Faculty of Engineering
Department of Textile Engineering

Study on Line Balancing in Sewing Line

Course Code: TE 4214 **Course Code:** Capstone Project (Thesis)

Submitted by:

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

Advanced in Apparel Manufacturing Technology

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Letter of Approval

To

The Department Head

Department of Textile Engineering,

Daffodil International University, Ashulia, Savar, Dhaka

Subject: Approval of Project Report of B.S.C in TE program.

Dear Sir,

We sincerely hope you will accept this project report and take everything into account for your final evaluation. I'm writing to inform you that the students Safayet Uddin Mishfat, ID 211-23-857, and Md Salim Raza, ID 191-23-5615, have finished their project report, "The investigation on the final inspection report to find out the fundamental causes of defects and their remedies," for final evaluation. The whole paper was created using appropriate research and interruption by thorough analysis of empirical data with the necessary elements. Students actively participated in their project activities, and the report became essential in providing readers with a wealth of useful information.

As a result, please accept and review this project report for the final assessment; your kindness will be greatly appreciated.

Yours Sincerely,

Dr. Md. Saifur Rahman

Professor

Department of Textile Engineering,

Daffodil International University

Author's Declaration

We declare that we are one of the creators of this project. Our advisors authorized the final, modified version of this document. Furthermore, we give Daffodil International University permission to make copies of this project and disseminate them, whether in print or digitally. Any required changes to ensure clarity and completeness will be included in this approval.

Submitted By:

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Statement of Contribution

First of all, we would want to sincerely thank the Almighty Allah for providing us with this initiative as a means of presenting our abilities.

We would want to send this report to our parents as a last request. We have the greatest admiration for them because of their constant encouragement and support during our education. Without their help, we wouldn't have been able to complete our research, and their assistance has provided us great joy. We sincerely appreciate this.

Additionally, we would like to extend our deepest appreciation to the employees at Tanzila Textile Ltd. for their invaluable contributions to this research.

In addition, we would like to accept this report from our academic supervisor, Dr. Md. Saifur Rahman a Professor in the Textile Engineering Department of Daffodil International University. We are immensely thankful for his help, as his advice and support were vital for completing this project.

Executive Summary

Our project topic is 'Line Balancing in sewing industry with their causes and remedies'. The objective of this study is to use line balancing strategies to balance the polo shirt operation's garment line. These methods are used to increase the A bay apparel industry's productivity and efficiency. Data on the calculation of times for each operation were gathered using stopwatch timing and observational techniques. The standard permitted minute was then established using the principles of work evaluation. We collected all the information c was statistically analyzed using the Arena input analyzer in order to identify the correct expressions for the current simulation modeling and determine statistical significance. In addition, this study utilized Arena simulation software to model and assess the efficiency of the suggested and existing polo shirt sewing line models. In addition, better models were suggested, building on the current model. Additional, better models were suggested, building on the present model. Many indicators of performance, including as output, capacity utilization, queue waiting time, and number of products waiting, showed significant improvement with the alternative approaches. Those improvements show that the adoption of balanced production lines has improved productivity. As a consequence of the modified scenario, output increased from 114 to 180; line efficiency increased from 39.06% to 55.64%; and labor productivity increased from 54.25% to 66%. Additionally, revenue increased by more than 30% while labor expenses decreased by 15.63%.

Acknowledgement

Firstly, we are grateful to Allah for providing us with the courage and capacity to finish our thesis, which is titled "Line balancing I sewing line “in order to find out the Intensity with their causes and remedies." In order to develop this thesis work, I would like to sincerely thank our supervisor Dr. Engr. Md. Saifur Rahman, Professor, Department of Textile Engineering, Faculty of Engineering, Daffodil International University, for his consistent guidance and support. Working with him has allowed us to gain essential expertise, but we have also been inspired by his creativeness, which has further enhanced our experience.

His strategies and thoughts were truly amazing.

Additionally, we would like to express our sincere gratitude to Tanvir Ahmed Chowdhury, Assistant Professor and Head of the Department of TE, for his significant management and inspiration. Our trip was greatly aided by his suggestions and encouragement. Our work was greatly aided by the insightful criticism and understanding of all among our educators, for which we are also thankful.

We also like to sincerely thank the diligent workers of the Tanzila Group, which is based in Baroypara, Ashulia, Savar, Dhaka Gazipur. Their invaluable help was critical to the completion of our thesis. It was extremely beneficial because they were willing to answer our questions honestly and give us valuable data that was important to our study. Their participation and contributions are highly valued. We are grateful to everyone who supported us with this thesis in any way they can.

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CHAPTER- 1
INTRODUCTION

1.1INTRODUCTION

1.1.1 Background of the study

The garment industry is a major world sector that provides a supply chain to the textile industry. The development of clothing patterns and design, fabric spreading and cutting, sewing, ironing, and packing are the four major phases of garment production process. This process of sewing is the most important. Since sewing is important component of the sewing industry, it is imperative that the sewing line be properly designed to achieve the greatest results at the greatest level of efficiency.

Apparel is produced in huge quantities. Systems of assembly line production were created to satisfy the increasing needs of society. Assembly lines have replaced traditional production methods due to requirements for shorter life cycles and higher product variability. In a mass production operation, an assembly line is an industrialized setup of beings, machinery, and equipment for a continuous flow of work items.

Partitioning the entire amount of work into a series of straightforward procedures known as work is essential when manufacturing a product on an assembly line. Based on limitations of varying labor skill levels, operators are given tasks. Lastly, a sewing line is generated by rowing across a number of workstations. This process consists of a number of work stations where certain method is completed in a specific rule. Thousands of subassemblies and hundreds of workers producing different designs at every time.

As a result, this process is crucial and requires more careful planning. For better both efficiency and quality, the sewing line should be drawn up with limited stocks and correct line balancing. Giving tasks to workstations so that their machines can carry out them with a balanced loading and variable labor skill levels is the aim of production line balancing in sewing lines.

1.2 Problem Statement

Tanzila Textile Ltd is one of the most recent clothing manufacturing companies in Bangladesh.

The profitability and efficiency of a bay Apparel Industry is negatively affected by the severe bottlenecks in the sewing line used to produce polo shirts. The problems outlined below have been identified:

Unbalanced Workloads: While certain workstations are underutilized, resulting in idle time, others have been overloaded, creating bottlenecks.

High Work-in-Progress (WIP): Unequal task distribution causes an accumulation of incomplete clothing at particular stations, which impedes output.

Low Line Efficiency: When workstations differ in task durations, resources are used less efficiently, which lowers line efficiency overall.

Delivery Delays: Insufficient line balancing makes it more difficult to reach production goals and delivery times, which irritates customers.

To solve these issues, a comprehensive look of the sewing line is required, as well as the identification of bottlenecks and the formulation of plans to create a balanced workflow.

1.3 Objectives

The goal of the study is to use effective line balancing to improve the productivity and efficiency of the sewing line utilized to produce polo shirts at A Bay Garment Industry. The study targets to achieve the following objectives such as

Primary Objective

- To optimize task distribution across all workstations in the sewing line, leading to increased efficiency.

Secondary Objectives

- To minimize idle time and eliminate of sewing process bottlenecks.
- To maintain a smooth production flow and reduce work-in-progress (WIP).
- To match tasks to operators' skill levels so as to increase operator productivity.
- To improve the capacity to fulfill schedules for delivery and production targets.

1.4 Scope of the study

We have learned every step of the polo t-shirt manufacturing procedure during the project work. Our endeavor began with the sewing section. We have collected comprehensive data about production requirements, dependencies, and task durations. We evaluated those weaknesses, their causes, and solution. We have gathered the layout for these from the IE department. Based on manufacturing goals, we have calculated the cycle time and the theoretical minimal number of workstations needed. For our initial configuration, we have balance delay and compute line efficiency. In order to improve production efficiency, this project will utilize heuristic strategies with systematic techniques to provide a workable solution to the line balance problem. This project will help build a more dependable and economical manufacturing system by focusing output maximization and idle time reduction.

This study's scope has been limited to the sewing processes used at Tanzila Textile Ltd Apparel Industry to produce polo shirts. The study's divides are defined by the following components:

Focus on Sewing Line: The study simply looks at the sewing line; it doesn't look at cutting, finishing, or packaging.

