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Improvement of line efficiency and line balancing of sewing line by utilizing man machine ratio

Mafzal Ahmed
Professor, Department of Textile Engineering, Port City International University, Chottagram, Bangladesh

Abstract
Nowadays, every apparel manufacturing business is attempting to produce high-quality items that match customer standards. The purpose of this study is line balancing to improve efficiency and maximize operator utilization for the single model assembly line. This paper will be effective in improving the existing line balancing and efficiency of the specified product Hoodie using existing resources such as personnel, machines, and other facilities. Because the hoodie is the most popular apparel in the world. When there is a lack of balance, the production cycle time and idle time both increase. However, the goal of selecting a better line product architecture is to reduce idle time in the line as much as possible to improve production efficiency. To improve efficiency, comprehensive work and a time analysis ire carried out along the way.

Keywords: time study, cycle time, standard minute value (SMV), line balancing

Introduction

Since 1978, Bangladesh has become a major player in the readymade clothes industry. Over the last three decades, Bangladesh's RMG sectors have undergone remarkable growth and have become one of the country's fastest-growing businesses. In terms of employment, foreign exchange profits, and GDP contribution, the sector quickly rose to prominence [1]. However, even in a fiercely competitive market, the Bangladesh RMG Sector's quality of garments, efficiency, and productivity are overlooked. According to a survey of the world economic situation (BGMEA's Chittagong unit as part of CAFAXPO, 2009), "factories in Sri Lanka had 80–90 percent efficiency, whereas factories in Bangladesh had 80–90 percent efficiency, According to some experts, productivity was only in between 35% and 55% of efficiency with very few exceptions [2]. Customers' expectations are rising, and producers must design and produce in as many kinds as possible to meet their needs. As a result, industries face a problem in producing items of the correct quality and quantity at the right time and at the least possible cost to ensure their survival and growth. This necessitates an enhancement in the organization's productive efficiency [3]. It can be tough to identify the important areas and methods that can be used to improve the current system and situation in the processes in the garment industry. The key issues that apparel manufacturers confront are delivering high-quality clothes at a reasonable cost and in shorter lead times. SMV and similar methods can be used efficiently in the apparel industry to improve manufacturing efficiency. This technique can be used to map the existing situation and then analyze it to set a better goal [4].

However, by employing time study and line balancing approaches, the paper suggests various ways to improve line efficiency. As a result, efficient line balancing with modest inventories in the sewing line is required to improve production efficiency and quality. Line balancing is critical in the manufacturing industry, particularly in the garment industry. The line must be balanced for it to have a high-efficiency value. The higher the line efficiency, the closer the operators along the line have to each other in terms of cycle time. Furthermore, the effort amongst operators is allocated evenly, resulting in greater line efficiency and the ability to meet the desired output without using overtime [5].

Until garment components are combined into a finished garment, they are assembled through a sub-assembly process in garment production. The manufacturing process consists of a series of workstations, each of which performs a specialized duty in a predetermined order, with hundreds of personnel and thousands of bundles of sub-assemblies simultaneously generating different styles [6]. The combining of components, known as the sewing process, which is the most labour-intensive element of garment manufacturing, makes the structure complex because some operations must be completed before [7].

Furthermore, because sewing is a labour-intensive activity, the cost structure of the sewing process is significant in addition to material costs. As a result, this procedure is crucial and requires more careful planning [8]. As a result, similar companies can utilize the research findings as a knowledge base to identify problems and develop appropriate solutions. Sewing is without a doubt the most important and teeming department in the apparel business, and it plays a critical function in the entire company. Time study is a very useful approach for improving the current state of this part and enhancing productivity [9].

As a result, to improve production efficiency and quality, good line balancing with minimal inventories in the sewing line must be drawn up [10]. Division of labour refers to the division of a task among numerous people. The division of labour should be equalized by ensuring that the time spent at each station is about equal. Each stage in the product assembly process must be thoroughly examined and assigned to stations in a balanced manner across the available workstations.

After that, each operator completes their tasks correctly, and the workflow is synchronized. Short distances between stations, limited volume of work in process, accurate planning of production periods, and predictable production quantity are all examples of synchronized lines in a comprehensive workflow [11]. Overall, in garment production,

the most important criteria are whether assembly work will be completed on time for delivery, how machines and employees are utilized, whether any station in the assembly line is behind schedule, and how the assembly line is performing overall [12].

