1	29	41.32	124.13	87	83
31	Belt loop joint	SND	17.1	19	28.17	189.4	131	128
32	Waist belt joint	SND	36	40	57.19	90	63	59
33	Label attaching	SND	18	20	29.29	180	126	122
34	Waist belt mouth closing	SND	15.3	17	24.19	211.76	148	144

Fig: 3.3 Data Analysis before balancing:

This figures data is before line blanching. So we calculate the SMV and production per hour, capacity. Without line balancing the production are decreasing than line balancing. At first we collect data of every operation and efficiency of worker. AT last we are done summary in data. And calculate the result. As this data compare the after balancing data. This figure data is productivity is 42.85% and line efficiency 66.67% production per hours 60 pcs. Manpower 53 and machine 39.

3.3 .1 Table of data Analysis before balancing

Buyer- PVH
Style- 437892
Item- Short pant
Line No.-7
Order quantity- 5k

S.L	FR PART	M/C	Basic time	SMV	Cycle time	Capacity /hr	Target/ hr	Production/ Hr
1	Ironing	Iron	12.6	14	20.12	257.14	180	176
2	Single fly over lock	O/L	9	10	14.3	360	252	248
3	double fly over lock	O/L	13.5	15	21.2	240	168	164
4	front part over lock with s/fly & 2 F. part join	O/L	18	20	29.1	180	126	122
5	Front pocket joint	SND	26.1	29	42.04	124.13	87	83
6	Front facing, body & pocket joint	SND	31.5	35	50.12	102.85	72	68
7	Front pocket rolling	DND	41.4	46	66.3	78.2	55	51
8	Front pocket facing close	SND	18	20	29.2	180	126	122
9	Side tack	SND	29.7	33	47.1	109	77	72
10	Front pocket over lock	O/L	34.2	38	56.04	94.73	66	62
11	Front pocket ¼ stitch	SND	26.1	29	42.2	124.13	87	83
12	Single fly top seam & zipper joint with single fly	SND	19.8	22	32.12	163.63	115	111
13	Double fl joint with zipper	SND	26.1	29	42.09	124.13	87	83
14	Care label attach	SND	30.6	34	49.1	105.88	74	70
	Back Part							
15	Back part dark mark & stitch	SND	9	10	14.13	360	252	248
16	Back part fusing with Iron	Iron	10.8	12	17.2	300	210	206
17	Back part top seam	Velcro	42.3	47	67.04	76.59	54	50
18	Back pocket tack	SND	12.6	14	20.5	257.14	180	176

19	Back pocket bone making	APW	18	20	29.2	180	126	122
20	Back pocket bone top seam	SND	31.5	35	50.2	102.85	72	68
21	Back pocket facing joint	SND	10.8	12	17.1	300	210	206
22	Back pocket over lock	O/L	36.9	41	59.2	87.8	61	58
23	Back pocket ¼ stitch	SND	35.1	39	55.13	92.3	65	60
24	Back pocket top seam	SND	29.7	33	47.14	109	76	72
25	Main label attach	SND	16.2	18	26.19	200	140	136
	ASSEMBLY							
26	Front & back part matching	H/W	18	20	29.31	180	126	122
27	Side seam over locking	O/L	31.5	35	50.2	102.85	72	68
28	Side top seam	F/arm	27	30	43.34	120	84	80
29	Inseam over locking	O/L	24.3	27	38.32	133.33	94	89
30	Back raise top seam	SND	26.1	29	41.32	124.13	87	83
31	Belt loop joint	SND	17.1	19	28.17	189.4	131	128
32	Waist belt joint	SND	36	40	57.19	90	63	59
33	Label attaching	SND	18	20	29.29	180	126	122
34	Waist belt mouth closing	SND	15.3	17	24.19	211.76	148	144
35	Waist belt tack	SND	27	30	43.26	120	84	80
36	Waist belt joint	Kansai	45	50	71.23	72	51	47
37	Bottom hem joint	DND	27	30	43.17	120	84	80
38	Loop Bartech (bone, front rise side pocket Bartech)	BTK	36	40	57.22	90	63	59
39	Loop Bartech (Loop upper & lower)	BTK	38.7	43	61.33	83.72	59	54

Table: 3.3 Data Analysis before balancing

This figure data is productivity is 42.85% and line efficiency 66.67% production per hours 60 pcs. Manpower 53 and machine 39.

3.4 Data Analysis after balancing

Goldtex Garments ltd.

Buyer- PVH
Style- 437892
Item- Short pant

Data Analysis after balancing

S. L. no	FRONT PART	M/C	Basic time	SMV	Cycle time	Capacity/hr	Target/hr	Production/hr
1	Ironing(10)	Iron	18	20.7	32.27	174	121	110
2	Single & D/fly overlock	O/L	22.5	25	36.32	144	100	97
3	F. part O/L with S/fly & 2 part joint	O/L	23.4	26	37.17	138.4	97	95
4	Front pocket joint	SND	26.1	29	41.19	124.13	87	84
5	Front facing, body & pocket joint	SND	28.8	32	45.29	112.5	79	77
6	Front pocket rolling	DND	24.3	27	38.19	133.33	93	90
7	Front pocket rolling	DND	25.2	28	40.26	128.57	90	88
8	Front pocket facing close	SND	26.1	29	41.23	124	87	85
9	Side tack	SND	28.8	32	45.17	112.5	79	76
10	Front pocket over lock(1)	O/L+O/L	27	30	42.22	120	84	80
11	Front pocket ¼ stitch	SND	26.1	29	41.33	124	87	85
12	Single fly top stitch & zipper join	SND	24.3	27	37.1	138	97	94
13	Double fl joint with zipper	SND	26.1	29	41.12	124	87	86
14	Care label attach	SND	28.8	32	45.3	112.5	79	76
	Back Part							
15	Back part dark mark & Ironing	Iron	24.3	27	38.2	133.3	93	90
16	Back part top seam	Velcro	23.4	26	37.1	138	97	95
17	Back part top seam	Velcro	26.1	29	41.04	124	87	85
18	Back pocket bone making	APW	24.3	27	39.12	133	93	90
19	Back p. tack & facing joint	SND	25.2	28	40.3	128.5	90	88
20	Back pocket bone top seam	SND	28.8	32	45.2	112.5	79	77
21	Back pocket over lock(40)	O/L	27	30	42.1	120	84	82
22	Back pocket over lock (40)	O/L	25.2	28	40.04	128.5	90	88
23	Back pocket ¼ stitch (25)	SND	27	30	42.2	120	84	80
24	Back pocket top seam	SND	29.7	33	46.12	109	77	73
25	Main label attach (23)	SND	27	30	42.09	120	84	80
	Assembly							
26	Front & back part matching (27)		27	30	43.1	120	84	82
27	Side seam over locking (26)	O/L	27	30	43.13	120	84	81
28	Side top seam	F/Arm	27	30	44	120	84	83
29	Inseam over locking	O/L	24.3	27	38.04	133	93	90
30	Back raise top seam	SND	26.1	29	41.5	124	87	84
31	Belt loop joint (32)	SND	27	30	43.2	120	84	81