Production of Polo Shirts: This study focuses on the processes and procedures that involve manufacturing polo shirts, such as hemming, stitching seams, and joining band collars.

Analysis at the Workstations Level: The study assesses each workstation individually, identifying workloads, task times, and bottlenecks.

Simulation-Based Analysis: The current sewing line is represented and improvements are offered utilizing Arena simulation software.

While polo shirts are the study's main significance, its findings and recommendations could be used as guidelines for balancing sewing lines in different types of apparel.

1.5 Significance of the study

The operational performance of A Bay Apparel Industry focuses on the sewing line's capability to balance lines efficiently. The following essentially summarizes the study's importance:

Improved Productivity: A balanced sewing line ensures that every workstation operates to its full capacity, improving total output from production.

Cost Efficiency: The study reduces manufacturing costs by reducing WIP and idle times, which improves productivity.

Timely Delivery: An organization can achieve delivery dates and improve consumer happiness through the use of balanced workflows which ensure continuous growth along the production line.

Increased Material Utilization: the workstation capabilities and operator skills should be matched to maximize the use of labor and machinery.

CHAPTER-2

LITERATURE REVIEW

2.1 Literature Survey

2.1.1 Line Balancing Concept

Line balancing is the process of reducing work center hours of operation to as closely resemble the necessary CT (cycle time) as achievable. The required cycle time is the output of a procedure or operation wherever the demand for the product being produced determines the process. A process that has equal actual cycle times at every stage is said to be balanced. The true production capacity of a procedure or operation is determined by the real cycle time. Physical aspects such as walking around the cell, performing manual or automated tasks, and other factors affect the actual cycle time in a work cell. In actuality, only timed systems that the material through workstations at a steady speed on a conveyor or chain are appropriate for the objective of creating a completely balanced process. The term "line balancing" defines the method of giving tasks (essential units of work) to a workstation in a way that ensures the tasks are given away in the proper order, the assignment is as efficient as possible, and the CT of the whole sequence of workstations satisfies the required CTs. First, there is enough output from the series of workstations to satisfy demand. In order for that to occur, the slowest workstation's CT needs to be more than the necessary CT. Second, tasks assigned to workstations adhere to precedence standards. There is always a logical order or sequence that must be followed when performing a variety of jobs. Third, considering the CT required and priority relationship, the outcome is the lowest number of workstations or operations along the line.

2.1.2 Objectives

Line balance is an important concept in production and manufacturing processes, particularly on assembly lines. It entails dividing jobs among multiple workstations so that each station has the same amount of work, minimizing downtime and increasing productivity.

The primary goals of line balance are:

1. Increase efficiency.

The goal is to equally distribute work across all workstations, ensuring that no single station is overburdened or inefficient. This helps to increase the assembly line's throughput.

2. Reduce idle time.

Balancing the line ensures that each workstation performs at full capacity, decreasing idle time where workers or instruments wait for the next task.

3. Optimize resource use.

Make sure that resources like labor, machinery, and equipment are used effectively and efficiently. The goal is to reduce unused resources while making sure that no station stresses any given resource.

4. Optimize bottlenecks.

Line balancing assists in discovering and fixing bottlenecks—areas where work accumulates and slows down the entire production process. Bottlenecks can be minimized or completely eliminated by evenly distributing workloads between workstations.

5. Improve production flow.

By breaking down duties equitably across the production line, items can move more smoothly and consistently, improving material flow and decreasing production delays.

6. Lower production costs.

Proper line balancing can assist reduce the need for extra resources or overtime, resulting in lower operational and personnel expenses. It may also reduce waste material and machine downtime.

7. Maximize output.

By removing inefficiencies like idle time, bottlenecks, and imbalanced workloads, the production system can enhance output and better meet demand.

8. Maintain flexibility and scalability.

Well-balanced lines are more adaptable to changes in volume of production or product design. The line can be rebalanced to allow for new product categories or changes in production schedules.

9. Improve worker satisfaction.

A balanced workload can assist reduce worker tiredness and stress by distributing jobs more equally. This may improve morale and reduce turnover.

10. Improve product quality.

When operations are correctly balanced, workers and machines have more time for focusing on quality, which reduces the possibility of errors and faults.

2.2 Steps in Line Balancing

The goal of line balancing is to optimize efficiency by providing tasks and workloads evenly among workstations in a sewing production line. Below is a summary of the main processes in line balancing:

1. Assess Every Step of the Production Process

Task Division: To begin, divide the production process into more manageable, smaller tasks or operations. Each operation should to be precisely specified and connected to a specific sewing function, like pressing, trimming, or stitching.

Time Study: To determine each task's Standard Minute Value (SMV), conduct a time study. Under typical operating conditions, this is the average amount of time an operator requires to finish a task.

2. Determine Cycle Time

- **Cycle Time Evaluation:** This is the maximum amount of time which each workstation can run**.** its task in order to meet the desired production output. It can be calculated as:

  Cycle Time = Target Production Quantity ÷ Total Available Production Time

The goal is to balance the tasks so that no workstation exceeds the cycle time.

4. Balance Workloads

- **Equal Distribution of Work**: The key objective is to balance the workload across the line to avoid bottlenecks or idle time. Tasks should be grouped in such a way that each workstation has roughly the same total time required to complete the tasks.
- **Rearrange Tasks if Necessary**: If one workstation is overloaded, consider redistributing tasks from that station to others. Similarly, if a workstation has excess idle time, consider reallocating tasks to optimize resource utilization.

5. Optimize Workstation Layout

- **Efficient Layout Design**: The layout should be designed to minimize unnecessary movement and to ensure a smooth flow of materials, tools, and operators. Ideally, tasks should be grouped in a logical sequence that reduces walking distance between workstations.
- **Workstation Setup**: Set up each workstation with the necessary tools, equipment, and materials to allow operators to work efficiently and without interruptions.

6. Monitor and Adjust

- **Continuous Monitoring**: After balancing the line, monitor the production process regularly to ensure that the workload is evenly distributed and that there are no delays or bottlenecks.
- **Feedback and Adjustments**: Get feedback from operators and supervisors about the balance. Adjust the assignments as needed based on real-time performance, unexpected changes in workload, or variations in operator skills.
- **Performance Metrics**: Track key performance indicators (KPIs) like cycle time, operator utilization, and production output to evaluate the effectiveness of the line balance.

7. Train Operators and Cross-Train

- **Operator Training**: Ensure that operators are trained on the specific tasks they will perform at each workstation. Proper training ensures efficiency and reduces errors.

8. Continuous Improvement

- **Evaluate and Refine**: Line balancing is an ongoing process. Regularly review the line balance as production changes (new models, different garment types, etc.) and make adjustments as necessary.
- **Use Tools and Software**: Leverage software tools to analyze and simulate line balancing for different production scenarios to improve accuracy and efficiency.

2.3 Maintaining the balance of the sewing line

Developing line balancing for a sewing line is a critical step toward increasing production, reducing costs, and making sure workstations are used efficiently. Line balancing is the process of allocating methods (operations) to workstation in a way that reduces idle time while improving throughput. The goal is to ensure that all stations have approximately the same amount of work, which will minimize bottlenecks and downtime.

Here's a step-by-step guide for establishing line balancing in a sewing line:

1. Understand the Product and its Processes.

Determine the Product: Before balancing the line, we must thoroughly understand the product being created. This entails recognizing the many components of the garment or product and comprehending how they are assembled.

Breakdown Operations: List all of the steps or processes involved in sewing the product, such as cutting, stitching, pressing, and trimming. Each work should be clearly stated, and if required, divided into smaller, more manageable parts.

2. Determine the work volume and duration for each operation.

Time Study: Complete a time study or collect information on how long each operation takes. This can be accomplished by observing the workers or using standard time tables (SMV—Standard Minute Value) for each task. Accurate time measurement is vital for balance.

3. Standard Operating Procedures (SOPs).

Clear guidelines: Establish and uphold uniform work instructions for each operation on the sewing line. These should include the best practices for each task, ensuring that personnel can finish them promptly and consistently.