To achieve this method, work-time study, assembly line balancing and simulation can be applied to the garment manufacturing line to develop alternative options to boost the efficiency of the sewing line [13]. In time studies, Standard Minute Value (SMV) has been calculated for each operation or work [14]. Because all workers are not equally talented in all operations, it is normal for some abilities to be underutilized, such as when one operator needs assistance to perform their job on time to keep the line balanced [15]. Improvements in the sewing segment have been obtained by implementing several strategies, such as SMV, labour utilization, output, objective, and workstation.

Materials and Method

In garments production, at first, a garment model needs to be developed. Then according to the model, the part of the garment is being cut and sewn according to assembled order. A sewing line consists of a set of work station in which a specific task in a predefined sequence is processed. In this study, to analyze sewing line efficiency and line balancing, a Hoodie sewing line was considered. This study was accomplished in a garments factory in Bangladesh. In this study, two cases are considered. In each case, I recorded the time required to finish each task, required operator and helper, type of machine to calculating SMV, BPT, efficiency, target output and balancing of the sewing line. In this study, I proposed a line that has maximum efficiency and a balanced line out of two cases by proper utilization of man and machine. I compared the efficiency and balancing value and got a production layout that has maximum efficiency and the most balanced line between the two.

Equations

The equations utilized, used and manipulated had listed here.

- Standard Minute Value (SMV) = Basic time + allowances
- Basic Time = (Observed time × Observed rating)/ Standard rating
- Basic pitch time = SMV/ No of workstation
- Efficiency = {(per hour production × total SMV)/(man required × working minute)} × 100%
- Target = working minute/ BPT
- Balancing = (Minimum output/ target output) × 100%

Data analysis and calculation

Before line balancing all the operations need to breakdown according to a pursuant logical order. The breakdown is for better understanding and redacts the sequential order of product processing steps. Taking the observed time for each operation manually and SMV is calculated by given equations. With the help of SMV, no of operations and man and minute value I can calculate BPT, efficiency, target production and balance for each sewing line.

Table 1: Data before line balancing for Hoodie production

Sl. No.	Operation name	Machine type	SMV	Target	Manpower
1	Hood inner double part join	O/L	0.26	185	1
2	Hood top double part join	O/L	0.26	185	1
3	Hood two part join	O/L	0.62	160	2
4	Hood two part top stitch	F/L	0.55	192	2
5	Eylet attach position mark	EYLET	0.32	171	1
6	Eylet attach with interlining to hood	EYLET	0.30	160	1
7	Hood hem	F/L	0.38	126	1
8	Hood tack with middle point	SNLS	0.28	171	1
9	Hood servicing	O/L	0.30	160	1
10	Hood tack	SNLS	0.27	178	1
11	Both shoulder join	O/L	0.30	160	1
12	Care label make and sew	SNLS	0.21	229	1
13	Hood tack with body	SNLS	0.35	137	1
14	Hood join	O/L	0.70	137	2
15	Back tape binding	SNLS	0.25	192	1
16	Back tape binding in tack	SNLS	0.26	185	1
17	Back tape top stitch with size LBL	SNLS	0.45	213	2
18	Front neck top stitch	F/L	0.25	192	1
19	Main LBL attach	SNLS	0.36	133	1
20	Sleeve join	O/L	0.50	192	2
21	Join side seam	O/L	0.75	192	3
22	Cuff join	O/L	0.34	141	1
23	Cuff top stitch	F/L	0.30	160	1
24	Bottom cuff make and fold	SNLS	0.32	150	1
25	Bottom cuff join	O/L	0.66	145	2
26	Bottom top stitch	F/L	0.32	150	1
27	Sleeve in tack	SNLS	0.26	192	1
28	Sleeve top tack	SNLS	0.24	200	1
29	Shoulder scissoring	Hand work	0.21	267	1
30	Main LBL position mark	Hand work	0.34	171	1
31	Hood hala mark	Hand work	0.30	200	1
32	Body cut mark	Hand work	0.24	200	1
33	Bottom cuff fold	Hand work	0.24	200	1

34	Bottom cuff cut mark	Hand work	0.24	200	1
35	Drawstring insert	Hand work	0.30	160	1
36	Body turn	Hand work	0.25	171	1
37	Finish thread cut	Hand work	0.60	160	2
Total			12.84		46

Calculation

Total manpower required before line balancing 46

SMV =12.84

160 pieces production per hour

Basic Pitch Time (BPT) = SMV / no. of workstation = 12.84/37 = 0.35

Now, Efficiency = {(per hour production*total SMV) / (man required × working min) × 100 = {(160 ×12.84) / (46 × 60)} × 100 = 74.43% (before balancing)

