

# Design & implementation of the production line in garment industry

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## ABSTRACT – REZUMAT

### Design & implementation of the production line in garment industry

*The traditional strategy in garment businesses is confronting a considerable measure of issues, for example, longer Production lead time, high work, supply sought after, high texture waste, longer production time and ailing in the utilization of assets. ABC clothing company is experiencing the previously mentioned issues. Enhancing efficiency through quantitative research strategies and distinctive lean assembling devices, for example, the institutionalization of the work process, line adjusting, and 5S were utilized to distinguish the issues and to address the arrangements. By understanding the real issue, the use of these lean assembling devices and their advantages were inspected. Earlier it was around 210 items for each day once in the day of actualizing the lean tools it was around 280 every day. The efficiency has increased by 25%. In like manner, the adjusting balancing loss was decreased by 35%. The implication of this investigation can give the entire practical answer to the usage of lean tools, minimization of waste and viable use of the asset in a piece of the garment industry for enhancing efficiency.*

**Keywords:** productivity, lean manufacturing, line balancing, 5S, efficiency

### Proiectarea și implementarea liniei de producție în industria de îmbrăcăminte

*Strategia tradițională în afacerile cu îmbrăcăminte se confruntă cu o serie de probleme, de exemplu, timp îndelungat între emiterea comenzilor și executarea acestora, durata mare de lucru, cerere mare de aprovizionare, cantitate mare de deșeuri, timp de producție mai lung și dificultăți în utilizarea activelor. Compania textilă ABC este una dintre unitățile producătoare de articole de îmbrăcăminte care se confruntă cu problemele menționate anterior. Creșterea eficienței prin strategii de cercetare cantitativă și dispozitive distinctive de asamblare de tip lean, de exemplu, instituționalizarea procesului de lucru, ajustarea liniilor de producție și 5S au fost utilizate pentru a distinge problemele și pentru a aborda soluțiile. Prin înțelegerea problemei reale, au fost analizate aceste dispozitive de asamblare de tip lean și avantajele acestora. Anterior, producția zilnică era de aproximativ 210 de articole, iar în ziua implementării acestor instrumente s-a ajuns la o producție zilnică de aproximativ 280 articole. Eficiența a crescut cu 25%. În mod similar, pierderea echilibrului de ajustare a fost redusă cu 35%. Implicația acestei investigații poate oferi răspunsul practic la utilizarea instrumentelor de tip lean, la reducerea deșeurilor și a activelor viabile utilizate în industria de îmbrăcăminte, pentru creșterea eficienței.*

**Cuvinte-cheie:** productivitate, producție de tip lean, echilibrarea liniilor de producție, 5S, eficiență

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## INTRODUCTION

The garment industry is one of the businesses that have the potential in building up an economy. History delineates that this industrial area has been a base for some effective modern improvements and hence Indian government has characterized an approach where one of the policies distinguished is quick development through the generation of high-esteem agricultural items and expanded help to send out situated assembling segments of textile and garment [1]. The garment industry in creating nations are lack of skilled workforce and additionally money to execute new advancements for enhancing efficiency and adaptability. Along these lines, ventures have been running generally for a considerable length of time and are inflexible to change. They don't have much certainty and will towards advancement over old procedures; henceforth coming about low efficiency and disappointment of clients [2]. Having a similar

circumstance part of this issue is looking for ABC textile mills, India. The most ideal approach to adapt to every one of these difficulties is the presentation and routine of lean Manufacturing tools [3]. Lean is a term to depict a framework that produces what the client needs, when they need it, with the least waste, based on the Toyota production system [4]. Lean thinking spotlights on esteem included lean and comprise of best practices, tools and strategies from all through the industry with the points of eliminating waste and expanding the flow and productivity of the general system to accomplish definitive consumer satisfaction [5]. Lean Manufacturing is a manufacturing philosophy that abbreviates the time between the customer order and the item assembly/shipment by taking outsourcing waste. Another method for taking lean is that it plans to accomplish a similar yield with less input-less time, less space, less human exertion, less machinery, less material, and fewer expenses [6]. There are quantities of LM tools when utilized as

a part of appropriate ways will give the best outcomes [3].