Consistent Quality Standards: Ensure that all workstations adhere to the same quality standards for stitching, fabric handling, and other operations. This prevents mistakes and reduces the need for rework, which can slow down the production line.

4. Workers' Skill Levels

Skill Matching: Assign staff according to their talents and expertise. More experienced personnel should undertake more difficult jobs, whereas less experienced people should concentrate on simpler processes.
Training programs: Workers should be trained on a regular basis to improve their skills and efficiency. Cross-training can also help maintain balance by allowing workers to move between different stations to make up for workload fluctuations.

5. Machinery and Equipment Management

Machine Efficiency: Ensuring that all machines are properly maintained and operating at maximum efficiency. Machines that break down frequently or work slowly could disrupt the line.

Establish a regular maintenance program for all machines to reduce delay. Any defective equipment might disturb the workflow and cause delays.

Proper Setup: Check that machines are properly configured and adjusted for each type of garment or operation being performed. Poorly adjusted machinery may take more time and result in problems.

6. Continuous Evaluation and Feedback.

Real-Time Monitoring: Use statistical analysis or a production management system to track the sewing line's performance in real time. This enables supervisors to quickly identify bottlenecks and inefficiencies and implement remedial actions.

Develop a feedback loop in which employees and supervisors can report problems or make suggestions for improving the flow of the line. Regularly examine performance indicators, such as cycle times, downtime, and defect rates, to find opportunities for improvement.

7. Material Management and Layout Optimization.

Efficient Material Flow: Ensure sure that raw materials (fabric, trimmings, etc.) are conveniently accessible to workers on the manufacturing line. A organized material flow minimizes unnecessary movement while improving productivity.

Workstation Layout: The sewing line's layout should be modified to reduce mobility while improving efficiency. Workstations should be positioned rationally, with minimal distances between them, so that workers may easily transfer materials or finished goods to the next station.

2.4 Advantages of line balancing in sewing industry

In the sewing industry, line balancing is the act of arranging function and workstations in such way that manufacturing runs smoothly, idle time is reduced, and efficiency is maximized. Here are the four main benefits of line balancing in the sewing industry:

1. Increased productivity.

Line balancing, which divides work evenly across all sewing stations, helps to eliminate bottlenecks or idle intervals in the production process. Therefore, the entire sewing line to run more efficiently, increasing the total number of garments produced in a given period.

2. Improved work efficiency.

When duties are properly balanced, each sewing operator is allocated a set of tasks that are appropriate for their skill level and time available. This reduces unnecessary delays and disruptions, resulting in a more efficient process and faster completion of garment production.

3. Cost Reduction

Line balancing increases labor consumption, reducing the need for extra personnel or overtime. By improving effectiveness and reducing delays, production costs (such as labor and energy) are lowered, contributing to lower overall manufacturing costs.

4. Improved Quality Control.

A balanced production line decreases worker stress and tiredness, which may result in fewer errors and faults. When workers can focus on their activities without getting sidetracked by excessive workload, the overall quality of the stitched items improves.

Line balancing allows sewing manufacturers to create a more streamlined, economical, and high-quality production process.

2.4 Challenges in Sewing Line Operations for Balancing

In the apparel industry, sewing line operations are essential to the prompt and effective creation of garments of superior quality. These processes, however, frequently encounter a number of challenges that might impair workflow, lower output, and raise costs. One essential remedy to lessen this issue and improve performance is line balancing. The main issues are addressed below, along with how balancing the sewing line eliminates them.

2.4.1 Key Challenges in Sewing Line Operations

1. Unbalanced Distribution of Workload

Operators with various levels of expertise share tasks on a sewing line. Inefficiency, idle time, and bottlenecks can arise from an unequal workload distribution. For example, if an operator takes longer than others to finish a task, the line as a whole gradually slows down as subsequent workstations are forced to wait, slowing the entire line.

2. **Variability in Skill Among Operators**

Sewing line operators usually have varying degrees of experience. Higher-skilled tasks might not be finished as quickly as simpler ones, which could cause irregularities in the flow of production.

3. Frequent Style Changes

Frequent changes to product design or style can throw off the sewing line's rhythm in the production of contemporary clothing. Operations become more complex when the line adjusts to make room for these changes.

4. Machine Downtime

- Equipment failures or breakdowns can halt production at specific workstations, causing delays throughout the line.
- Poor maintenance or improper machine allocation can exacerbate this issue.

5. Bottlenecks and Idle Time

- While idle time occurs when workers or machines wait for work to arrive, bottlenecks occur when one process takes substantially more time than others.
- These inefficiencies can raise labor costs and lower productivity.

6. Problems with Quality Control

Insufficient coordination can lead to rapid or uneven sewing techniques, which can result in quality issues. Rework improves the operation's time and expense.

2.4.2 Methods for achieving Line Balance

1. Analysis of Workload

To find out how long each task requires, do motion and time studies. Utilize this information to distribute tasks evenly throughout the line.

2. Assignment Based on Skills

Assign tasks to operators according to their qualifications and experience to maximize work efficiency and minimize variability.

3. Utilizing Line Balancing Instruments

To create and optimize the sewing line, use software or methods like lean manufacturing concepts, line balancing methods, or simulation models.

4. Continuous monitoring and modification

Maintain an eye on production data to spot imbalances and make necessary corrections.

5. Operator Cross-Training

To improve flexibility and lessen disruptions from change or absenteeism, train operators to perform multiple tasks**.**

6. Lean and Kaizen Methods

Use techniques for continuous improvement, such as Kaizen, to improve procedures and maintain equilibrium on the sewing line.

2.5 Steps for Line Balancing and Basic Equations

The questions and information listed below are taken from Jacobs.

1. Prepare a precedence diagram to show the tasks' sequential relationship. There are many circles and arrows in the diagram.
2. For the reason of calculating cycle Time

   Ct = Production time per day/ Average output per day.
3. Find the theoretically required smallest number of workstations.

   Nt = Sum of tusk time /Ct
4. To calculate the line's efficiency and balance its delay.

Efficiency = Sum of task time / Actual number of workstation (Na) × Cycle time (Ct) 5. To calculate the time delay (D)

Actual Number of stations × Ct – Sum of task time ÷ Actual Number of Work station × Ct

2.6 Key formulas for productivity

The following inquiries are taken from Mahto (2013).

1. To calculate efficiency

   E = Actual Output / Theoretical Output *100%

2. Theoretical results

   Theoretical results = No of operators × Working hours ÷ SMV

CHAPTER-3 EXPERIMENTAL DETAILS

3.1 Data collection-

3.1.1 Layout Report:

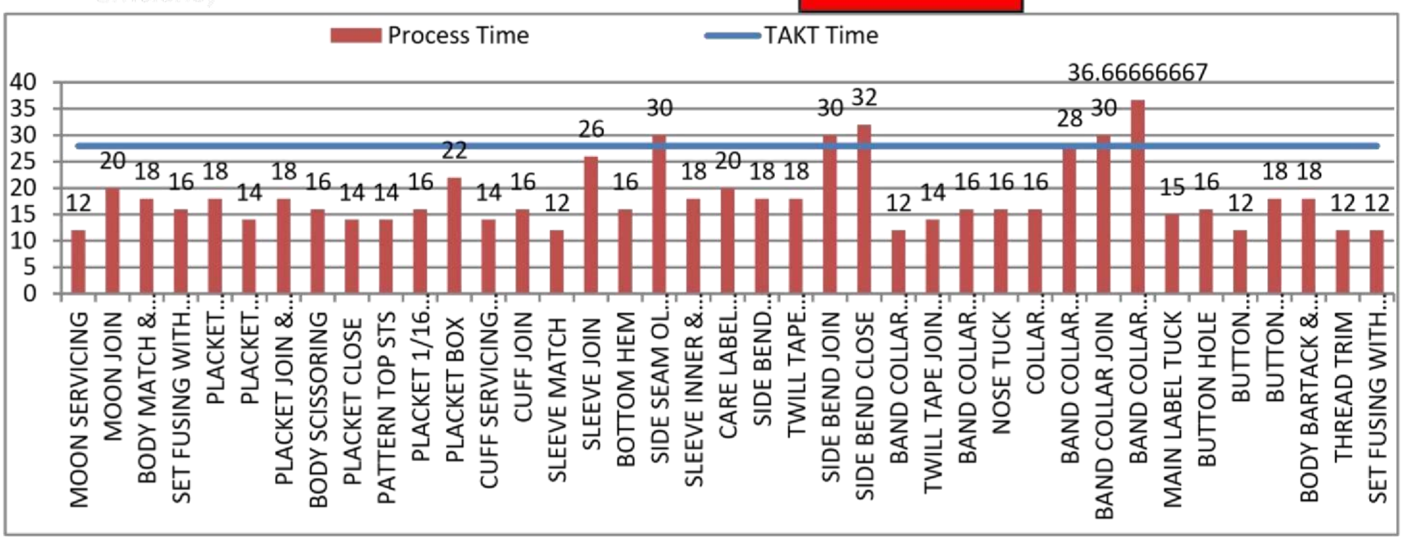
We have collected layout report, some production study sheet, line balancing sheet from Tanzila Textile Ltd of MANGO buyer. These reports are enlisted below:

