Estimation of Standard Minute Value of blazer Production Process by work study for well-balanced assembly line

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Abstract

This article presents a study on the estimation of the Standard Minute Value (SMV) of the blazer production process through work study for a well-balanced assembly line. The objective of the study was to optimize the production process by identifying inefficiencies, reducing the SMV, and optimizing the required manpower. Data were collected through time and motion studies and process analysis in a garment factory. The initial SMV for blazer production was determined to be 76.30 minutes. Through the implementation of work study and line balancing techniques, the SMV was successfully reduced to 73.15 minutes. Additionally, the manpower required for the assembly line was reduced from 139 workers to 136, leading to improved productivity and cost savings. The results show how work study and line balancing may be used to optimize the blazer manufacturing process. The study underlines the need of putting lean manufacturing ideas into practice to reduce waste and boost productivity. Employee engagement and motivation were increased by involving them in the line balancing process, which was essential for obtaining good results. This research contributes on work study and line balancing in the garment industry. The findings provide practical insights for garment manufacturers seeking to optimize their production processes. By implementing the recommended approaches, companies can reduce SMV, optimize manpower requirements, and improve competitiveness. This research enhances our comprehension of work study and line balancing within the apparel industry. The results provide garment manufacturers with valuable insights to streamline their production processes. Through the adoption of recommended strategies, companies can lower Standard Minute Values (SMV), fine-tune workforce requirements, and improve their competitive edge.

Keywords: *Standard Minute Value (SMV), work study, line balancing, blazer production, productivity, manpower optimization*

1. Introduction

A blazer is a type of jacket resembling a suit jacket but cut more casually. Blazers are generally distinguished from sport coats as more formal garments and tailored from

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solid color fabrics. They often have naval-style metal buttons to reflect their origin as jackets worn by boating club members. A blazer is a type of garment worn by males, which can be worn casually or formally and is constructed from materials such as velvet or wool. Blazers are versatile garments that can be worn for both formal and casual occasions, and they can add class and unity to a man's ensemble (Debnath, 2016). It appears that the blazer has a long history as a garment worn for boating and maritime activities. The first known use of the term "blazer" was in 1952 to describe the red jacket worn by the Lady Margaret Boat Club at Cambridge University. However, the blazer's origins can be traced back much further, with its first appearance in Vogue in June 1893 as a yachting costume. The name "blazer" is believed to have come from a ship, the HMS Blazer Overall, while the history of the sports apparel industry is a relatively recent phenomenon, the blazer has been a popular and fashionable garment for over a century (Judd, 2016). The Standard Minute Value represents the amount of time a well-trained and skilled worker should take to perform a particular task at a standard pace. This standard pace includes allowances for rest, delays, and normal variations in work. SMV is crucial for estimating production times, setting production targets, and optimizing workflow efficiency in various industries, including apparel manufacturing, assembly lines, and other production environments(Akter et al., 2015)**.** The contemporary business environment for clothing manufacturers necessitates the implementation of low inventory and rapid response systems that facilitate the production of a diverse range of merchandise to satisfy consumer demand. Managers in the apparel industry are endeavoring to enhance their existing systems or explore novel production techniques to align with the swift transformations in the fashion industry(Howlader et al., 2015). To improve production efficiency and quality, the sewing line needs effective line balance with modest stockpiles.

An assembly line is a set of jobs allocated to a set of workstations linked by a transport mechanism under precise assembling sequences that specify how the assembling process runs from station to station. Assembly line balancing allocates jobs to machines to reduce operator workflow, throughput time, and work in progress, boosting productivity. Division of labor involves sharing a job. Ensure equal time at each station to balance labor. Each product assembly phase must be thoroughly studied and balanced between available workstations. Each operator performs activities appropriately, synchronizing work flow. Synchronized lines in detailed work flows have small distances between stations, minimal work in process, accurate production time planning, and predictable output quantity (Bappy et al., 2019; Eberle et al., 2004; Shumon et al., 2010). Thus, effective line balance with limited inventories in the sewing line is needed to improve production efficiency and quality.

An assembly line constitutes distinct tasks allocated to specific workstations interconnected by a transport system, following precise assembly sequences dictating the flow from one station to the next. Line balancing, in the context of assembly, involves assigning tasks to machines to minimize human effort, decrease throughput time, reduce work in progress, and enhance production. The primary focus is on achieving equilibrium in the division of labor among multiple individuals. Station times need to be equal to achieve balanced division of labor. To attain this, each stage of product assembly requires thorough examination and balancing across workstations. Line balancing ensures a coordinated workflow where operators perform activities efficiently. A well-organized assembly line with synchronized operations features minimal distances between stations, reduced work in process, accurate production time planning, and predictable output quantities. This approach involves careful consideration of Standard Minute Value (SMV) calculations to optimize the efficiency of each task in the assembly process (Azim et al., 2016; Kitaw et al., 2010; Raihan, 2016).

2.1. Work Study

Work study is a well-known approach to enhance productivity in manufacturing processes, and time study is a crucial component of work study. Time study involves measuring the time required to perform a specific task, and it helps to determine the Standard Minute Value (SMV) of a production process (Kanawaty, 1992)**.**

2.1.1. Standard Minutes Value

The SMV is defined as the amount of time required for a skilled worker to perform a given task at a predetermined performance level, and it serves as a benchmark to estimate the time required to produce a unit of a product. By determining the SMV, work study engineers can identify opportunities for improving productivity, reduce cycle times, and optimize production processes (Biswas, 2013)**.**
Step wise procedure to calculate the SMV as follows: (Azim et al.)

Step 1: First a job to be to be selected to study. Breakdown the work content of the job into smallest possible elements. Then inform the worker and define the best method

Step 2: Observing the time for appropriate number of cycles

Step 3: Determining the average **cycle time (CT)**

$$CT = \Sigma \text{ Times/ No. of cycles}$$

Step 4: Determine the **basic time (BT)**

$$BT = CT \times PR \text{ [PR=Performance Rating]}$$

Step 5: Determine the **standard minutes value (SMV)** using the following formula

$$SMV = BT (1+ AR) \quad \text{[AR=Allowance Rate]}$$

2.2. Work Study increases productivity

The SMV estimation process should be done by following a standard procedure that involves breaking down the production process into its constituent elements, measuring the time required to perform each task, and then calculating the SMV for each element. This process can help in identifying bottlenecks and inefficiencies in the production process, which can then be addressed through process improvement initiatives (Moktadir et al., 2017). In conclusion, work study and time study are closely related concepts that are used to improve productivity in manufacturing processes. Time study helps in determining the SMV, which is an essential metric for optimizing production processes, reducing cycle times, and identifying opportunities for process improvement. By using a standard procedure to estimate the SMV, work study engineers can improve the efficiency and effectiveness of the manufacturing process (Akter et al., 2015).