### Problem definition

Garment takes after a traditional creation framework. In this industry, the procedure stream format of an article of garment production which has between reliance between the cuttings and sewing segments is not legitimately format. Likewise in the sewing segment, the generation line is inadequately adjusted. Sewing tasks (concerning cutting and completing) need high skill and in addition quality work, as a result, related to repairing items sewed with wrong specifications [3]. Some other issues confronted which affect directly the garment industry is fabricating which straightforwardly influences profitability, for example, no standard circumstances exist for different creation tasks and target setting depends on mystery or encounter, pointless development, low generation limit and poor asset usage, for example, space, work, machine and time. Besides, keeping in mind the end goal to accomplish a constant efficiency increase and aggressive in the market, it is smarter to have the business with a smart production framework.

### Research methodology

Research related to assembly line balancing problems and various lean tools. The underlying advance in this examination was methodically auditing the related literature such as various tools and strategies of the Lean Manufacturing framework, including the institutionalization of the work process, line balancing, and 5S. Likewise, rank positional weight (RPW) has been utilized for line balancing. Following this, the current creation arrangement of garments was considered utilizing qualitative research approaches [7] for gathering and examining the information. Primary information was gathered through physical observation and by utilizing a stopwatch time study on the shop floor. On account of the secondary information source, it was acquired through a literature review, internet sources identified with lean assembling and industry-specialized reports. In this study availability sampling techniques were utilized. Availability sampling techniques depend on the accessible possibility of the subject amid the study.

### Objective

The objective of assembly line balancing is to divide the total work content of the job as evenly as possible between the stations and maximize the use of scarce resources. It helps to find out the production parameters and hence production planning and scheduling. In general, line balancing means minimizing idle time or balancing loss, minimizing the number of workstations, and distributing balancing loss evenly between stations while not violating any constraints [8]. In the apparel industry, these constraints are resource constraints, precedence constraints, and time constraints.

In practice, a perfect balance could not normally be achieved as shown in figure 1, where the workstation times are balanced and equal to the desired cycle time. In reality there exist an imbalance, which results from imperfect line balance. In practice periods of idleness caused by the difference between cycle times and workstation times is hard to find because a worker will normally be inclined to perform his or her work operations within the time available. It has been estimated that the balancing loss is normally between 5 and 20 percent in the garment industry.

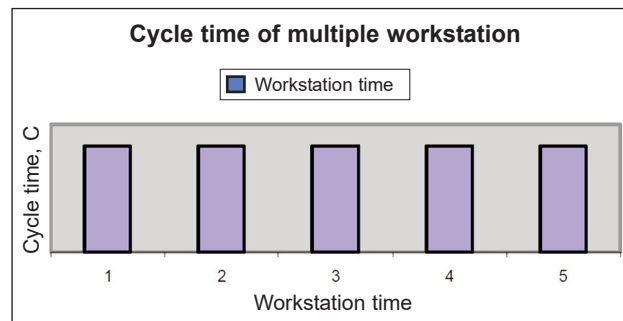


Fig. 1. Line balancing

### LINE BALANCING PROCEDURE

Line balancing could be achieved by using many methods [9]. Some of them are linear programming, dynamic programming, heuristic methods, and computer programming. A heuristic method is one based on trials with logical ground rules or policies to guide the assignment of job elements to workstations [10]. Among other heuristic methods the Ranked Positional Weights (RPW) procedure (developed by Helgerson and Birnei) is a rapid, but approximate, method, which has been shown to provide acceptable good solutions quicker than many of the alternative methods; it is capable of dealing with both precedence and equipment constraints.