Target output = working min / BPT =60 / 0.35=171 pcs/hour

Balancing= (Minimum output / target output) × 10 = (126 / 171) × 100 = 73%

Table 2: Data after line balancing for Hoodie production

Sl. No.	Operation name	Machine type	SMV	Target	Manpower
1	Hood inner double part join	O/L	0.26	185	1
2	Hood top double part join	O/L	0.26	185	1
3	Hood two part join	O/L	0.60	160	2
4	Hood two part top stitch	F/L	0.50	192	2
5	Eylet attach position mark	EYLET	0.28	171	1
6	Eylet attach with interlining to hood	EYLET	0.30	160	1
7	Hood hem	F/L	0.38	126	1
8	Hood tack with middle point	SNLS	0.28	171	1
9	Hood servicing	O/L	0.30	160	1
10	Hood tack	SNLS	0.27	178	1
11	Both shoulder join	O/L	0.30	160	1
12	Care label make and sew	SNLS	0.21	229	1
13	Hood tack with body	SNLS	0.35	137	1
14	Hood join	O/L	0.70	137	2
15	Back tape binding	SNLS	0.25	192	1
16	Back tape binding in tack and cut	SNLS	0.24	185	1
17	Back tape top stitch with size LBL	SNLS	0.45	166	1
18	Front neck top stitch	F/L	0.25	192	1
19	Main LBL attach	SNLS	0.36	133	1
20	Sleeve join	O/L	0.50	144	1.5
21	Join side seam	O/L	0.75	160	2.5
22	Cuff join	O/L	0.34	141	1
23	Cuff top stitch	F/L	0.30	160	1
24	Bottom cuff make and fold	SNLS	0.32	150	1
25	Bottom cuff join	O/L	0.66	145	2
26	Bottom top stitch	F/L	0.32	150	1
27	Sleeve in tack and sleeve top tack	SNLS	0.38	126	1
28	Main LBL position mark	HW	0.28	171	1
29	Hood mark	HW	0.24	200	1
30	Body cut mark	HW	0.24	200	1
31	Bottom cuff fold	HW	0.24	200	1
32	Bottom cuff cut mark	HW	0.24	200	1
33	Drawstring insert	HW	0.30	160	1
34	Body turn	HW	0.28	171	1
35	Finish thread cut	HW	0.60	160	2
Total			12.53		43

From Table 2, it is found that SL. No. 20 and 21 manpower 1.5 and 2.5 means 1 and 2 operators continuing their work and remain 1 operator operate the 1st operation 30min and operate 2nd operation 30min.

Calculation

Total manpower required after line balancing 43

SMV=12.53

160 pieces production per hour

Basic Pitch Time (BPT) = SMV / no. of workstation = 12.53/35 = 0.36

Now, Efficiency = {(per hour production × total SMV) / (man required × working min) × 100 = {(160 × 12.53) / (43 × 60)} × 100 =77.70% (after balancing)

Target output = working min / BPT = 60 / 0.36 = 167 pcs

Balancing = **(**Minimum output / target output) × 100 = (126 / 167) × 100 = 75%.

Results and Discussion

Comparative before and after efficiency and balancing

Table 3: Comparison between before and after line balancing and efficiency

Name	SMV	Work station	Manpower	Efficiency	Balancing
Before line balancing	12.84	37	46	74.43%	73%
After line balancing	12.53	35	43	77.70%	75%