Fig: 3.4 Data Analysis after balancing

This figures data is after line blanching. So we calculate the SMV and production per hour, capacity. After line balancing the production are increasing than before line balancing. At first we collect data of every operation and efficiency of worker. AT last we are done summary in data. And calculate the result. As this data compare the after balancing data. This figure data is productivity is 73.63% and line efficiency 87.85% production per hours 81 pcs. Manpower 48 and machine 40.

3.4.1 Table of data Analysis after balancing

Buyer- PVH
Style- 437892
Item- Short pant
Line No.-7
Order quantity- 5k

S. L no .	FRONT PART	M/C	Basic time	SMV	Cycle time	Capacity/hr	Target/hr	Production/hr
1	Ironing	Iron	18	20.7	32.27	174	121	110
2	Single & D/fly overlock	O/L	22.5	25	36.32	144	100	97
3	F. part O/L with S/fly & 2 part joint	O/L	23.4	26	37.17	138.4	97	95
4	Front pocket joint	SND	26.1	29	41.19	124.13	87	84
5	Front facing, body & pocket joint	SND	28.8	32	45.29	112.5	79	77
6	Front pocket rolling	DND	24.3	27	38.19	133.33	93	90
7	Front pocket rolling	DND	25.2	28	40.26	128.57	90	88
8	Front pocket facing close	SND	26.1	29	41.23	124	87	85
9	Side tack	SND	28.8	32	45.17	112.5	79	76
10	Front pocket over lock	O/L+O/L	27	30	42.22	120	84	80
11	Front pocket ¼ stitch	SND	26.1	29	41.33	124	87	85
12	Single fly top stitch & zipper join	SND	24.3	27	37.1	138	97	94
13	Double fl joint with zipper	SND	26.1	29	41.12	124	87	86
14	Care label attach	SND	28.8	32	45.3	112.5	79	76
	Back Part							
15	Back part dark mark & Ironing	Iron	24.3	27	38.2	133.3	93	90
16	Back part top seam	Velcro	23.4	26	37.1	138	97	95
17	Back part top seam	Velcro	26.1	29	41.04	124	87	85
18	Back pocket bone making	APW	24.3	27	39.12	133	93	90
19	Back p. tack & facing joint	SND	25.2	28	40.3	128.5	90	88
20	Back pocket bone top seam	SND	28.8	32	45.2	112.5	79	77
21	Back pocket over lock	O/L	27	30	42.1	120	84	82
22	Back pocket over lock	O/L	25.2	28	40.04	128.5	90	88
23	Back pocket ¼ stitch	SND	27	30	42.2	120	84	80

24	Back pocket top seam	SND	29.7	33	46.12	109	77	73
25	Main label attach	SND	27	30	42.09	120	84	80
	Assembly							
26	Front & back part matching		27	30	43.1	120	84	82
27	Side seam over locking	O/L	27	30	43.13	120	84	81
28	Side top seam	F/Arm	27	30	44	120	84	83
29	Inseam over locking	O/L	24.3	27	38.04	133	93	90
30	Back raise top seam	SND	26.1	29	41.5	124	87	84
31	Belt loop joint	SND	27	30	43.2	120	84	81
32	Waist belt joint	SND+ SND	28.8	32	45.2	112.5	79	77
33	Label attaching	SND	24.3	27	39.1	133	93	91
34	Waist belt mouth closing	SND	25.2	28	40.2	128	90	88
35	Waist belt tack	SND	27	30	44	120	84	81
36	Waist belt joint	Kansai	22.5	25	36.14	144	100	98
37	Waist belt joint	Kansai	24.3	27	38.19	133	93	90
38	Bottom hem joint	DND	27	30	44	120	84	81
39	Bartech(bone, fr. Rise, side pocket)	BTK	28.8	32	45.2	112.5	79	77
40	Loop Bartech (Loop upper & lower)	BTK	27	30	44.4	120	84	81

Table-3.4 Data Analysis after balancing

This figure data is productivity is 73.63% and line efficiency 87.85% production per hours 81 pcs. Manpower 48 and machine 40.

3.5 Calculation of Sewing Line Efficiency

Line efficiency = (Total production×SMV×100) / (No of operator ×Working hour ×60)