2.3. Assembly Line Balancing

Assembly Line Balancing is a crucial concept in the Ready-Made Garments (RMG) industry in Bangladesh to ensure productivity and efficiency in the production process (Kamble & Kulkarni, 2014).Work Study techniques such as Time Study and Motion Study are utilized in ALB to determine the Standard Minute Value (SMV) of each task in the assembly line. By optimizing the allocation of tasks among workers and machines, the productivity and efficiency of the assembly line can be improved (Kamble & Kulkarni, 2014).

3. Literature review

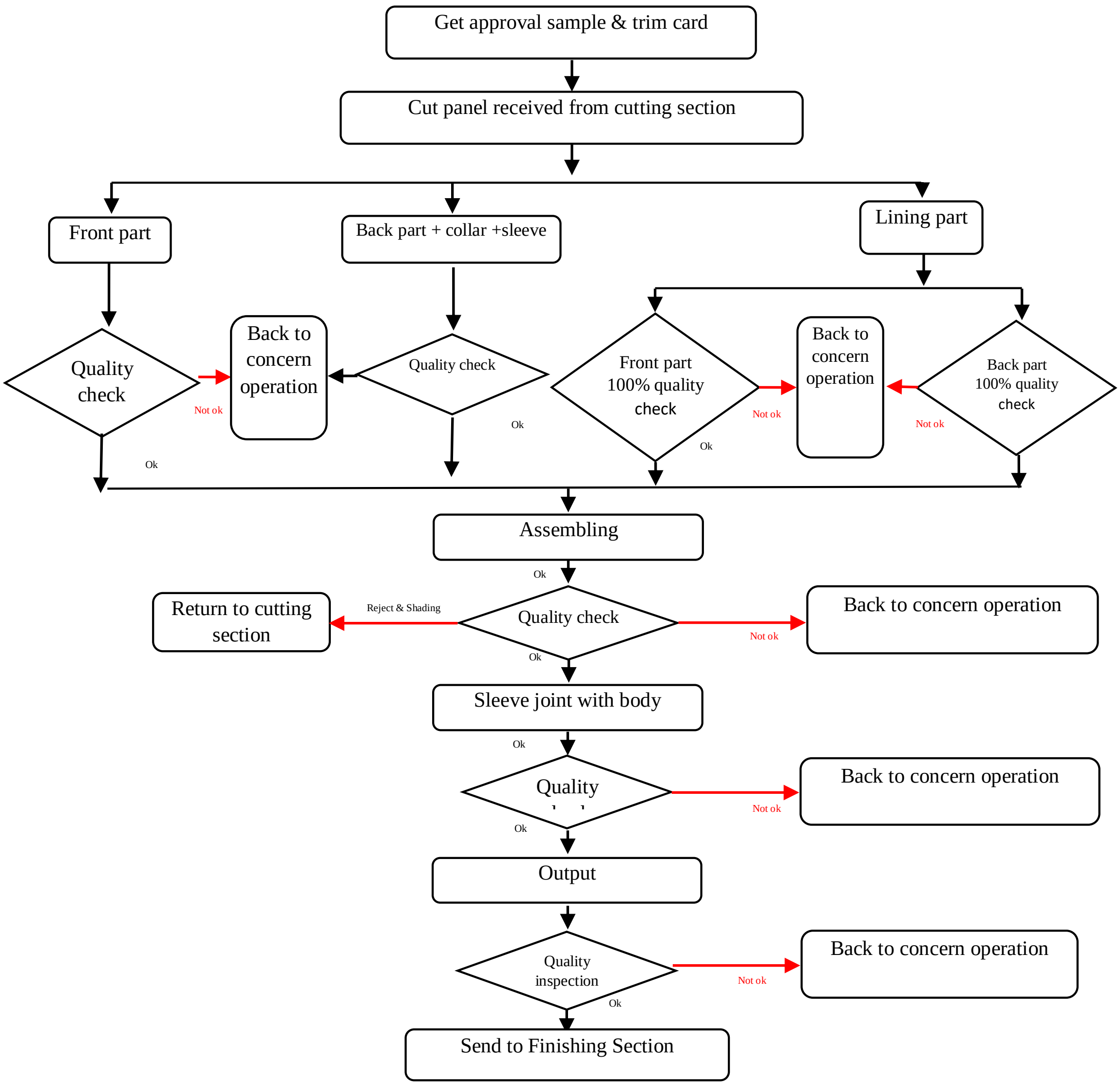
Productivity is a significant indicator of the condition of an economy, industry, corporation, or process. Productivity is the ratio of the value of the products and services produced to the value of the resources utilized in their production (Krajewski et al., 2008). In the RMG firm, productivity improvement means getting more work done in less time and wasting less. Plant output can also be affected by things like the time it takes to get ready, the time it takes to change machines, the skill and efficiency of the user, and so on. Monitoring the system's performance makes it possible to use methods like time study, motion study, and line balance to boost output. The line-balancing method made Bangladeshi garment factories 22% more productive (Shumon et al., 2010). Depending on how their parts work, different kinds of production methods can be made. The progressive package system and the one-piece flow system are the most common ways that ready-made clothes is made. One-piece flow is hard to get and requires an improved method and very specific conditions. Single product line balance recommended that Bangladeshi RMG businesses use a new production system that combines traditional and modern modular manufacturing systems to improve output (Masud, 2010). Utilizing lean tools like cellular manufacturing, single piece flow, work standardization, and just in time production, a polo shirt manufacturer can increase output and efficiency. A study found that operator multi-skilling and style changeover flexibility increased while production cycle time, operator needs, rework levels, and production lead time all decreased (Akter et al., 2015). A single-piece flow is used in manufacturing where the cycle times of individual workers may be somewhat different without significantly slowing down production. Overproduction and waiting times will result from insufficient cycle time balance between the processes. To increase output in the RMG industries of Bangladesh, it was suggested that a new production system be implemented, one that utilizes both conventional and contemporary modular production techniques where work study techniques can be used to improve the productivity of the garment industry (Raihan, 2016). On the other hand, for polo t shirt, study showed that the results were very promising. The primary advantages include an 8% reduction in production cycle time, a 14% decrease in the required number of operators for the same garment output, an 83% reduction in rework, a decrease in production lead time from two days to one hour, and a consistent work-in-progress inventory of 100 units instead of fluctuating between 500 and 1500 units (Ahmed et al., 2018). But, no research has not been found that work on the blazer production process using work study to estimate standard minute value with well-balanced assembly lines.