Efficiency calculation

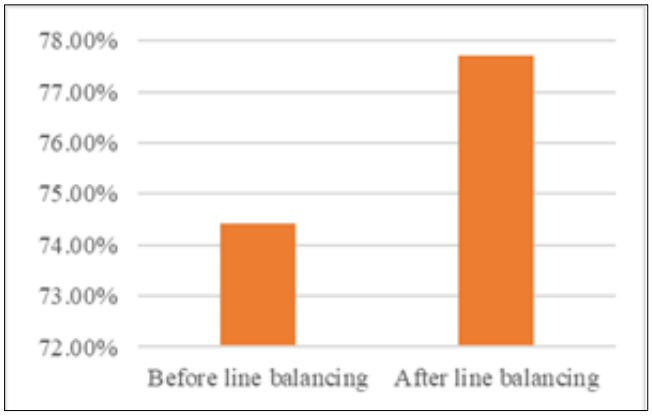

Fig 1: Efficiency improvement of before and after

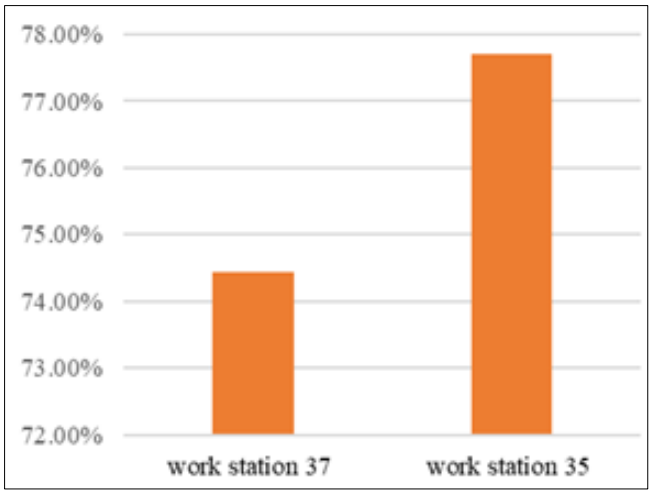

Fig 2: Number of workstation reduced before and after

Line balancing calculation

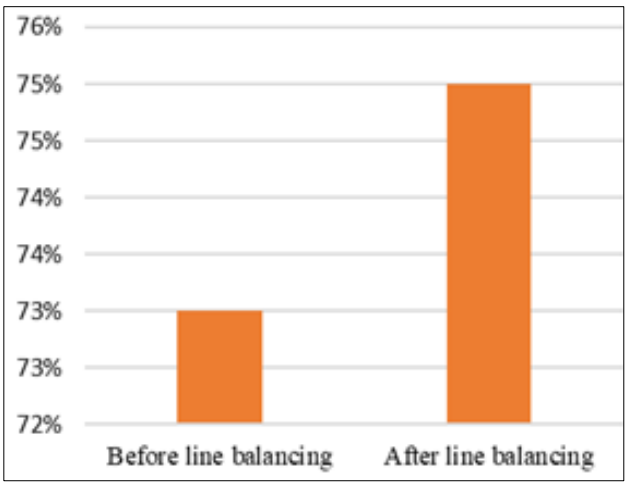

Fig 3: Balanced situation before and after

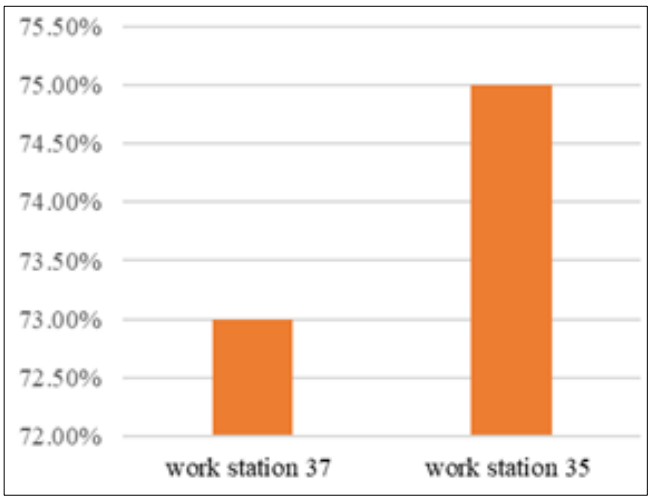

Fig 4: Reduced the number of work station after balancing

From this analysis, it can be easily seen that efficiency and balancing are increasing with the proper utilization of man and machine. Before line balancing the number of workstation (man, machine) was applied 37 but efficiency and balancing was 74.43% and 73% respectively. But after line balancing the number of workstations was 35 where 2 workstations are less than before and the efficiency and balancing was 77.70% and 75% respectively, which is the most in this study (see in Fig. 1 and 3). And this is my improvement line layout. After balancing I merge some operations to reduce the number of men and machines to operate the job. In our merging process, I took proper care about the sequences of the operation to make Hoody. That is why balancing also increased.

Conclusion

The article compares the efficiency and balancing percent for creating Hoodies before and after using Industrial engineering technologies such as line balancing and time study approaches. This is still true today, with organizations wasting millions of dollars every day due to a lack of knowledge of the need to constantly improve efficiency. The majority of it can be avoided by utilizing methods, time, capacity, and production analysis. It is possible to increase efficiency while appropriately utilizing man and machine. The possibility of a standard procedure for each step, as ill as a significant amount of time, have both been discussed. A time study was conducted to determine each worker's actual individual capacity. The time taken to complete each step for each worker was recorded to determine the optimal number of operators and assistance, machine type, basic and standard pitch time, and individual capacity. Process-wise capacity was computed to determine the (standard minute value) SMV. I believe that my insights will assist others in creating Hoodie, particularly the worker.

One who seek greater efficiency and balance with a smaller desk and better worker balancing.

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