Before balancing line efficiency: (60*26*100)/ (39*1*60) = 66.67%

After balancing line efficiency: (81*26*100)/ (40*1*60) = 87.75%

3.6. Calculation of Sewing Productivity

Productivity = (output amount/input amount) ×100%

Before balancing productivity = (60/140) *100% = 42.85%

After balancing productivity = (81/110) *100% = 73.63%

CHAPTER-04

RESULT & DISCUSSION

4. Result & Discussion:

4.1 Before balancing graphical diagram

Buyer- PVH
Style- 437892
Item- Short pant
Line No.-7
Order quantity- 5k

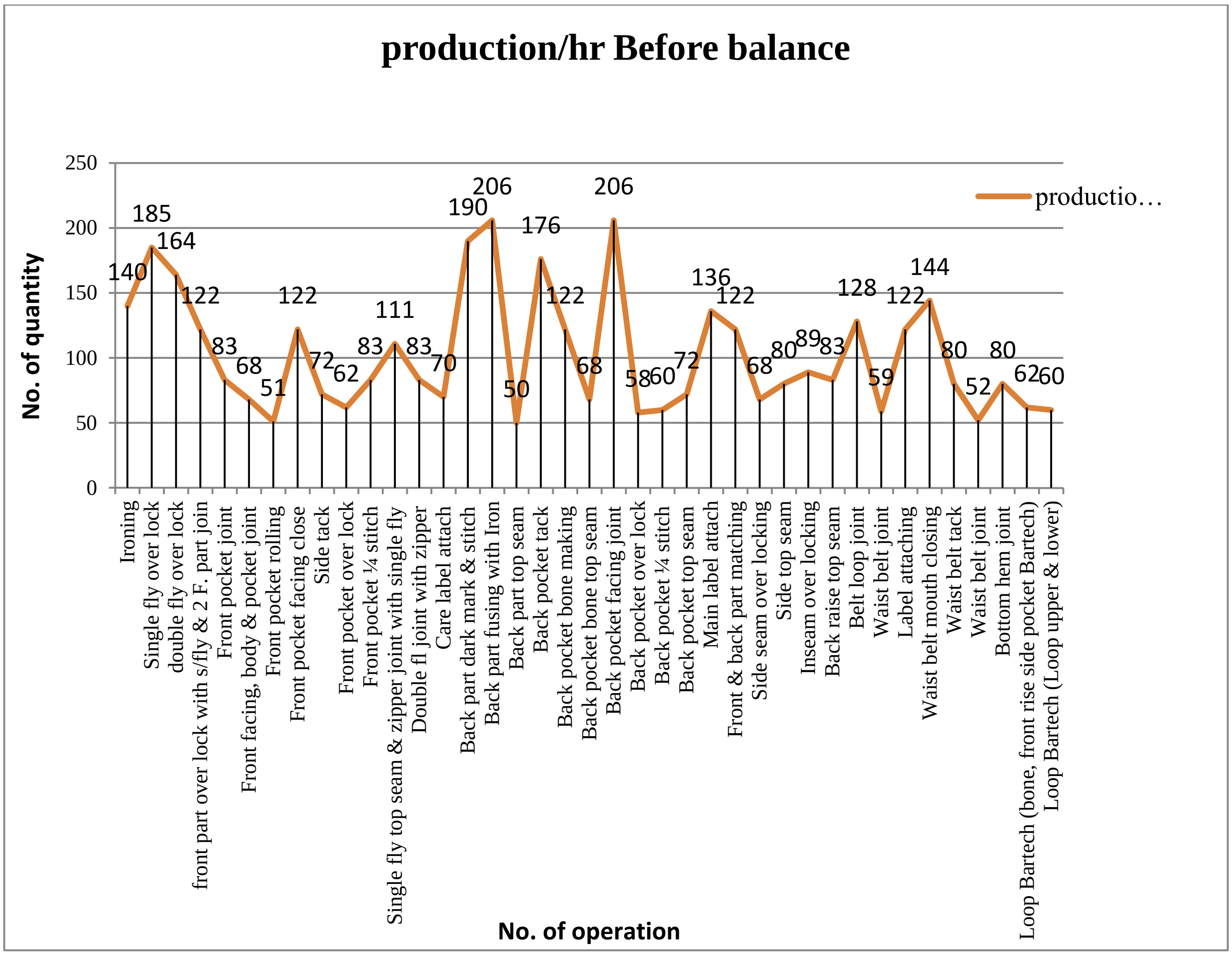

Fig: 4.1 Before balancing graphical diagram

In the above graph we can see the operation 39 and production per hours 60 pcs. Some operation give high production and some operation give low production. But we selected average equal point production in graphical diagram.