3.1. Objectives of the Present Work

- To identify and measure the time required for individual tasks involved in the blazer production process through a comprehensive work study.
- To estimate the Standard Minute Value for each task, considering standard conditions, skill levels, and other relevant factors, in order to establish a baseline for efficient production.

- Develop strategies for achieving a well-balanced assembly line by redistributing tasks among workstations to minimize bottlenecks and improve overall production flow.
- Devise recommendations for optimizing the overall workflow, ensuring a smooth and synchronized operation from one workstation to another.

4. Overall Blazer production process



5. Experimental Data Analysis

First we have to calculate the SMV as following steps:

Step 1: Entire blazer production has been occurring by following parts:

i. Front part
ii. Back part
iii. Sleeve
iv. Lining
v. Collar
vi. Assembly
vii. Final output

Also, each production part has been changed into different small process mentioned later.

Step 2: Observing the time for 5 no of cycles.

Sl. #	Cycle time (min)
1	0.60
2	0.52
3	0.54
4	0.58
5	0.51

Step 3: Determining the average **cycle time (CT)**

$$CT = \Sigma \text{ Times/ No. of cycles}$$

$$CT = (0.60+0.52+0.54+0.58+0.51)/\ 5 = 0.55\text{min}$$

Step 4: Determine the **basic time (BT)**

In the operation (body sewing allowance mark) the operator rated 80% as per proficiency in the operation

$$BT = CT \times PR \text{ [PR=Performance Rating]}$$

$$BT = 0.55 \times .80 = 0.44 \text{ min}$$

Step 5: Determine the **standard minutes value (SMV)** using the following equation

$$SMV = BT\ (1+ AR)$$

$$SMV = 0.44\ (1+ 0.25) = 0.55\ \text{min}$$

Here, 25% allowance rate has been considered to overlook the loss time of time production floor.

Its overall operations bulletins have been prepared below:

Table 1: Operations breakdown for the blazer production process with SMV calculation, hourly capacity

Front Part								
#	**Operation Description**	**Machine**	**Cycle Time (Min)**	**Basic Time (Min)**	**SMV**	**Man power**	**Planned Work Station**	**Capacity/Hr/ Machine**
1	Body Sewing allowance mark	HW	0.55	0.44	0.55	1	1	109
2	Dart Position mark & Panel matching	HW	0.45	0.36	0.45	1	1	133
3	Dart Make	SNLS	0.50	0.40	0.50	1	1	120
4	Panel Joint (B)	SNLS	1.01	0.81	1.01	2	2	119
5	Body Press & Fusing Attach	I/M	0.86	0.68	0.86	2	2	140
6	Flap Make	SNLS	0.50	0.40	0.50	1	1	120
7	Flap Cut & Turn Up	HW	0.55	0.44	0.55	1	1	109
8	Flap Make Iron (Pattern)	I/M	0.50	0.40	0.50	1	1	120
9	Flap Matching With Body	HW	0.47	0.37	0.47	1	1	129
10	Bone Joint	APW	0.50	0.40	0.50	1	1	120
11	Bone Cut & Turn Up	HW	1.03	0.83	1.03	2	2	116
12	Bone Tack	SNLS	0.55	0.44	0.55	1	1	109
13	Bone Iron	I/M	0.50	0.40	0.50	1	1	120
14	Supporting Join	SNLS	0.55	0.44	0.55	1	1	109
15	Pocketing Join & pkt top close	SNLS	0.47	0.37	0.47	1	1	129

16	Mouth Close & Lapel Position Tack	SNLS	0.67	0.53	0.67	2	2	99
17	Pocket side Close	SNLS	0.55	0.44	0.55	1	1	109
18	Flap & Pocket Iron	I/M	0.63	0.51	0.63	1	1	95
19	Show Bone Position Mark & Body Matching	HW	0.62	0.49	0.62	1	1	97
20	Show Bone Make (Pattern)	I/M	0.53	0.43	0.53	1	1	113
21	Show Bone Cut & Mark	HW	0.47	0.37	0.47	1	1	129
22	Show Bone Join	SNLS	0.55	0.44	0.55	1	1	109
23	Show Bone Cut	HW	0.62	0.49	0.62	1	1	97
24	Show Bone Iron & Gum Attach	I/M	0.63	0.51	0.63	1	1	95
25	Show Bone Zig Zag	ZZ	0.59	0.47	0.59	1	1	102
26	Show Bone Pocketing Attach &1/4	SNLS	0.53	0.43	0.53	1	1	113
27	Arm Hole Tap Join & Back Part	A/H	0.50	0.40	0.50	1	1	120
28	Body Press	Press	1.17	0.93	1.17	2	2	103
29	Arm Hole Edge Cut	K/M	0.55	0.44	0.55	1	1	109

Back								
#	**Operation Description**	**Machine**	**Cycle Time (Min)**	**Basic Time (Min)**	**SMV**	**Man power**	**Planned Work Station**	**Capacity/Hr/ Machine**
1	Back Center join	SNLS	0.47	0.37	0.47	1	1	129
Sleeve								
#	**Operation Description**	**Machine**	**Cycle Time**	**Basic Time**	**SMV**	**Man power**	**Planned Work**	**Capacity/Hr/ Machine**

			(Min)	(Min)			Station	
1	Cuff Folding With Iron	I/M	0.63	0.50	0.63	1	1	96
2	Sleeve side panel matching	HW	0.63	0.50	0.63	1	1	96
3	Sleeve side seam Join	SNLS	0.65	0.52	0.65	1	1	92
4	Sleeve nose make	SNLS	0.62	0.49	0.62	1	1	97
5	Sleeve nose Cut & Turn Up	HW	0.61	0.49	0.61	1	1	99
6	Sleeve Nose Iron	I/M	0.51	0.41	0.51	1	1	117
7	Nose Tack	SNLS	0.49	0.40	0.49	1	1	121
8	Button position mark	SNLS	0.51	0.41	0.51	1	1	117
9	Button Join (6 Button)	BN/S	0.53	0.43	0.53	1	1	113
10	Lining Side Join	C/S	0.63	0.50	0.63	1	1	96
11	Lining side Iron	I/M	0.53	0.43	0.53	1	1	113
12	Lining side seam safety stitch	SNLS	0.62	0.49	0.62	1	1	97
13	Lining matching with Sleeve	HW	0.58	0.47	0.58	1	1	103
14	Lining join with Sleeve	SNLS	0.63	0.50	0.63	1	1	96
15	Sleeve side Iron	I/M	0.63	0.50	0.63	1	1	96
16	Sleeve Inseam	SNLS	0.63	0.51	0.63	1	1	95
17	Sleeve Inseam Iron	I/M	0.80	0.64	0.80	2	2	150
18	Lining Inseam	SNLS	0.67	0.53	0.67	1	1	90
19	Lining Inseam safety stitch	SNLS	0.88	0.71	0.88	2	2	68
20	Mouth Close/Safety Stitch	SNLS	0.46	0.36	0.46	1	1	132
21	Lining Tack	SNLS	0.61	0.49	0.61	1	1	99