Tanzila Textile Ltd

Baroypara, Ashulia, Savar, Dhaka **Layout**

for POLO T SHIRT

Working Hour	11	Buyer	MANGO
Plan DownTime	45	Ref. No	HANOICY
SMV	12.86	Order Qty	10000
TAKT Time	28	Studied Size	
Flow	5	Size Qty	FOB-2.76
Customer Demand	180	Colour Qty	
Target Efficiency	64%	DATE	10/11/2024
Work station/Unit		GSM	
Line	11	Item	Polo Shirt-Polo
Studied By:Md.NAZRUL ISLAM		Andon Qty (Set-Yellow & Red)	34
Design Efficiency	52%	**Loading Point**	
Target Efficiency	85%	**Mistake Proffing**	



Placeholder	Operation Breakdown	Machine	ST	SMV	Target	Manpower	Loading point	Mistake Proofing
1	MOON SERVICING	Overlock Machine	12	0.20	255	1		

2	MOON JOIN	Plain Machine	20	0.33	153	1.5		
3	BODY MATCH & SHOULDER JOIN	Overlock Machine	18	0.30	170	1		
4	SET FUSING WITH PLACKET	Helper	16	0.27	191	1		
5	PLACKET ROLLING & MARK	Plain Machine	18	0.30	170	1		
6	PLACKET POSITION MARK	Helper	14	0.23	219	1		
7	PLACKET JOIN & 1/16	Plain Machine	18	0.30	170	1		
8	BODY SCISSORING	Helper	16	0.27	191	1		
9	PLACKET CLOSE	Plain Machine	14	0.23	219	1		
10	PATTERN TOP STS	Plain Machine	14	0.23	219	1		
11	PLACKET 1/16 TOP STS	Plain Machine	16	0.27	191	1		
12	PLACKET BOX	Bartack Machine	22	0.37	139	1.5		
13	CUFF SERVICING MARK	Overlock Machine	14	0.23	219	1		
14	CUFF JOIN	Overlock Machine	16	0.27	191	1		
15	SLEEVE MATCH	Helper	12	0.20	255	1		
16	SLEEVE JOIN	Overlock Machine	26	0.43	118	1.5		
17	BOTTOM HEM	C - F/L Machine	16	0.27	191	1		
18	SIDE SEAM OL WITH SIDE BEND	Overlock Machine	45	0.75	68	2.5		

19	SLEEVE INNER & OUTER TUCK	Plain Machine	18	0.30	170	1		
20	CARE LABEL MAKE & TACK	Plain Machine	20	0.33	153	1		
21	SIDE BEND SERVICING & PLACKET SECURITY TUCK	Plain Machine	18	0.30	170	1		
22	TWILL TAPE TRIM,MINAR MAKE & MARK	Plain Machine	18	0.30	170	1		
23	SIDE BEND JOIN	Plain Machine	30	0.50	102	2		
24	SIDE BEND CLOSE	Plain Machine	32	0.53	96	2		
25	BAND COLLAR MAKE	Overlock Machine	12	0.20	255	1		
26	TWILL TAPE JOIN AT BAND	Plain Machine	14	0.23	219	1		
27	BAND COLLAR SERVICING	Plain Machine	16	0.27	191	1		
28	NOSE TUCK	Plain Machine	16	0.27	191	1		
28	COLLAR SERVICING & MARK	Overlock Machine	16	0.27	191	1		
29	BAND COLLAR TOP STS	Plain Machine	28	0.47	109	2		
30	BAND COLLAR JOIN	Plain Machine	45	0.75	68	3		
31	BAND COLLAR CLOSE	Plain Machine	55	0.92	56	3		
32	MAIN LABEL TUCK	Plain Machine	15	0.25	204	1		
33	BUTTON HOLE	Button Hole	16	0.27	191	1		
34	BUTTON POSITION MARK	Helper	12	0.20	255	1		
35	BUTTON POSITION ATTACH	Button Attach	18	0.30	170	1		

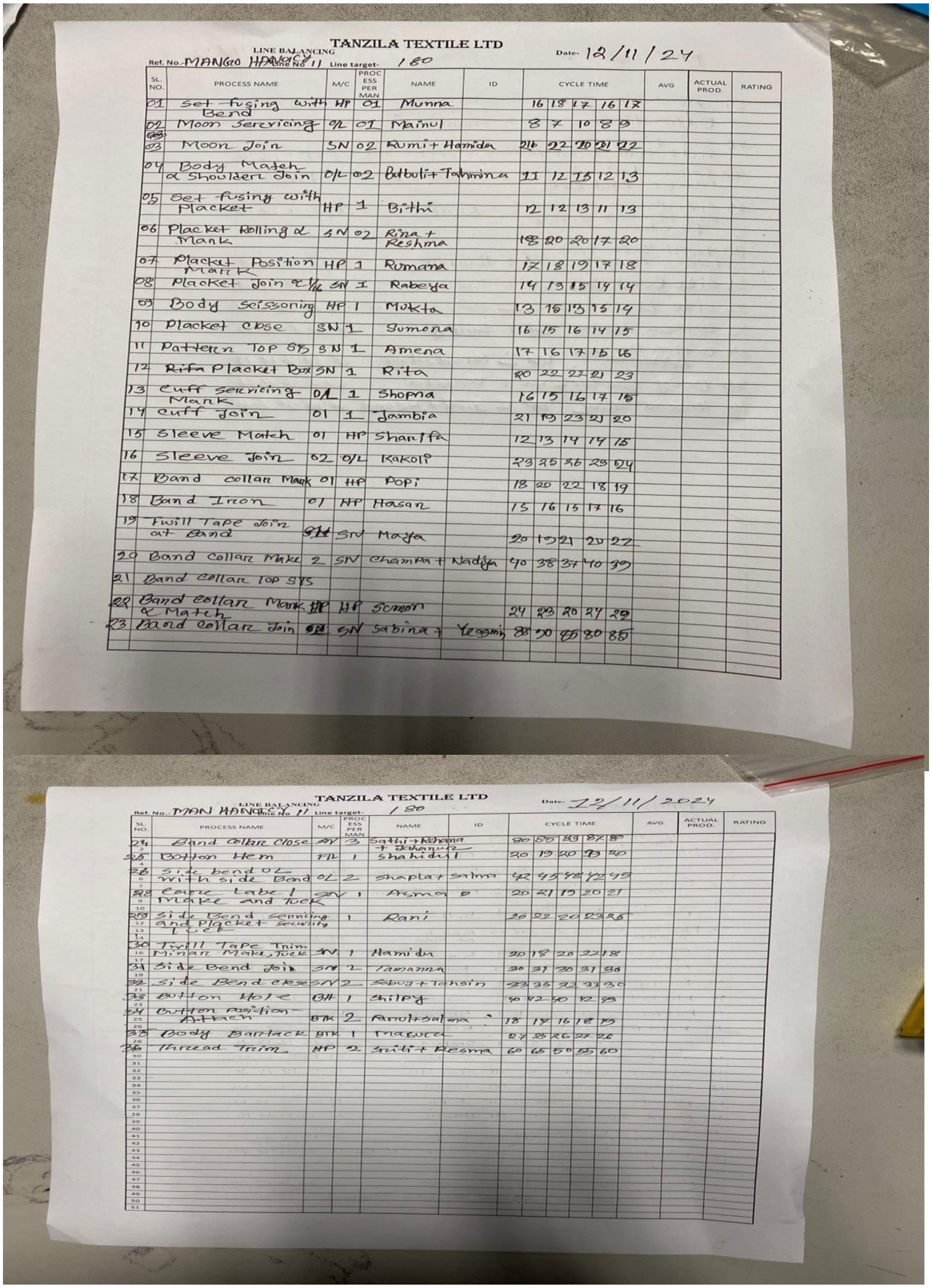
36	BODY BARTACK & BUTTON CLOSE	Bartack Machine	18	0.32	159	1		
37	THREAD TRIM	Helper	12	0.22	232	1		
38	SET FUSING WITH BAND	Helper	12	0.22	232	1		