Balancing problems arise from the nature of work performed in garment factories [11]. The work is mostly manual and performed mostly by semi-skilled or unskilled workers. Their performance is unpredictable, which makes it difficult to determine the standard time of elements. Where the standard time of an element is the time required to operate for that particular element considering 100% performance for average workers and 15% personal allowance. A variety of orders also makes balancing harder in the garment industry. An order for garments may be one of two types [12]. In the first case, a single product is manufactured in large volumes for an individual client. In the second model, more than one product is manufactured for the client at the same time. This multi-model problem requires more planning and iteration [13]. Overall, the line-balancing problem in a garment factory becomes a complex activity due to the wide product variety. Unpredictable performance of mostly unskilled workers, very tight production schedules, supply chain problems and offline production is not always possible.

A production line should be so designed to achieve several goals. These goals are to improve productivity in terms of throughput and better utilization of scarce resources, to reduce material flow path and conflict, to provide a definite space for each production line, to create a conducive environment for the workers in each production line, and to increase the social interaction between workers and supervisors [12]. To meet these goals following issues need to be addressed. They are the number of production lines, the number of workstations and the number of workers per line, the floor space for each production line, and the adaptability of different models in a single line [13]. In designing the production line three aspects are considered in this research. They are balancing the production line and layout.

### DATA COLLECTION

Using the RPW method a balanced production line has been designed. The parameters of the balanced line are calculated in the following manner. The time required to complete the work allocated to each station is known as the service time. The time available at each station for the performance of the work is known as the cycle time, the cycle time normally being longer than the service time.

$$\text{Thus Cycle time} = \text{Service time} + \text{Idle time or loss} \quad (1)$$

The cycle time ( $C$ ) and the minimum number of workstations ( $n_{\min}$ ) can be calculated as follows,

$$C = T/N \quad \text{and} \quad n_{\min} \geq N \sum t / T \quad (2)$$

where  $N$  is number of items to be produced,  $t$  – element time and  $T$  – time to produce  $N$ .

The average workstation time ( $c$ ) is simply the total work content ( $\sum t$ ) divided by the actual number of stations ( $n$ ).

$$c = \sum t / n \quad (3)$$

Balancing loss percent is calculated as:

$$\begin{aligned} \text{Balancing loss} &= \{(C - c) / C\} \times 100 = \\ &= \{n(C) - \sum t\} \times 100 / n(C) \end{aligned} \quad (4)$$

The detailed steps of line balancing are shown below. RPW method takes standard time for each element as input and can come up with precedence diagram and other design parameters.

Step 1: Break down the whole assembly task into reasonable elements.

Step 2: Take several numbers of readings (Performance time) for each element. The average of these will give a selected time for each element.

Step 3: Determine the rating of each operator performing of each element based on normal Performance equal to 100%.

Step 4: Determine the Standard time for each element using Standard time = Normal time  $\times$  100 / (100 – allowance in percent), where Normal time = Selected time  $\times$  Rating in percent / 100.

Step 5: An allowance of 15% for Personal time is usually considered for the assembly operation.

Step 6: Determine for each element the immediately preceding element(s).

Step 7: For each task determine positional weight. Positional weight of each task = element times of the task itself + time of all tasks that must follow it.

Step 8: Arrange the positional weight in descending order and construct a precedence diagram.

Step 9: Determine cycle time ( $C$ ), where  $C$  = Available time per shift / production rate per shift.

Step 10: Select each workstation by summing the time of the highest positional weights such that the time should not exceed the cycle time & will not violate technological sequence.

Step 11: If an element violates either of the above restrictions passes over it and take the next acceptable element. When a station cycle time is filled. Move on to the next station.

Step 12: Sum up times for all operations to get total time  $\sum t_i$

Step 13: Theoretical number of workstations,  $n = \sum t_i / C$  (should be integer number).

Step 14: Maximum efficiency,  $E_{\max} = \sum t_i / nC$ , actual efficiency,  $E = \sum t_i / mC$ . Where,  $m$  = actual number of workstations.

Step 15: Note what elements constitute each workstation task. Thus an approximate layout will be obtained.