	With Sleeve							
22	Sleeve Turn Up	HW	0.49	0.40	0.49	1	1	121
23	Sleeve Head Padding Make	SNLS	0.62	0.49	0.62	1	1	97
24	Hade Pad Join	S/H	0.61	0.49	0.61	1	1	99
25	Sleeve Iron	I/M	0.59	0.47	0.59	1	1	102

Lining								
#	**Operation Description**	**Machine**	**Cycle Time (Min)**	**Basic Time (Min)**	**SMV**	**Man power**	**Planned Work Station**	**Capacity/Hr/ Machine**
1	Back Center Join	SNLS	0.51	0.41	0.51	1	1	117
2	Panel & Shoulder Lining Matching	HW	0.58	0.47	0.58	1	1	103
3	Panel Join	SNLS	0.60	0.48	0.60	1	1	100
4	All seam edge overlocked	3 O/L	0.42	0.33	0.42	1	1	144
5	Three safety stitch & dart make	SNLS	1.08	0.87	1.08	2	2	111
6	Panel & Back Part Iron	I/M	0.53	0.43	0.53	1	1	113
7	Shoulder Join	SNLS	0.59	0.47	0.59	1	1	102
8	Shoulder Iron & Care label Iron	I/M	0.49	0.40	0.49	1	1	121

9	Lining Body Matching With Facing	HW	0.49	0.40	0.49	1	1	121
10	Lining Facing joint with piping	S/N	0.60	0.48	0.60	1	1	100
11	Facing Iron	I/M	0.63	0.51	0.63	1	1	95
12	Size, washcare label arrange & join	SNLS	0.65	0.52	0.65	1	1	92
13	Loop make & iron	SNLS	0.62	0.49	0.62	1	1	97
14	Main label join	SNLS	0.52	0.41	0.52	1	1	116
15	Side seam Joint (B)	SNLS	0.57	0.46	0.57	1	1	105
16	Lining Side Iron (B)	I/M	0.61	0.49	0.61	1	1	99
17	Stopple Tap Join	S/T	0.53	0.43	0.53	1	1	113
18	Thread Cut	HW	0.76	0.61	0.76	2	2	158

Collar								
#	**Operation Description**	**Machine**	**Cycle Time (Min)**	**Basic Time (Min)**	**SMV**	**Man power**	**Planned Work Station**	**Capacity/Hr/ Machine**
1	Collar inside two part joint & Band Joint	SNLS	0.62	0.49	0.62	1	1	126
2	Collar seam open & Collar iron	I/M	0.60	0.48	0.60	1	1	126
3	Collar top Stitch 2 psn	SNLS	0.60	0.48	0.60	1	1	156
4	Collar edge tack & cut edge psn	SNLS	0.58	0.47	0.58	1	1	130
5	Collar Mark & Matching	HW	0.50	0.40	0.50	1	1	134

Assembly								
#	**Operation Description**	**Machine**	**Cycle Time (Min)**	**Basic Time (Min)**	**SMV**	**Man power**	**Planned Work Station**	**Capacity/Hr/ Machine**
1	Shell Side seam joint (B)	SNLS	0.62	0.49	0.62	1	1	97
2	Shoulder Joint (B)	SNLS	0.55	0.44	0.55	1	1	109
3	Shoulder Iron (B)	I/M	0.50	0.40	0.50	1	1	120
4	Shell Side seam iron (B)	I/M	0.50	0.40	0.50	1	1	120
5	Sleeve matching with body	HW	0.50	0.40	0.50	1	1	120
6	Sleeve Joint	S/J	1.10	0.88	1.10	2	2	109
7	Sleeve hanger loop & Padding Joint	S/P	0.50	0.40	0.50	1	1	120
8	Padding Bar-tack	T/M	0.52	0.42	0.52	1	1	115
9	Hem position mark	HW	0.60	0.48	0.60	1	1	100
10	Arm hole press	I/M	0.50	0.40	0.50	1	1	120
11	Lining matching with body	HW	0.63	0.51	0.63	1	1	95
12	Sticker remove	HW	0.50	0.40	0.50	1	1	120
13	Facing joint	SNLS	1.17	0.93	1.17	2	2	103
14	Facing cut & turn over	HW	0.58	0.47	0.58	1	1	103
15	Facing Edge cut	K/M	0.60	0.48	0.60	1	1	100
16	Facing Side iron	I/M	0.56	0.45	0.56	1	1	107
17	Hem folding	I/M	0.70	0.56	0.70	2	1	171
18	Facing iron	I/M	0.76	0.61	0.76	1	1	79

Output								
#	**Operation Description**	**Machine**	**Cycle Time (Min)**	**Basic Time (Min)**	**SMV**	**Man power**	**Planned Work Station**	**Capacity/Hr/ Machine**
1	Collar Matching	HW	0.57	0.46	0.57	1	1	105
2	Collar Join	SNLS	1.10	0.88	1.10	2	2	109
3	Collar Edge cut	HW	0.61	0.49	0.61	1	1	99
4	Hem Tack	SNLS	0.68	0.55	0.68	1	1	88
5	Neck iron	I/M	0.67	0.53	0.67	1	1	90
6	Nose & Hem iron	I/M	0.57	0.46	0.57	1	1	105
7	Lining Sleeve Join	SNLS	0.95	0.76	0.95	2	2	126
8	Hem iron	I/M	0.67	0.53	0.67	1	1	90
9	vent position mark	HW	0.57	0.46	0.57	1	1	105
10	Vent Joint	SNLS	0.67	0.53	0.67	1	1	90
11	Hem joint	SNLS	0.83	0.67	0.83	2	2	144
12	Hem tack with point	SNLS	0.60	0.48	0.60	1	1	100
13	Sticker remove	HW	0.57	0.46	0.57	2	2	211
14	Body turn up	HW	0.67	0.53	0.67	2	2	180
15	Vent top stitch	SNLS	0.67	0.53	0.67	1	1	90
16	Facing bottom top stitch	SNLS	0.65	0.52	0.65	1	1	92
17	Collar top stitch	SNLS	0.57	0.46	0.57	1	1	105
18	Sleeve turn up	HW	0.57	0.46	0.57	1	1	105
19	Sleeve Safety Stitch	SNLS	0.61	0.49	0.61	1	1	99
20	Body turn up	HW	0.55	0.44	0.55	1	1	109
21	Hem, Facing, & Collar T/S	SNLS	1.96	1.57	1.96	3	3	92
22	Trimming	HW	1.00	0.80	1.00	2	2	120
23	Vent & Hem Iron	I/M	0.57	0.45	0.57	1	1	106