Figure: 1 Process Layout

3.1.2 Description

The table provides a detailed breakdown of the various operations in the polo shirt production line, including categories like servicing, joining, marking, fusing, stitching, button attachment, and trimming. It includes machine types like Overlock, Plain, Bartack, C-F/L, Button Hole, and Attach. The standard time for each task varies from 12 seconds to 55 seconds, and the standard minute value ranges from 0.20 SMV to 0.92 SMV. The target quantity for each operation is specified, ranging from 56 to 255 units. Most operations require one worker, with a few requiring 1.5 workers. The loading point indicates the number of stations used for operations, with most being single-station operations. Mistake-proofing measures are not listed for most operations. The summary helps estimate the time, employees, and quality required for each operation, with efficiency with minor mistakes being the goal. The table does not provide detailed error-proofing, but it helps in estimating the sum of time, employees, and quality required for each operation.

3.2 Check Layout with Cycle time


TANZILA TEXTILE LTD
LINE BALANCING
Ref. No.- MANGO HANGCY Line No 11 Line target- 180 Date- 12/11/24

SL. NO.	PROCESS NAME	M/C	PROCESS PER MAN	NAME	ID	CYCLE TIME					AVG	ACTUAL PROD.	RATING
01	Set fusing with Bend	HP	01	Munna		16	18	17	16	17			
02	Moon Servicing	OL	01	Mainul		8	7	10	8	9			
03	Moon Join	SN	02	Rumi + Hamida		26	22	20	21	22			
04	Body Match & Shoulder Join	O/L	02	Bulbuli + Tahmina		11	12	15	12	13			
05	Set fusing with Placket	HP	1	Bithi		12	12	13	11	13			
06	Placket Rolling & Mark	SN	02	Rina + Reshma		18	20	20	17	20			
07	Placket Position Mark	HP	1	Rumana		17	18	19	17	18			
08	Placket Join & 1/16	SN	1	Rabeya		14	13	15	14	14			
09	Body Scissoring	HP	1	Mukta		13	16	13	15	14			
10	Placket close	SN	1	Sumona		16	15	16	14	15			
11	Pattern Top STS	SN	1	Amena		17	16	17	15	16			
12	Rifa Placket Box	SN	1	Rita		20	22	22	21	23			
13	Cuff Servicing Mark	OL	1	Shopna		16	15	16	17	15			
14	Cuff Join	01	1	Jambia		21	19	23	21	20			
15	Sleeve Match	01	HP	Sharifa		12	13	14	14	15			
16	Sleeve Join	02	O/L	Kakoli		23	25	26	23	24			
17	Band collar Mark	01	HP	Popi		18	20	22	18	19			
18	Band Iron	01	HP	Hasan		15	16	15	17	16			
19	Twill Tape Join at Band	1	SN	Maya		20	19	21	20	22			
20	Band collar Make	2	SN	Champa + Nadiya		40	38	37	40	39			
21	Band collar Top STS												
22	Band collar Mark & Match	HP	HP	Sumon		24	23	20	27	22			
23	Band collar Join	02	SN	Sabina + Yeasmin		88	90	85	80	85			

TANZILA TEXTILE LTD
LINE BALANCING
Ref. No.- MAN HANGCY Line No 11 Line target- 180 Date- 12/11/2024

SL. NO.	PROCESS NAME	M/C	PROCESS PER MAN	NAME	ID	CYCLE TIME					AVG	ACTUAL PROD.	RATING
24	Band collar Close	SN	3	Sathi + Rehana + Jahanur		80	85	83	87	80			
25	Botton Hem	FL	1	Shahidul		20	19	20	19	20			
26	Side bend OL with side Bend	OL	2	Shapla + Salma		42	45	48	42	45			
28	Care Label Make and Tuck	SN	1	Asma		20	21	19	20	21			
29	Side Bend Serving and Placket security Tuck		1	Rani		20	22	20	23	25			
30	Twill Tape Trim Minar Make, Tuck	SN	1	Hamida		20	18	20	22	18			
31	Side Bend Join	SN	2	Tamanna		30	31	30	31	30			
32	Side Bend close	SN	2	Sobuj + Tahsin		33	35	32	33	30			
33	Button Hole	BH	1	Shilpy		40	42	40	42	43			
34	Button Position Attach	BTK	2	Parul + Salma		18	17	16	18	19			
35	Body Bartack	BTK	1	Mabura		27	25	26	27	26			
36	Thread Trim	HP	2	Sriti + Resma		60	65	50	55	60			

Figure: 2 Check Layout with CT

3.2.1 Description

The records show an optimized production flow, balancing workloads and task coordination in the sewing section, leading to increased productivity, consistent output rates, and improved employee morale.

3.3 Before Line balancing Report

TANZILA TEXTILE LTD Line Balance

REF.	MANGO HANOICY	ITEM	POLO
LINE TARGET	180	LAYOUT SMV	12.7
LINE NO	11	LINE SMV	13.7
BOTTLENECK	114		

M/C TYPE	SN	4TOL	3TFL	5TFL	FOA	BH	BA	SB	BTK	IRON	HP	TOTAL	TOTAL MP
LAYOUT	27		1	0	0	1	1	0	1	0	8	41	49
LINE	27		1	0	0	1	1	0	1	0	8	42	50

SL. NO.	PROCESS NAME	M/C	LINE MP	DESIGN MP	CYCLE TIME					AVG	LINE TARGET	Line Capacity
1	MOON SERVICING	4TOL	1	1	8	9	10	10	10	9.4	180	351
2	MOON JOIN	SN	2	1.5	23	23	23	23	23	23	180	287
3	BODY MATCH & SHOULDER JOIN	4TOL	2	1	18	18	18	18	18	18	180	367
4	SET FUSING WITH PLACKET	HP	1	1	14	14	14	14	14	14	180	236

5	PLACKET ROLLING & MARK	**SN**	2	1	28	28	28	28	28	28	180	236
6	PLACKET POSITION MARK	**HP**	1	1	18	18	18	18	18	18	180	183
7	PLACKET JOIN & 1/16	**SN**	1	1	16	16	16	16	16	16	180	206
8	BODY SCISSORING	**HP**	1	1	15	15	15	15	15	15	180	220
9	PLACKET CLOSE	**SN**	1	1	16	16	16	16	16	16	180	206
10	PATTERN TOP STS	**SN**	1	1	15	15	15	15	15	15	180	220
11	PLACKET 1/16 TOP STS	**SN**	1	1	17	17	17	17	17	17	180	194
12	PLACKET BOX	**SN**	1	1.5	18	18	18	18	18	18	180	183
13	CUFF SERVICING MARK	**4TOL**	1	1	17	17	17	17	17	17	180	194
14	CUFF JOIN	**4TOL**	1	1	21	21	21	21	21	21	180	157
15	SLEEVE MATCH	**HP**	1	1	13	13	13	13	13	13	180	254
16	SLEEVE JOIN	**4TOL**	2	1.5	22	22	22	22	22	22	180	300
17	BOTTOM HEM	**3TFL**	1	1	18	18	18	18	18	18	180	183
18	SIDE SEAM OL WITH SIDE BEND	**4TOL**	2	2.5	40	42	42	42	42	42	180	159
19	SLEEVE INNER & OUTER TUCK	**SN**	1	1	15	15	15	15	15	15	180	220
20	CARE LABEL MAKE & TACK	**SN**	1	1	18	18	18	18	18	18	180	183
21	SIDE BEND SERVICING & PLACKET SECURITY TUCK	**SN**	1	1	18	18	18	18	18	18	180	183
22	TWILL TAPE TRIM,MINAR MAKE & MARK	**SN**	1	1	18	18	18	18	18	18	180	183