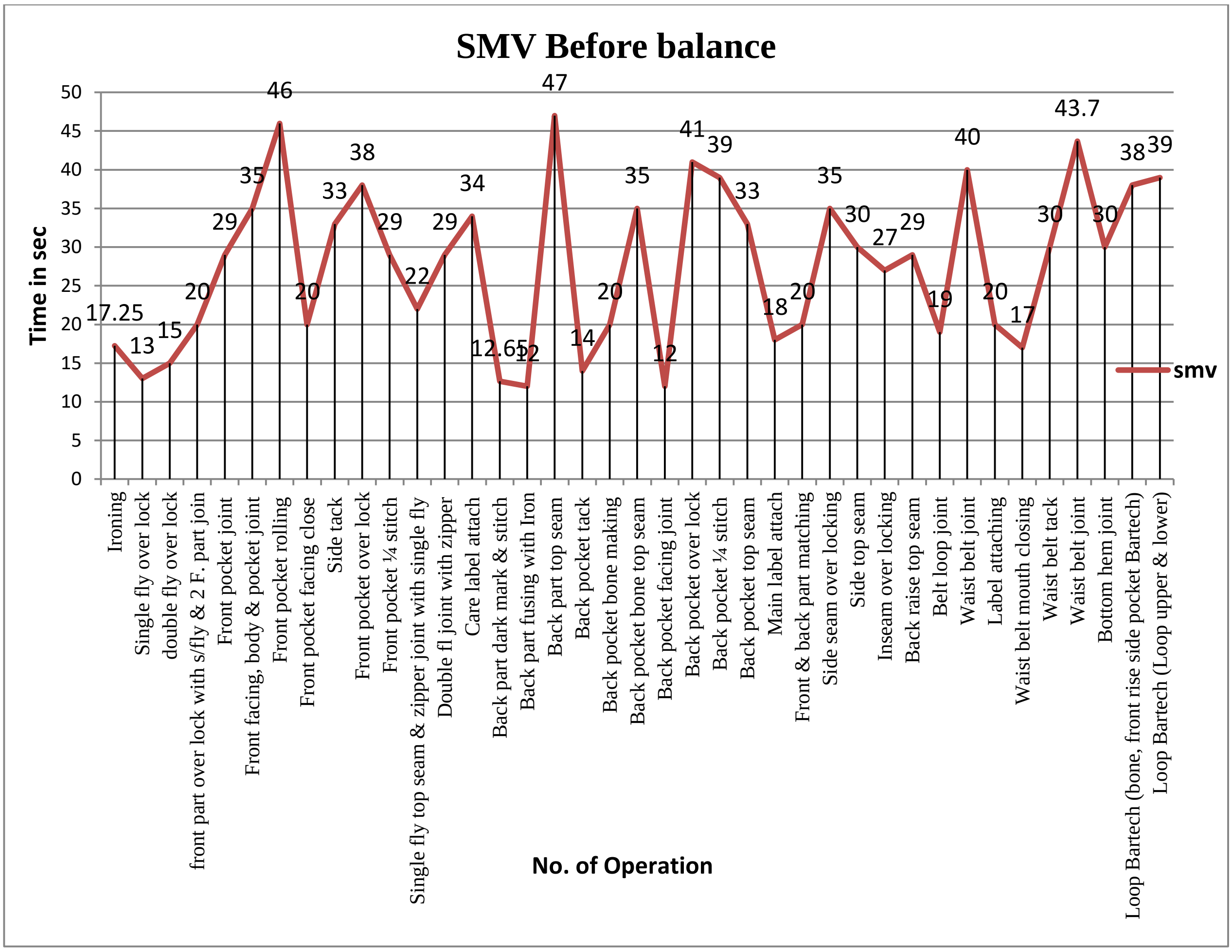

Fig: 4.2 SMV Before balancing graphical diagram

In the above graph we can see the operation 39 and SMV. Some operation SMV is low and Some operation SMV is high. But we selected average equal point SMV in graphical diagram.

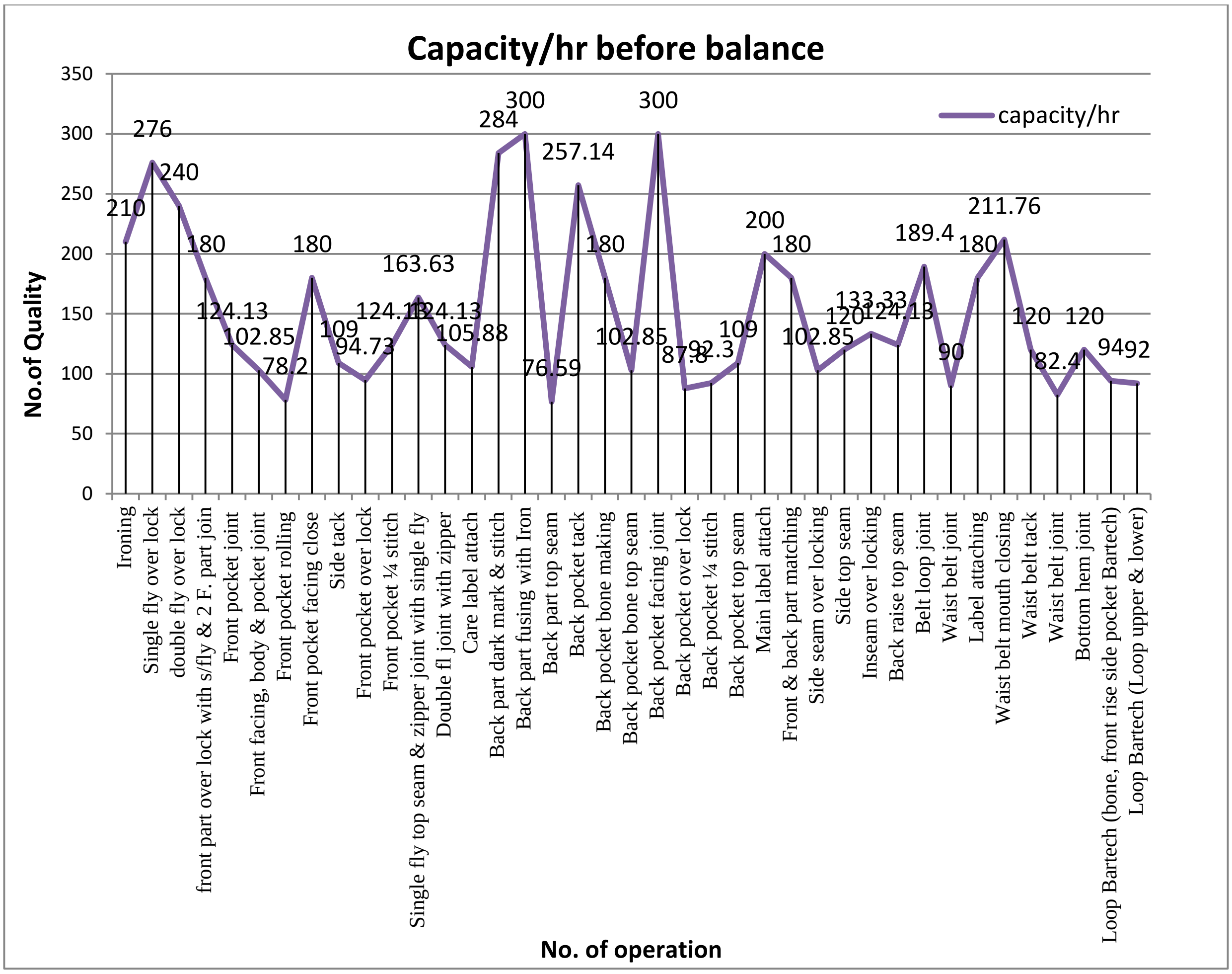

Fig: 4.3 Capacity/hr. Before balancing graphical diagram

In the above graph we can see the operation 39 and capacity per hours. But we selected average equal point production in graphical diagram.