24	Sleeve Mouth Close	SNLS	0.57	0.46	0.57	1	1	105
Performance Rating = 80%, AR = 25%			**Overall SMV =**		**76.30**			

5.1. Identifying Problem and possible recommendation:

Following abnormalities was found as following:

i. In the front part, process 1 & 2 were done by same type HW (Body Sewing Allowance mark & lapel mark and dart position mark & panel matching), processes were nearly similar capacity, is imbalanced 109 and 133
Possible recommendation: These two processes can be merged.

ii. In the front part, process 16 &17 were done by same type machine SNLS (Mouth Close & Lapel Position Tack and Pocket side Close), processes were nearly similar capacity has imbalanced capacity 90 and 109
Possible recommendation: These two processes can be merged

iii. In sleeve joint process, process 19 & 20 were done by SNLS machine (Lining Inseam safety stitch and Mouth Close/Safety Stitch) processes are nearly similar capacity which has imbalanced capacity 64 and 132
Possible recommendation: These two processes can be merged

iv. In the Lining section, process 13 & 14 (Loop make & iron and Main label join) were done by SNLS machine has been merge with process which has imbalanced capacity 97 and 116
Possible recommendation: These two processes can be merged

v. In the output section, process 10 & 11 (Vent Joint and Hem joint) were done by SNLS machine merged with process which has imbalanced capacity 90 and 144
Possible recommendation: These two processes can be merged

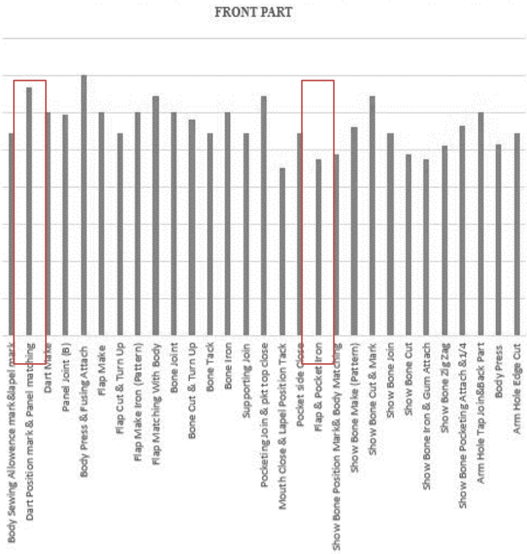
Some machine has excess unutilized capacity such as:

i. In the assembly section, process 16 (Hem folding) has been 2 manpower and machine from where the existing capacity is 171/hr.

ii. In the output section, process 13 (sticker remove) has been 2 manpower and machine from where the existing capacity is 211/hr.

iii. In the output section, process 14 (Body turn up) has been 2 manpower and machine from where the existing is capacity 180/hr.

Possible recommendation: for these three processes manpower should be reduced to reduce unutilized capacity



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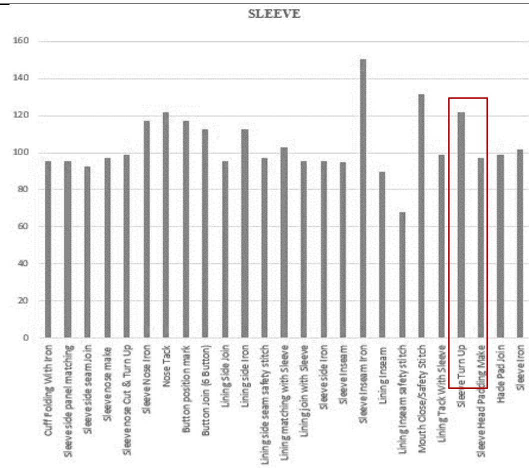

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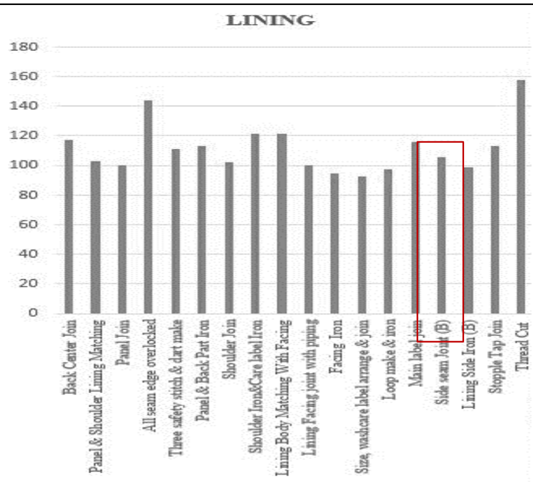
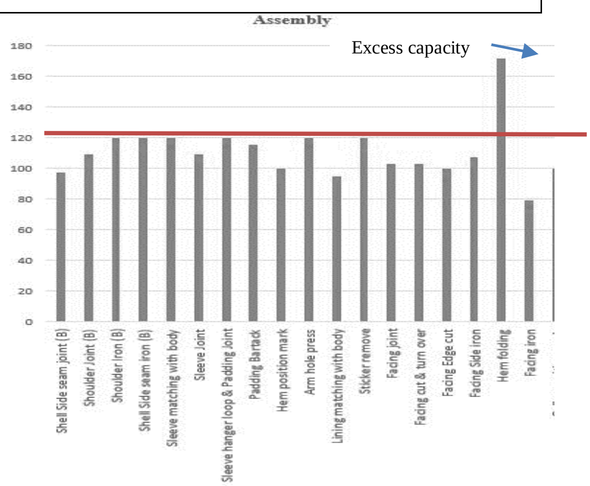
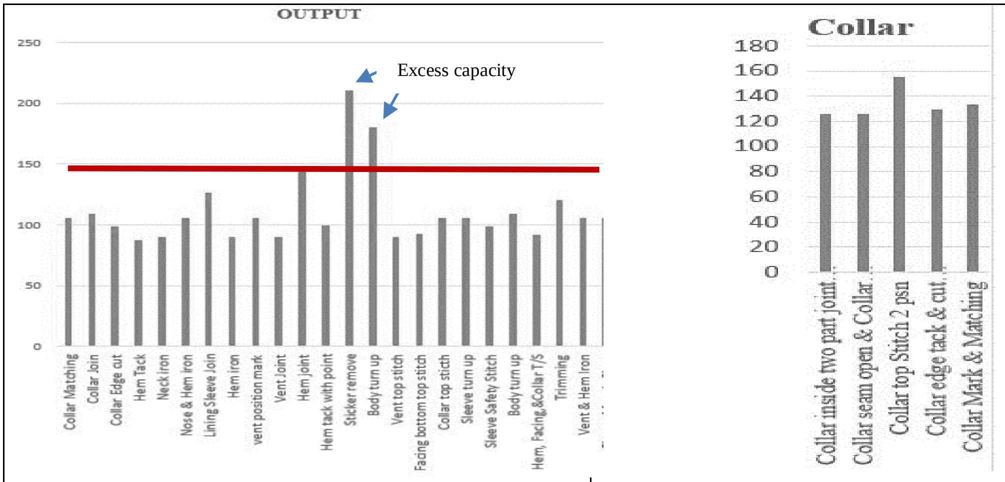