23	SIDE BEND JOIN	**SN**	1	2	22	22	22	22	22	22	180	150
24	SIDE BEND CLOSE	**SN**	2	1	18	18	18	18	18	18	180	367
25	BAND COLLAR MAKE	**SN**	2	2	40	40	40	40	40	40	180	165
26	TWILL TAPE JOIN AT BAND	**SN**	1	1	17	17	17	17	17	17	180	194
27	BAND COLLAR SERVICING	**4TOL**	1	1	17	17	17	17	17	17	180	194
28	NOSE TUCK	**SN**	1	1	15	15	15	15	15	15	180	220
29	COLLAR SERVICING & MARK	**4TOL**	1	1	16	16	16	16	16	16	180	206
30	BAND COLLAR TOP STS	**SN**	2	2	35	38	39	36	35	37	180	180
31	BAND COLLAR JOIN	**SN**	3	3	60	60	55	60	55	58	180	114
32	BAND COLLAR CLOSE	**SN**	3	3	55	55	55	55	55	55	180	180
33	BUTTON HOLE	**BH**	1	1	18	18	18	18	18	18	180	183
34	BUTTON POSITION MARK	**HP**	1	1	14	14	14	14	14	14	180	236
35	BUTTON POSITION ATTACH	**BA**	1	1	17	17	17	17	17	17	180	194
36	BODY BARTACK & BUTTON CLOSE	**BTK**	1	1	16	16	16	16	18	16	180	201
37	THREAD TRIM	**HP**	2	2	36	36	36	36	37	36	180	182
38	SET FUSING WITH BAND	**HP**	1	1	17	17	17		17	17	180	194

Figure : 3 Before Line Balancing

3.3.1 Description

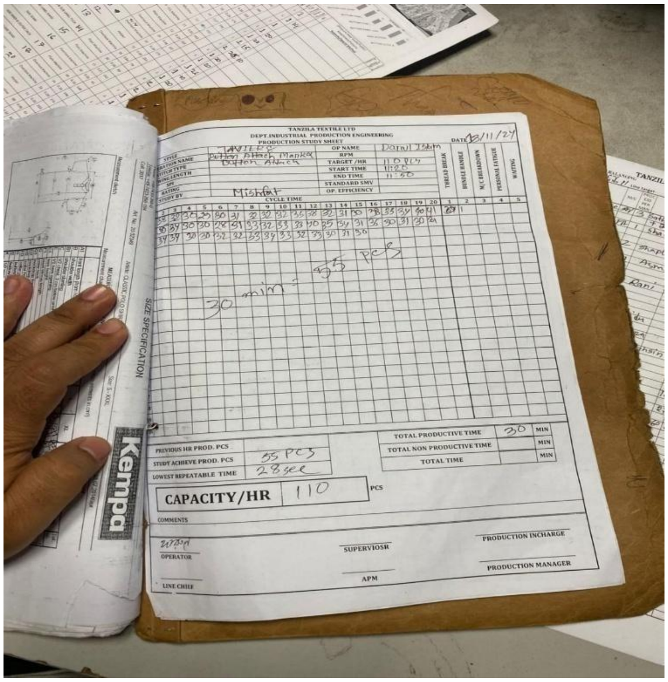
The data shows the line balance information for Tanzila Textile Ltd.'s Polo T-shirt manufacture, particularly for the Mango Hanoicy style. Line 11 has an actual Standard Minute Value (SMV) of 13.7 minutes per unit, which indicates less efficiency than the desired aim of 180 units each day or shift, with an SMV of 12.7 minutes per unit.

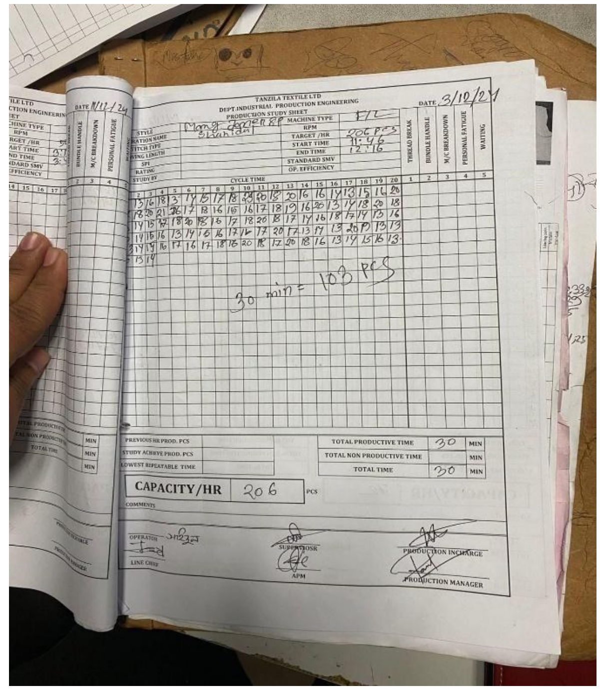
The bottleneck at process 114 is a specific step or machine where production flow is delayed or slowed down, slowing down the overall output of the line. Additionally, to the total number of machines in every section and the overall, the total number of machines used for each task in the line is given.

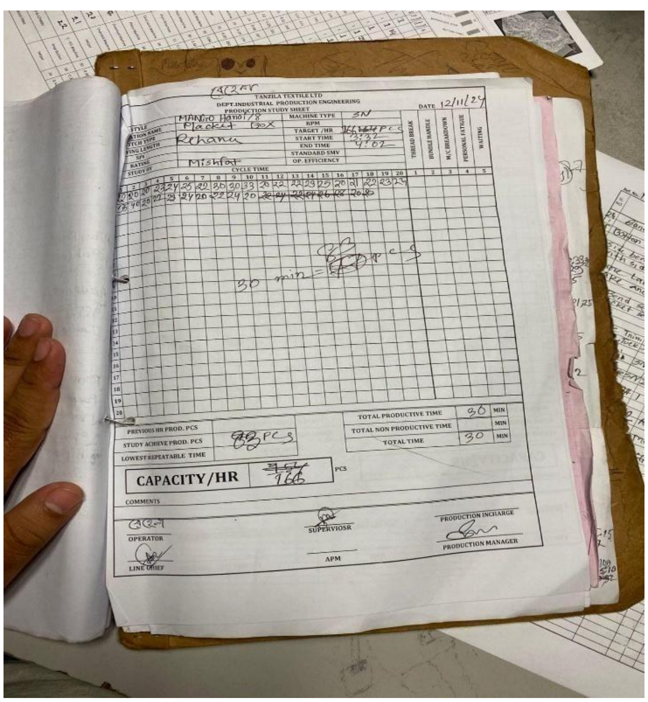
Finally, the data shows the number of machines for each process and contrasts it with the layout design to find any imbalances or gaps in the distribution of machines. Analyzing where the production line might be improved—for example, by removing a bottleneck, increasing machine utilization, or modifying cycle times to reach the 180-unit production target per shift—can be done with the help of this data.