4.2 After balancing diagram

Buyer- PVH
Style- 437892
Item- Short pant
Line No.-7
Order quantity- 5k

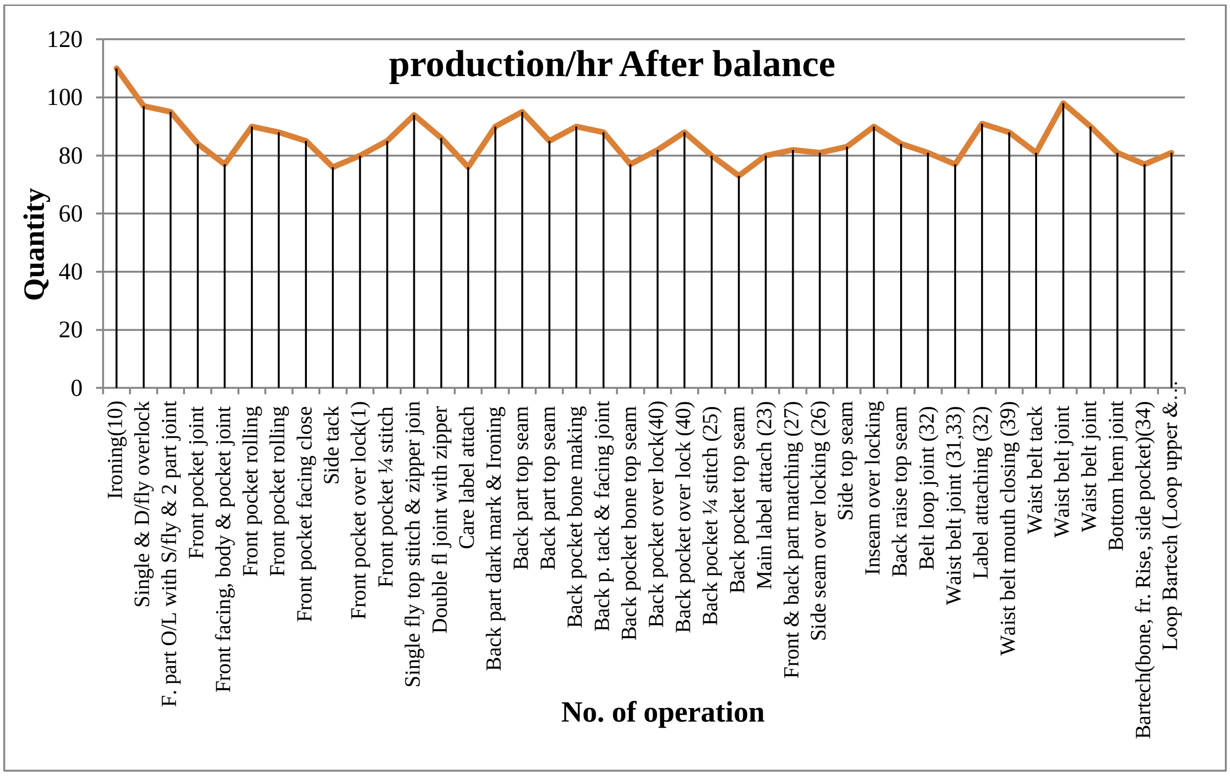

Fig: 4.4 after balancing graphical diagram

In the above graph we can see the operation 39 and production per hours 81 pcs. Some operation give high production and some operation give low production. But we selected average equal point production in graphical diagram.

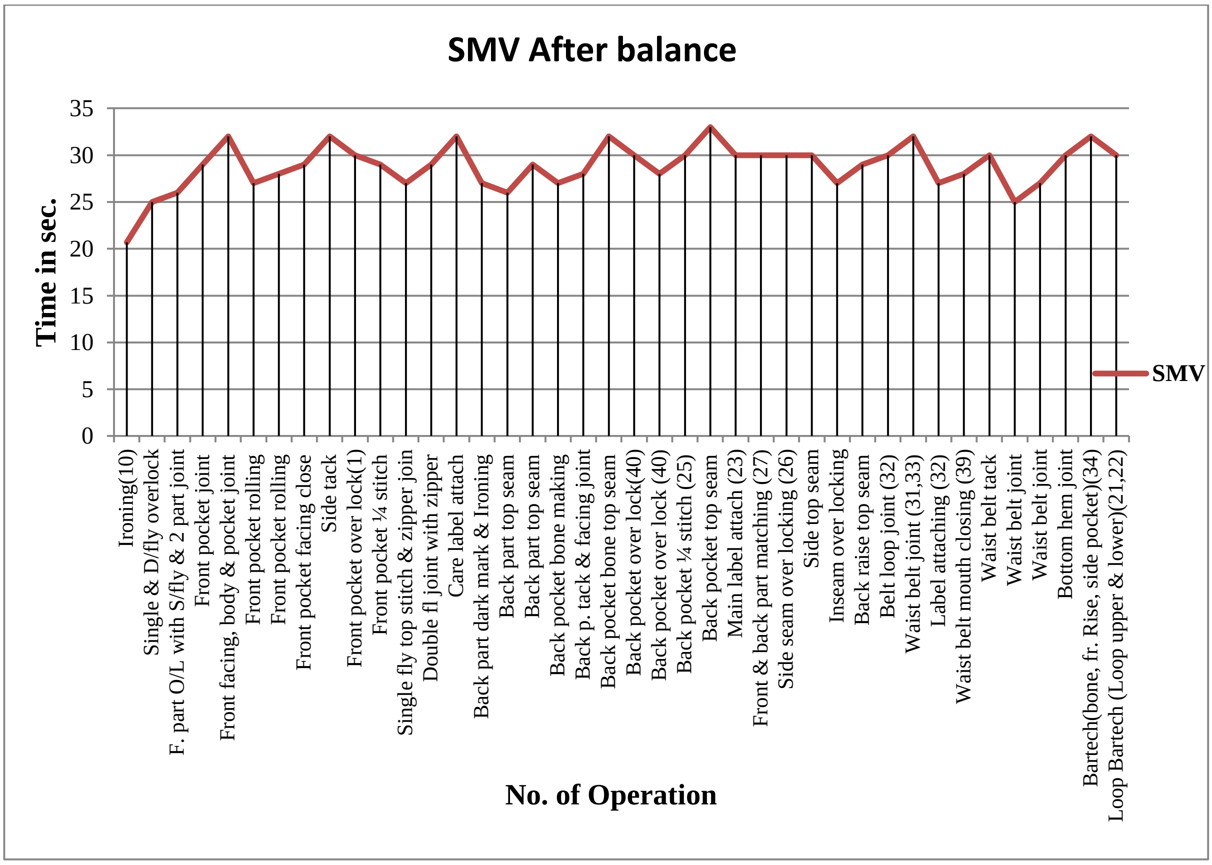

Fig: 4.5 SMV after balancing graphical diagram

In the above graph we can see the operation 39 and SMV 26. Some operation SMV is low and Some operation SMV is high. But we selected average equal point SMV in graphical diagram.