(c)



(d)



(e) (f)

Fig. 1 Different element wise capacity in each process initial layout (before line balancing)

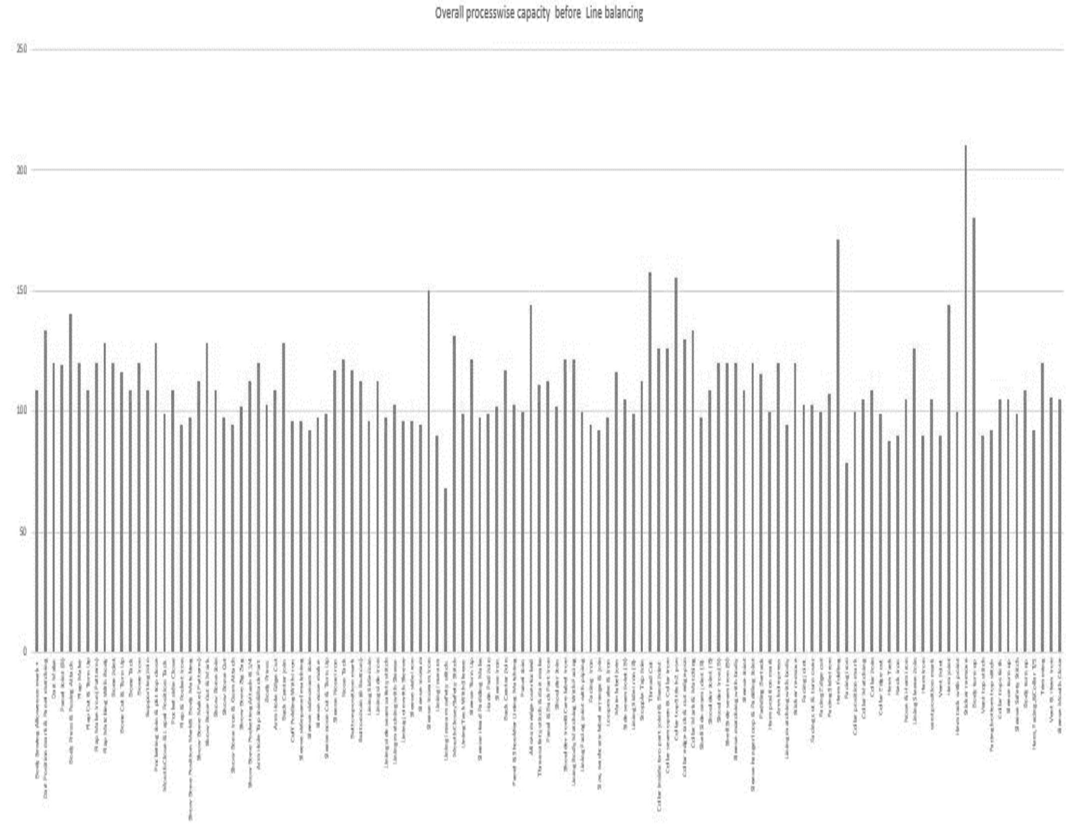


Fig. 2 Overall process wise capacity before line balancing

5.2. Proposed Line balancing with recommendation:

Here, for imbalanced capacity several processes were merged such as:

i. In the front part, process 1 & 2 (Body Sewing Allowance mark & lapel mark and dart position mark & panel matching) were merged with process and updated capacity has been 120 hr/machine

ii. In the front part, process 16 & 17 (Mouth Close & Lapel Position Tack and Pocket side Close) were merged with process and updated capacity has been 99 hr/machine

iii. In sleeve joint process, process 19 & 20 (Lining Inseam safety stitch and Mouth Close/Safety Stitch) were merged with process and updated capacity has been 90 hr/machine

iv. In the Lining section, process 13 & 14 (Loop make & iron and Main label join) were merged with process and updated capacity has been 106 hr/machine

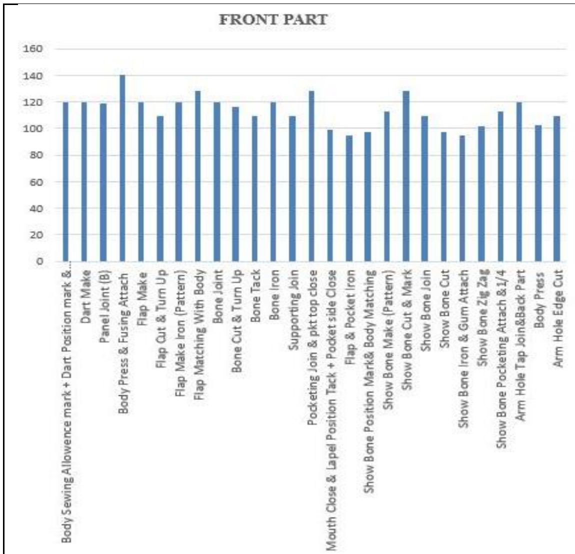
v. In the output section, process 10 & 11 (Vent Joint and Hem joint) were merged with process and updated capacity has been 120 hr/machine