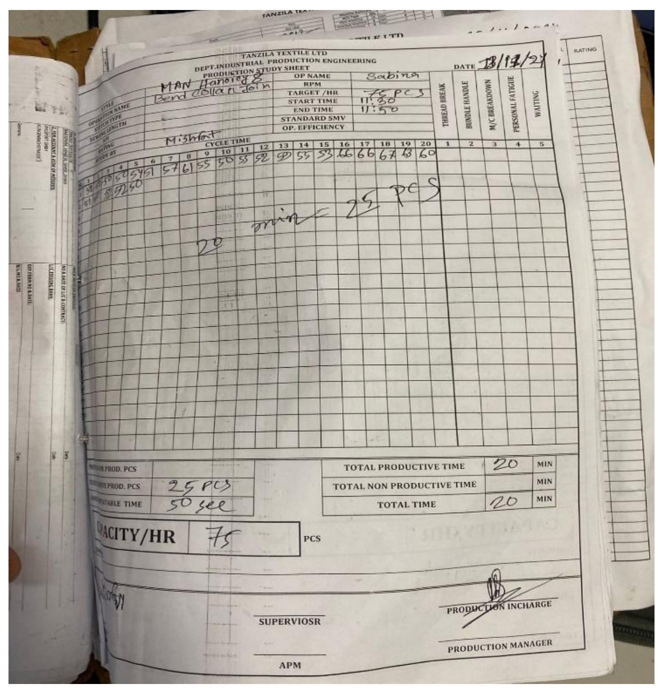
In order to sum up, this data offers major insights into the efficiency of the production line, including the target amount produced, the SMV setup, the bottleneck, machine kinds, process breakdown, and line capability. In order to achieve the production target of 180 units per shift, Tanzila Textile Ltd. can make the needed modifications by discovering differences or imbalances in machine allocation.

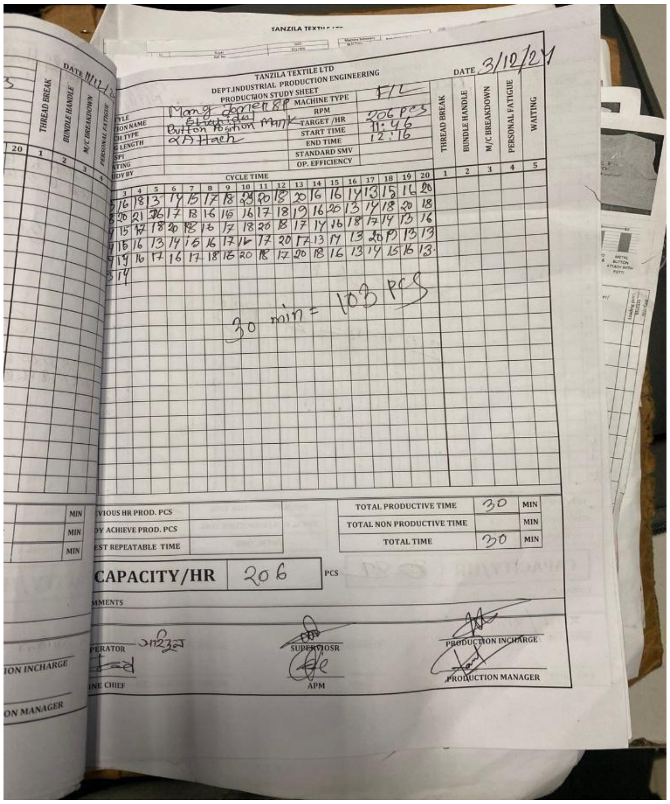
3.3 Production study sheet

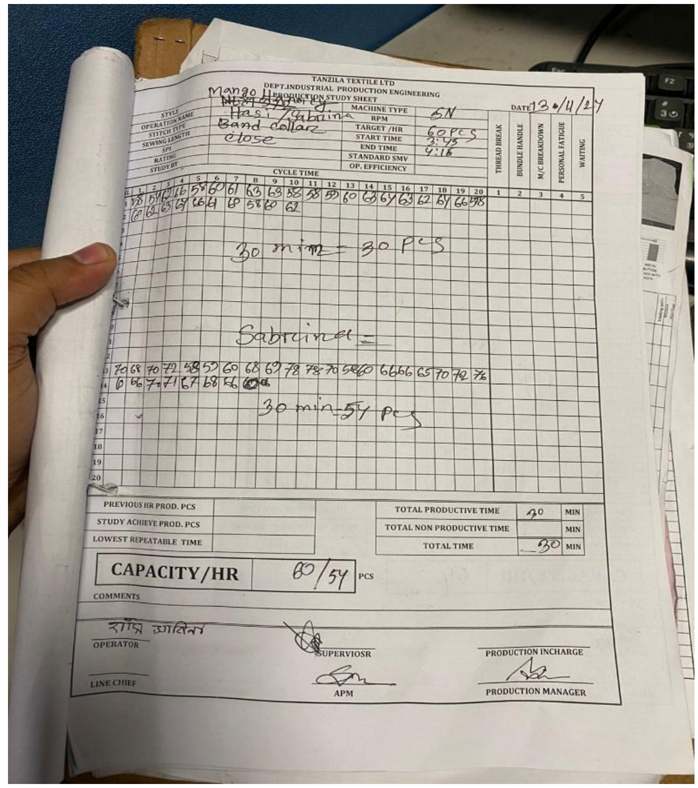












3.3.1 Description

This image shows a detailed production study sheet from the garment manufacturing industry, specifically used to analyze the efficiency of sewing operations. The sheet includes key metrics such as target production rates, cycle times, and capacity per hour. Handwritten annotations provide observations, including productive time (30 minutes,20 minutes), achieved production (Button join & Mark 110 pcs, Placket Box 83 pcs, Band Collar Join 25 pcs, Band Collar Close 30 pcs), and calculated capacity per hour. These data points are critical for identifying bottlenecks, improving efficiency, and balancing production lines to optimize overall performance.

3.4 After Line Balancing

TANZILA TEXTILE LTD
Line Balance

REF.	MANGO HANOICY	ITEM	POLO	
LINE TARGET	180	LAYOUT SMV	12.7	
LINE NO	**11**	LINE SMV	13.7	
BOTTLENECK	0			

M/C TYPE	SN	4TOL	3TFL	5TFL	FOA	BH	BA	SB	BTK	IRON	HP	TOTAL	TOTAL MP
LAYOUT	27		1	0	0	1	1	0	1	0	9	42	51
LINE	27		1	0	0	1	1	0	1	0	9	42	50

SL. NO.	PROCESS NAME	M/C	LINE MP	DESIGN MP	CYCLE TIME					AVG	LINE TARGET	Line Capacity
1	MOON SERVICING	4TOL	1	1	8	9	10	10	10	9.4	180	351
2	MOON JOIN	SN	2	1.5	23	23	23	23	23	23	180	287
3	BODY MATCH & SHOULDER JOIN	4TOL	2	1	18	18	18	18	18	18	180	367
4	SET FUSING WITH PLACKET	HP	1	1	14	14	14	14	14	14	180	236
5	PLACKET ROLLING & MARK	SN	2	1	28	28	28	28	28	28	180	236
6	PLACKET POSITION MARK	HP	1	1	18	18	18	18	18	18	180	183

7	PLACKET JOIN & 1/16	**SN**	1	1	16	16	16	16	16	16	180	206
8	BODY SCISSORING	**HP**	1	1	15	15	15	15	15	15	180	220
9	PLACKET CLOSE	**SN**	1	1	16	16	16	16	16	16	180	206
10	PATTERN TOP STS	**SN**	1	1	15	15	15	15	15	15	180	220
11	PLACKET 1/16 TOP STS	**SN**	1	1	17	17	17	17	17	17	180	194
12	PLACKET BOX	**SN**	1	1.5	18	18	18	18	18	18	180	183
13	CUFF SERVICING MARK	**4TOL**	1	1	17	17	17	17	17	17	180	194
14	CUFF JOIN	**4TOL**	1.5	1.5	21	21	21	21	21	21	180	190
15	SLEEVE MATCH	**HP**	1	1	13	13	13	13	13	13	180	254
16	SLEEVE JOIN	**4TOL**	2	1.5	22	22	22	22	22	22	180	300
17	BOTTOM HEM	**3TFL**	1	1	18	18	18	18	18	18	180	183
18	SIDE SEAM OL WITH SIDE BEND	**4TOL**	2.5	2.5	40	42	42	42	42	42	180	183
19	SLEEVE INNER & OUTER TUCK	**SN**	1	1	15	15	15	15	15	15	180	220
20	CARE LABEL MAKE & TACK	**SN**	1	1	18	18	18	18	18	18	180	183
21	SIDE BEND SERVICING & PLACKET SECURITY TUCK	**SN**	1	1	18	18	18	18	18	18	180	183
22	TWILL TAPE TRIM,MINAR MAKE & MARK	**SN**	1	1	18	18	18	18	18	18	180	183
23	SIDE BEND JOIN	**SN**	2	2	22	22	22	22	22	22	180	240
24	SIDE BEND CLOSE	**SN**	2	1	18	18	18	18	18	18	180	367
25	BAND COLLAR MAKE	**SN**	2	2	35	35	35	34	34	35	180	188
26	TWILL TAPE JOIN AT BAND	**SN**	1	1	17	17	17	17	17	17	180	194