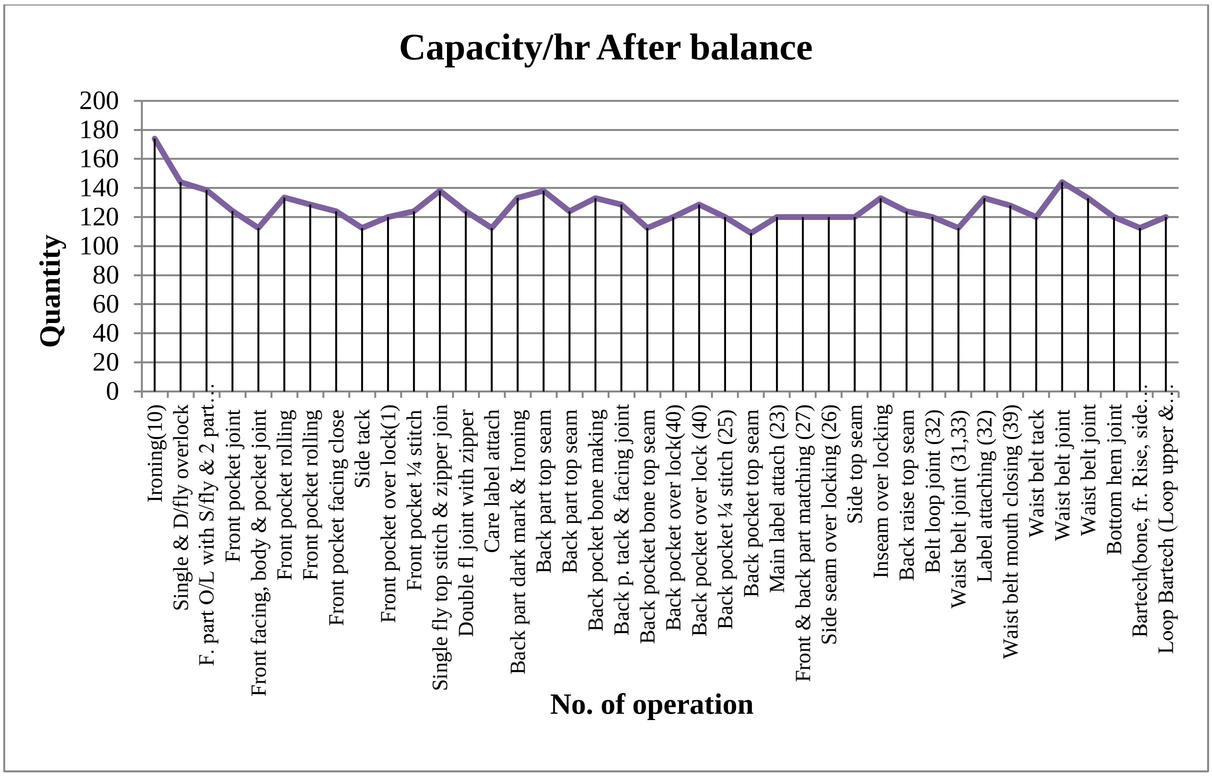

Fig: 4.6 Capacity/hr. Before balancing graphical diagram

In the above graph we can see the operation 39 and capacity per hours. This graph we see the capacity are increasing than before line balancing. And we selected average equal point production in graphical diagram.