Here, for unutilized capacity several process's manpower has been reduced such as:

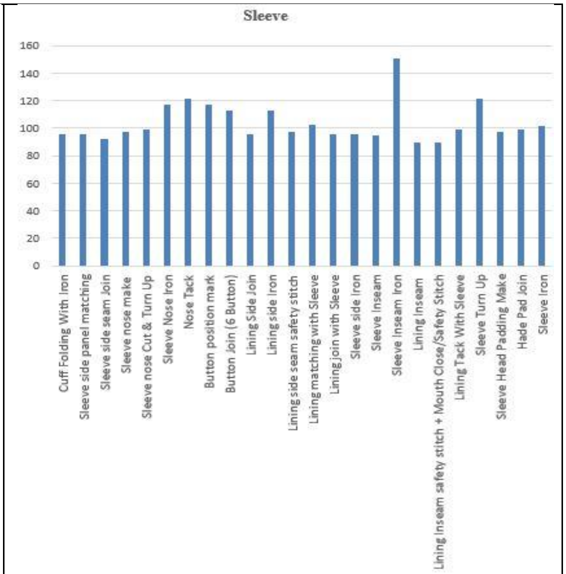
iv. In the assembly section, process 16(Hem folding) were reduced the manpower and machine from 2 machine to 1 machine where the capacity were reduced to 86 from 171.

v. In the output section, process 13 (sticker remove) reduced the manpower and machine from 2 to 1 where the capacity is reduced to 105 from 211.

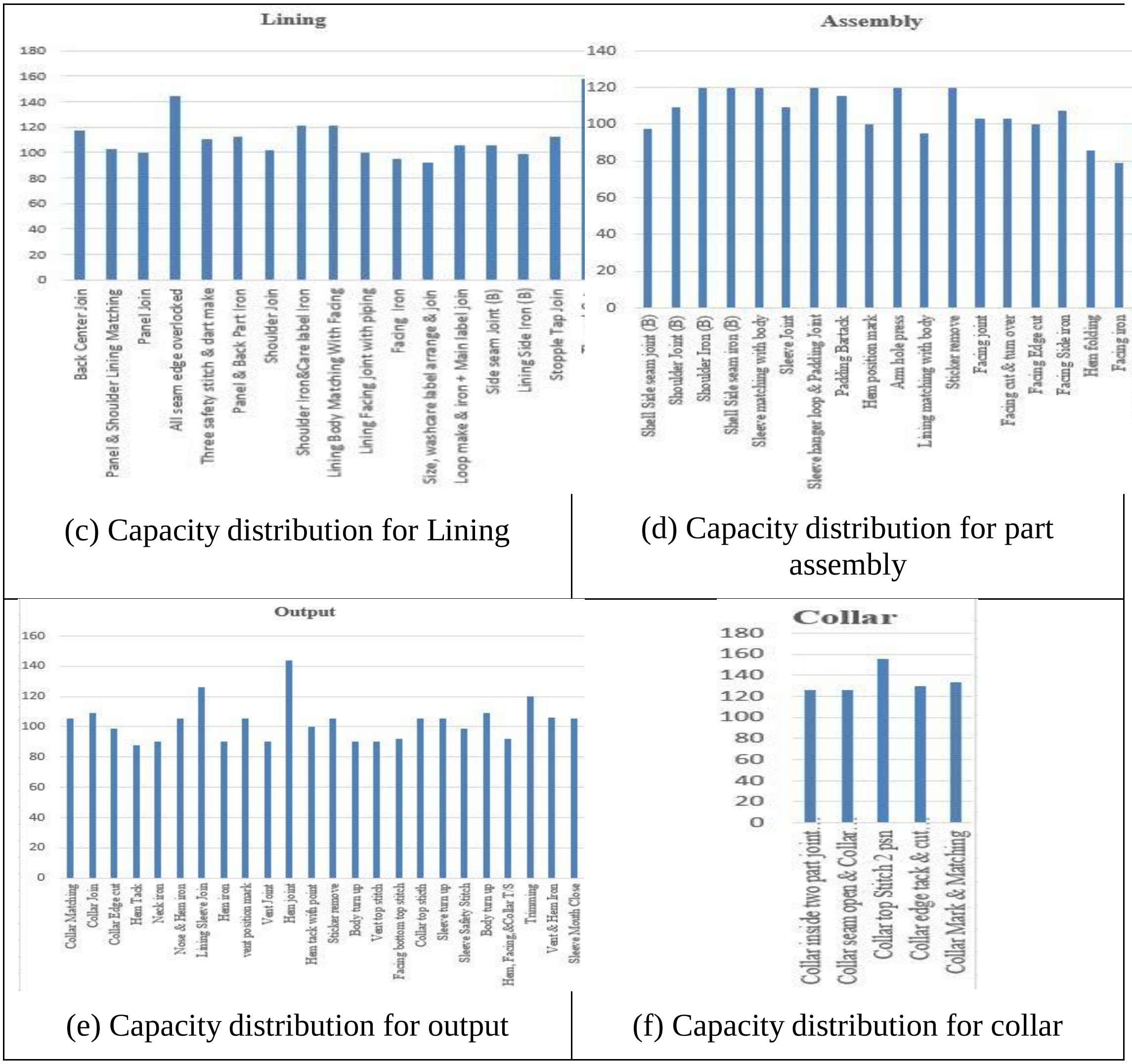
vi. In the output section, process 14 (Body turn up) reduced the manpower and machine from 2 to 1 where the capacity is reduced to 90 from 180.