27	BAND COLLAR SERVICING	**4TOL**	1	1	17	17	17	17	17	17	180	194
28	NOSE TUCK	**SN**	1	1	15	15	15	15	15	15	180	220
29	COLLAR SERVICING & MARK	**4TOL**	1	1	16	16	16	16	16	16	180	206
30	BAND COLLAR TOP STS	**SN**	2	2	35	38	39	36	35	37	180	180
31	BAND COLLAR JOIN	**SN**	3	3	55	55	55	54	55	58	180	180
32	BAND COLLAR CLOSE	**SN**	3	3	55	55	55	55	55	55	180	180
33	BUTTON HOLE	**BH**	1	1	18	18	18	18	18	18	180	183
34	BUTTON POSITION MARK	**HP**	1	1	14	14	14	14	14	14	180	236
35	BUTTON POSITION ATTACH	**BA**	1	1	17	17	17	17	17	17	180	194
36	BODY BARTACK & BUTTON CLOSE	**BTK**	1	1	16	16	16	16	18	16	180	201
37	THREAD TRIM	**HP**	2	2	36	36	36	36	37	36	180	182
38	SET FUSING WITH BAND	**HP**	1	1	17	17	17	17	17	17	180	194

3.4.1 Discussion

The line balancing process for Tanzila Textile Ltd was initially unobstructed, but high cycle times in certain processes could slow productivity. To address these, process optimization measures were implemented, including improving machine efficiency, refining operator techniques, and potentially automating certain steps. Additionally, machines and operators were redistributed to support operations with higher cycle times, eliminating imbalances in resource allocation. The overall line flow was optimized by adjusting the layout and machine allocation, ensuring efficient production stages. The line now operates at a more balanced state, with smoother workflow, reduced cycle times in critical areas, and optimized machine utilization. This continuous improvement approach will help sustain optimal performance and prevent future bottlenecks.

CHAPTER- 04
RESULT & DISCUSSION

4.1 Result and discussion

4.1.1 Results

1. Line Performance Overview

- Line Target: 180 units/hour.
- Line SMV (Standard Minute Value): 13.7 minutes.
- Layout SMV: 12.7 minutes.
- Total Manpower Layout: 49 operators.
- Current Manpower Deployed: 50 operators
- Bottleneck Identified: The process "Band Collar Join" (SL 31) has a cycle time of 60 seconds and achieves only 114 units/hour, significantly below the line target.
- Line Capacity: The line has 50 operators distributed across multiple machines, but line balancing inefficiencies lead to uneven performance.

2. Bottleneck Analysis

- The major bottleneck is: Band Collar Join (SL 31) ✞ Cycle Time: 60 seconds.

- Output: 114 units/hour (shortfall of 66 units).
- Line Target: 180 units/hour.
- This process is the slowest and causes delays in the overall production flow.

4. Contributing Factors to Bottlenecks

- High Cycle Time: Band Collar Join has the longest cycle time (60 seconds). This is more than 3 times the average cycle time of other processes (17–20 seconds).
- Underutilization of Operators: While some processes have excess manpower (e.g., "Band Collar Close" with 3 operators achieving 180 units/hour), the bottleneck process still underperforms with 2 operators.

5. Machine Dependency:

- Processes using SN (Sewing Machine) dominate the line but lack sufficient optimization for bottleneck tasks.
- Line Imbalance: Processes such as "Side Bend Join" (SL 23) and "Side Seam OL with Side Bend" (SL 18) also perform below the target, compounding delays.

4. Solutions to Address the Bottleneck

- Add Additional Operators
- Current Scenario: Band Collar Join has 2 operators.

Solution: Add an extra operator to split the workload, reducing cycle time and improving output **I.**

Task Parallelization

- Break the Band Collar Join operation into smaller sub-tasks. Assign each sub-task to different operators or machines to streamline the process.

ii. Machine Optimization

- Use specialized or automated machines to reduce the cycle time. For instance:
- Replace the standard SN machine with a semi-automatic sewing machine for Band Collar Join.
- Workload Redistribution
- Reassign operators from overstaffed processes (e.g., Band Collar Close or other balanced tasks) to assist with the Band Collar Join operation.

iii. Time Study and Process Improvement

- Conduct a detailed time study to identify any non-value-added activities (idle time, machine setup delays, etc.) in the Band Collar Join process.
- Optimize the workflow to minimize delays.

iii. Training and Skill Enhancement

- Provide training to operators working on the bottleneck process to enhance their speed and efficiency.
- Skilled operators can complete tasks faster, reducing cycle time.

iv. Balancing Other Low-Performing Processes

- Side Bend Join (SL 23): Cycle time of 22 seconds with an output of 150 units/hour.
- Solution: Add operators or balance workload across similar tasks.
- Side Seam OL with Side Bend (SL 18): Cycle time of 42 seconds with 159 units/hour.
- Solution: Optimize machine usage and reduce idle time.

6. Expected Outcome

By addressing the bottleneck at Band Collar Join and optimizing other low-performing processes:

- **Line Output:** Increase from 114 units/hour to match the target of 180 units/hour.

4.1.2 Discussion

The bottleneck at Band Collar Join (SL 31) is the most critical issue preventing the line from meeting its target of 180 units/hour. Adding operators, optimizing machines, and redistributing workload are key solutions. Implementing these improvements will eliminate production delays, increase efficiency, and balance the overall line.

4.2 Before vs after line balancing

Metric	Before Balancing	After Balancing	Improvement

Cycle Time Consistency	Highly variable	Uniform	Improved workflow
Idle Time	High at some stations	Minimized	Efficient utilization
Bottlenecks	Multiple observed	None	Eliminated
Work-In-Progress Inventory	Excessive	Reduced	Streamlined flow
Output Rate	Inconsistent	Steady	Stable production
Employee Morale	Mixed	Improved	Balanced workloads

CHAPTER-5
CONCLUSION

5.1 Conclusion

In the process of writing this theoretical report, we did our best to meet our responsibilities. Throughout the study, we focused on the line balancing problem in sewing section. We have investigated and worked on this project, identifying some kinds of problem in sewing floor such as bottlenecks, quality problem, machine problem etc. In addition, we discuss their causes and offer some potential solutions. The line balancing problem in the garments industry is crucial for optimizing production efficiency, minimizing costs, and improving overall output quality. We carefully assigning tasks to various workstations along a production line, companies can achieve smoother workflows, reduce idle times, and enhance labor productivity. Through the application of various techniques, such as mathematical models, heuristic methods, and simulation tools, garment manufacturers can strategically balance work assignments to achieve optimal results. Despite the challenges inherent in garment production, such as varying task times and production complexities, addressing line balancing issues leads to significant improvements in operational performance. Future research can explore advanced automation and artificial intelligence technologies that further refine the balancing process, helping the industry meet the growing demands for customization, sustainability, and cost efficiency. By continuing to focus on effective line balancing practices, garment manufacturers can remain competitive in an increasingly dynamic global market.

5.2 REFERANCES

1. Heizer, J., & Render, B. (2017)
2. Groover, M. P. (2016). *Automation, Production Systems, and Computer Integrated Manufacturing* (4th ed.). Pearson.
3. Smith, R. G., & Patel, R. (2019). "Improving Efficiency through Line Balancing in the Garment Industry." *Journal of Manufacturing Science and Technology*, 32(4), 455-468.
4. Jain, A., & Singh, R. (2021). "Use of Simulation in Manufacturing: A Case Study on Apparel Production." *International Journal of Simulation and Process Modelling*, 16(3), 212-229.
5. Arena Simulation Software Manual.
6. A Bay Apparel Industry. (2024). *Internal Data on Polo Shirt Production line*
7. Sharma, R., & Kumar, A. (2021). "An approach to solve garment production line balancing problem: A review." International Journal of Textile and Fashion Technology, 11(4), 41-52. 8. https://www.lean.org

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