4.3 Pie chart is Line A

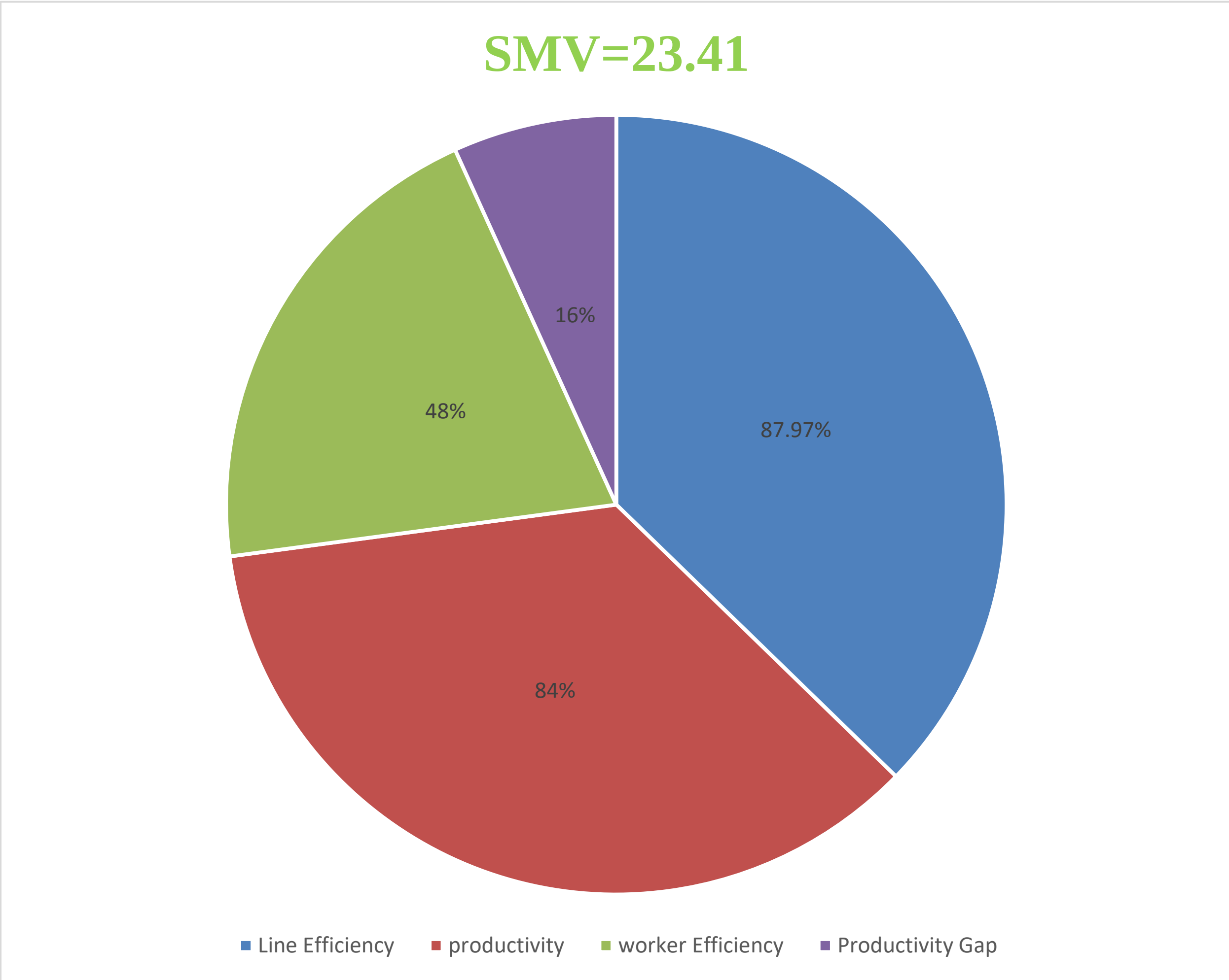

Fig: 4.7 SMV, line effy, productivity, worker effy, graphical diagram

We can see this pie chart, its line efficiency is 87.97%, and Productivity is 84% worker efficiency is 48% productivity gap 16%.

Here we see that production capacity & cycle time is increased as well as balanced by the way of shearing & changing workstation. Actually our project main target was to increase or improved the final output or production. By this experimental data & graphical chart we have found that final output or production is really improved compared to unbalanced line condition. So line balancing system is really useful in sewing line for proper production.