(a) Capacity distribution for front part



(b) Capacity distribution for sleeve operations



(c) Capacity distribution for Lining

(d) Capacity distribution for part assembly

(e) Capacity distribution for output

(f) Capacity distribution for collar

Fig. 3 Different element wise capacity in each process after line balancing

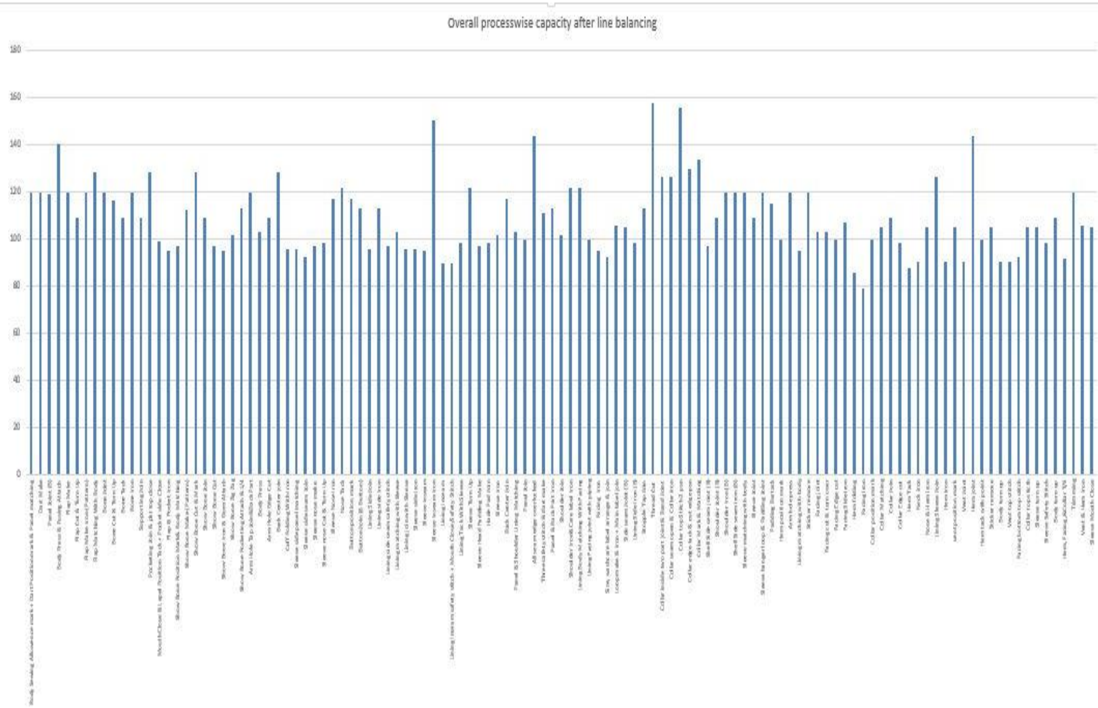


Fig. 4 Overall process wise capacity after line balancing

6. Result & Discussion

The study was conducted in a garment factory, and data were collected through time and motion studies, as well as process analysis. The results showed that the initial SMV for blazer production was 76.30 minutes. Through the implementation of work study and line balancing, the SMV was reduced to 73.15 minutes. Furthermore, the manpower required for the assembly line was reduced from 139 to 136 manpower where 02 helper and 01 iron man have been reduced. The findings of this study are significant, as they demonstrate the effectiveness of work study and line balancing in optimizing production processes. The reduction in SMV and manpower required not only leads to increased productivity but also reduces production costs. The study also demonstrates the importance of implementing lean manufacturing principles in the garment industry, where the cost of labor is a significant factor in the production process as before line balancing the process has overall capacity with 60% overall targeted capacity 660 pcs and after the line balancing 03 manpower has been reduced also the output targeted capacity has been increased with 669 pcs. The study also highlights the importance of employee involvement in the process of line balancing.

The workers were consulted during the process of line balancing, and their feedback was used to optimize the assembly line. The involvement of workers in the process of line balancing not only leads to a better understanding of the process but also enhances employee engagement and motivation.

Finally, the study demonstrates the effectiveness of work study and line balancing in optimizing the production process of blazers. The reduction in SMV and manpower required leads to increased productivity and reduced production costs. The involvement of workers in the process of line balancing enhances employee engagement and motivation, leading to a more efficient and effective production process.

Table 2. Summary results after process optimization

Before Line balancing		**After Line balancing**	
Total Machine	86	Total Machine	86
Total Operator	86	Total Operator	86
Helper (HW)	35	Helper (HW)	33
Total iron man	18	Total iron man	17
Total Manpower	139	Total Manpower	136
Overall PR	80%	Overall PR	80%
Allowance factor	25%	Allowance factor	25%
Total SMV	76.30	Total SMV	73.15
Target @ 60% Efficiency/hr.	66 pcs	Target @ 60% Efficiency/hr.	66.9 pcs
Target @ 60% Efficiency/day	660 pcs	Target @ 60% Efficiency/day	669 pcs
Total Manpower reduced		**02 Helper & 01 Iron Man**	

7. Conclusion

In conclusion, the study on the Standard Minute Value (SMV) calculation of the blazer production process through work study for a well-balanced assembly line offers insightful information and useful implications for the apparel sector. The research successfully reduced SMV and optimized the amount of labor needed for the assembly line by putting work study approaches and line balance into practice. The results emphasize the value of work study in locating and eliminating manufacturing process inefficiencies. The original SMV of 76.30 minutes was shortened to 73.15

minutes using time and motion studies and process analysis. This decrease represents a major boost in productivity and efficiency because it enables the production of more blazers in the same amount of time. Furthermore, the study demonstrates the effectiveness of line balancing in achieving a well-balanced assembly line. By redistributing tasks and optimizing the workflow, the manpower required for the assembly line was reduced from total helper 35 to 33 also 18 ironmen to 17 ironmen. This reduction not only results in cost savings for the company but also ensures a smoother and more streamlined production process.

8. Future Work

The successful implementation of work study and line balancing techniques in this study emphasizes the importance of adopting lean manufacturing principles in the garment industry. By continuously striving to eliminate waste and improve processes, companies can achieve higher levels of productivity, reduce costs, and enhance overall competitiveness in the market. While the study on the estimation of the Standard Minute Value (SMV) of the blazer production process by work study for a well-balanced assembly line has provided valuable insights, there are several avenues for future research and improvement in this area. The following are some potential areas of focus for future work as follows:

- Impact of Technology
- Worker Well-being and Ergonomics
- Continuous Improvement and Optimization

With the rapid advancement of technology, it is important to explore how the implementation of automation, robotics, and other advanced technologies can further optimize the blazer production process. Future work can investigate the integration of technological solutions to enhance productivity, reduce human errors, and improve overall efficiency. Worker Well-being and in the context on ergonomics while the study focused on reducing SMV and manpower, future research can explore the impact of work study and line balancing on worker well-being and ergonomics. This can involve analyzing the physical demands of tasks, identifying potential areas of improvement to reduce strain and fatigue, and ensuring a safe and healthy working environment for the employees. Line balance and work study are examples of continuous improvement techniques. Future studies may look on methods for tracking and evaluating the efficiency of the improved assembly line over time. To do this, it would be necessary to create key performance indicators (KPIs), put feedback systems in place, and carry out routine evaluations to pinpoint areas that could benefit from additional optimization and efficiency improvements.

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