4.4 Sewing Line Efficiency

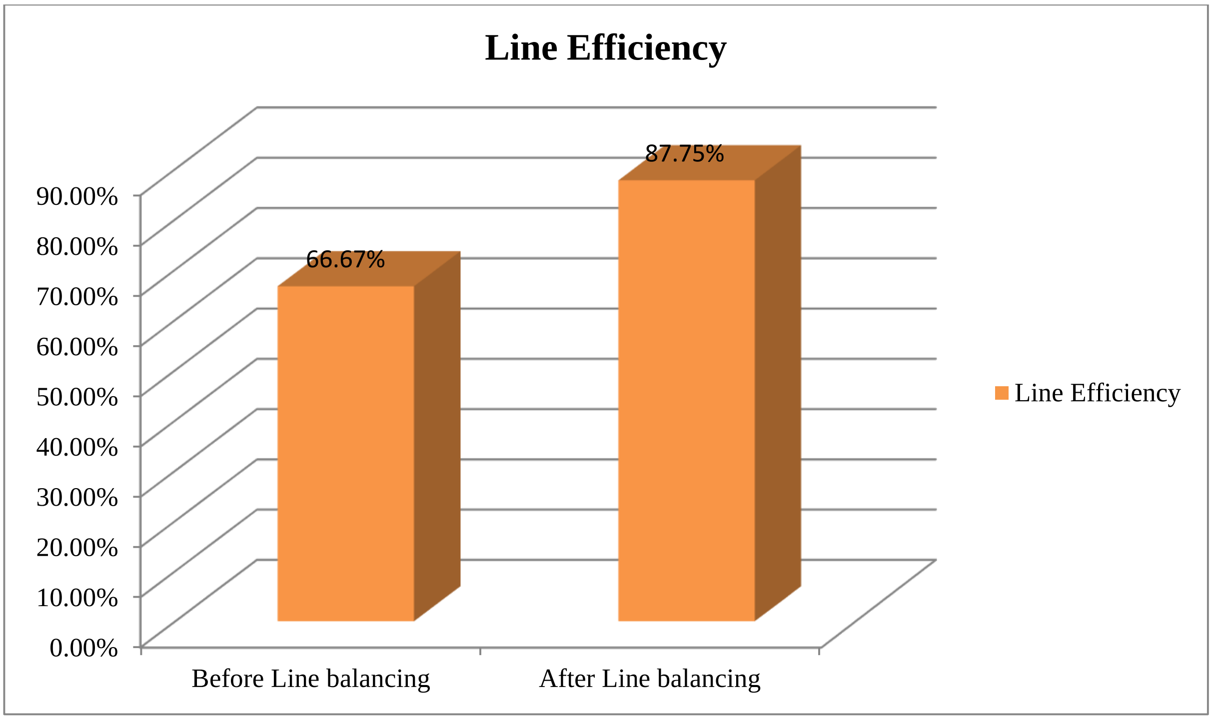

Fig: 4.8 Sewing Line Efficiency

4.5 Sewing Productivity

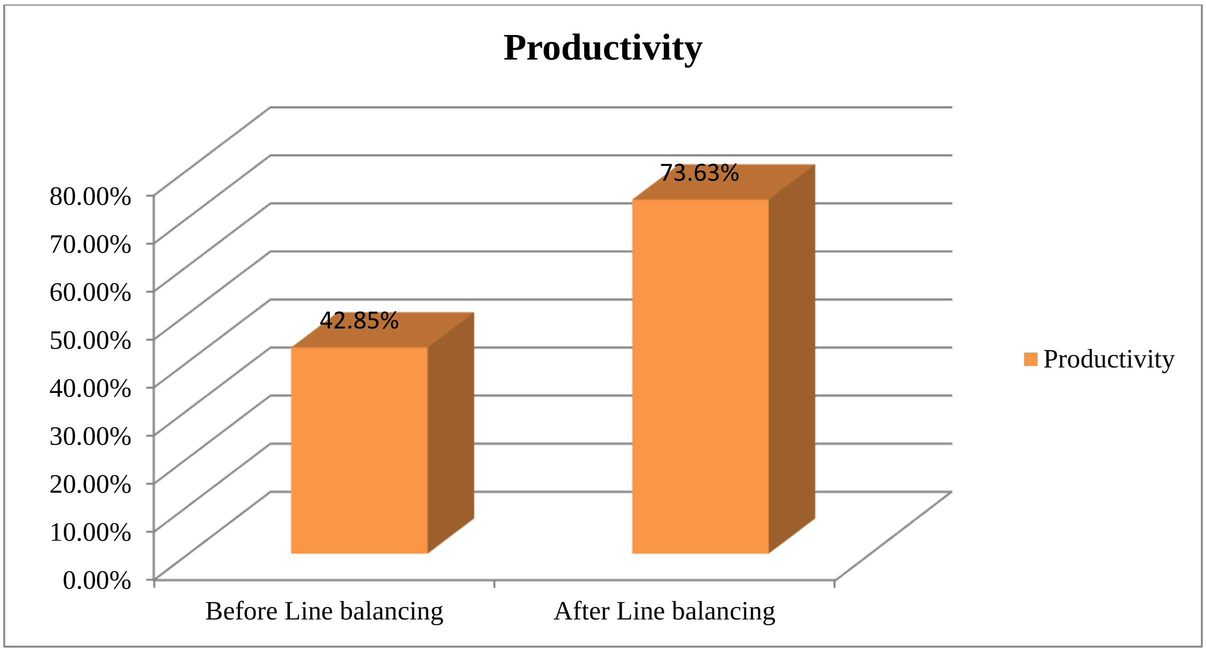

Fig: 4.9 Sewing Productivity

Here we see that the final output of after balancing is relatively very high then before balancing condition. Though the manpower, machine, SMV, Performance rating, individual efficiency are almost same but the final output is increased. It is just come in true for the cause of line balancing through changing or sharing the workstation. This is a manual process of the industry. There should be many process of line balancing. But it is the easiest process of line balancing to improve final output or production.

4..6 Result Summary

Parameter	Before Line balancing	After Line balancing
Productivity	42.85%	73.63%
Line Efficiency	66.67%	87.75%
Production/hr (Pieces)	60	81
Manpower	53	48
Machine	39	40

Table: 4.1 Result Summary

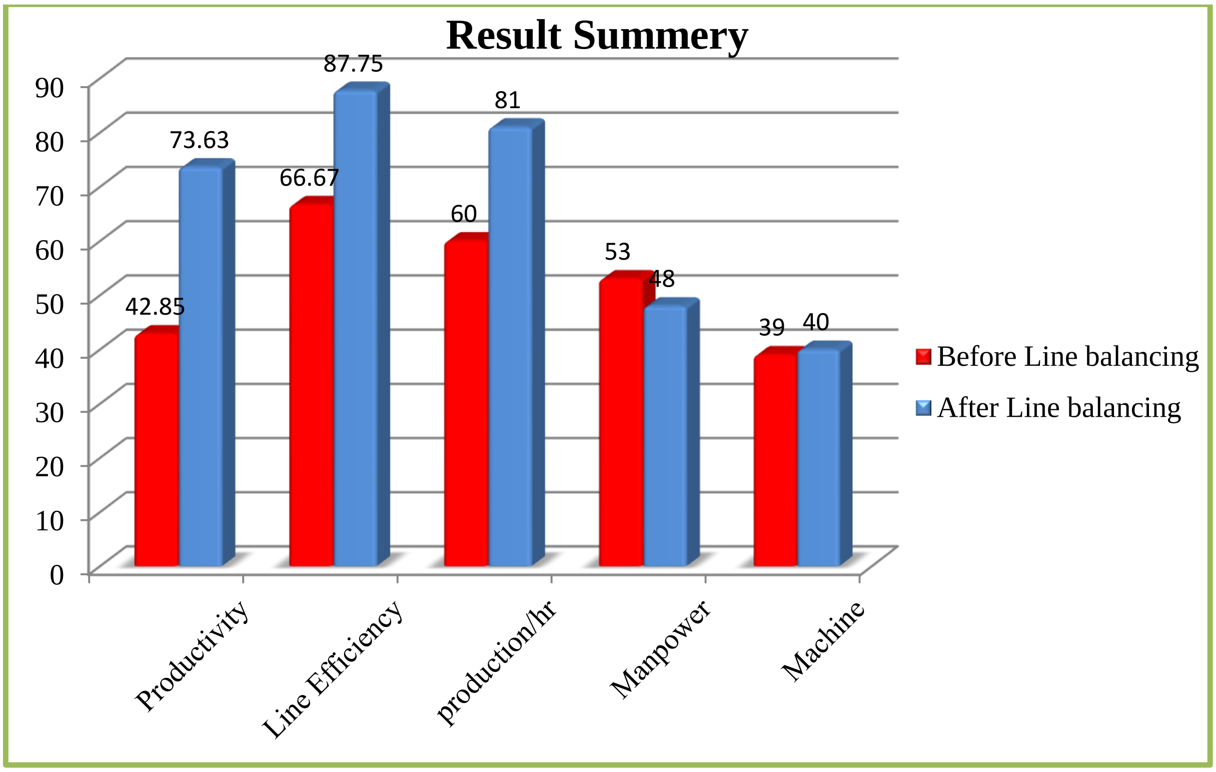

Fig: 4.10 Result Summary

At last we have seen this result summary and we can say that production are increasing by doing line balancing than before line balancing .

CHAPTER-05
Conclusion

5. Conclusion

A line balancing technique is developed for sewing line in garment industry. We've done this project to improve productivity through line balancing (Sharing & Changing workstation) in the sewing section. In our project, we are trying to show that line balancing is very important fact in garments section as well as sewing section. Overall productivity improvement depends on proper line balancing. During the working period of this project, we have seen that there is a huge change in production depending on line balancing. We worked at New age garments ltd, and Goldtex garments ltd for this project. It is a 100% export oriented garments factory in our country that located at Saver. We tried our best to collect the actual data & information from the factory. We worked hard with the patient to complete the project. The proper handling of our supervisor helps us to complete our project properly. So we are grateful to our supervisor. However from this project we gathered a vital experience about line balancing, SMV, productivity, line efficiency, manpower, machine, cycle time, time study, sewing line etc. It can be said that without arranging a proper line balancing on the sewing floor of a garments factory optimum productivity & efficiency cannot be gained. So productivity can be achieved by allocating skill & semi-skilled workers to the right place and unskilled operator should be trained properly. At last, the noticeable achievements of line balancing are-: improvement of productivity, smooth work flow, balanced cycle time, easy fault finding, reduced bottleneck, balanced line efficiency, reduction operation breakdown, equal distribution of work, skilled, semiskilled & unskilled co-ordination and easy way to supervise.

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