Step 16: Since the RPW technique does not necessarily give an optimum balance (i.e.  $E < E_{\max}$ ), attempt should be taken to get better efficiency by minor rearranging elements in a better configuration (if possible).

Girls top was selected for analysis using the RPW method. For each operation, a time study was conducted to determine all elements and the performance rating of the labour is assumed as 100%. Allowance was provided by 15% to the normal time for arriving standard time of the process. The corresponding standard time of various operations is shown in table 1. Other allowances are not considered for the calculation of the standard time.

### DISCUSSION

Actual Number of Workstations in the existing system is 7, with one operator for each station. Takt time is calculated to improve the balancing of the process. The takt time is the average time between two successive units and can be evaluated as:

Takt time

$$T = \frac{\text{Total Available time per shift}}{\text{Demand per shift}} \quad (5)$$

$$T = \frac{25200}{210}$$

$$T = 120 \text{ Sec}$$

The efficiency of the exiting line is calculated to evaluate the current performance of the system

$$\eta = \frac{\text{Total Minutes produced}}{\text{Total Minutes available}} \quad (6)$$

Table 1

STANDARD TIME FOR GIRLS TOP											
Process number	Operation	Observed time in sec						Performance rating	Normal time in sec	Allowance	Standard time in sec
		1	2	3	4	5	AVG				
1	One side shoulder attach	60	63	58	65	65	62.2	100%	62.20	15.55	78
2	Label attachment	180	178	178	180	180	179.2	100%	179.20	44.80	234
3	Neck binding	120	123	120	118	115	119.2	100%	119.20	29.80	117
4	Back neck tape overlock	180	175	200	195	185	187	100%	187.00	46.75	149
5	The second shoulder attach	90	96	98	95	90	93.8	100%	93.80	23.45	224
6	Sleeve hem lower	120	125	130	118	120	122.6	100%	122.60	30.65	153
7	Sleeve attachment	240	243	228	230	248	237.8	100%	237.80	59.45	297
8	Side seam overlock	360	380	396	348	336	364	100%	364.00	91.00	455
9	Bottom hem (full length)	180	178	187	186	175	181.2	100%	181.20	45.30	227
10	Peak (in sleeve and rib)	180	169	178	180	189	179.2	100%	179.20	44.80	224
Total time required / Piece (sec)											2158

$$\eta = \frac{\text{Output} \times \text{Standard Time}}{\text{Available time} \times \text{Number of Operator}} \times 100$$

$$\eta = \frac{42 \times 2158}{25200 \times 7} \times 100$$

$$\eta = 51.38 \%$$

Balancing loss

$$B_L = 100 - \text{Efficiency} \quad (7)$$

$$B_L = 100 - 51.38 = 46.62\%$$

Cycle time

$$C = \frac{\text{available time per shift}}{\text{production rate per shift}} \quad (8)$$

$$C = \frac{25200}{42} = 600 \text{ sec}$$

Based on the various operation carried out in manufacturing girls top precedence is calculated as shown in table 2. The operation starts with a shoulder attach and ends in a peak. The total number of operations in the girls top is limited to 10.

The precedence diagram was constructed as shown in figure 2 to identify the process flow of the girl' top. Once the precedence diagram is constructed the critical path in manufacturing the product is calculated, the various path in the girls top manufacturing are as follows:

$$\text{Path 1: } 1-5-8-9-10 = 78 + 224 + 455 + 227 + 224 = 1208 \text{ sec}$$

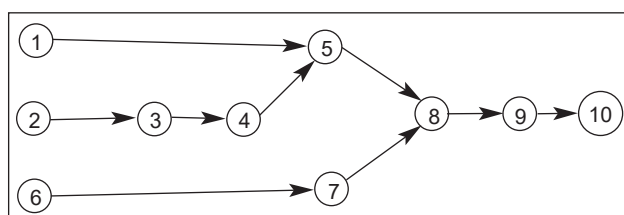


Fig. 2. Precedence diagram

Table 2

PRECEDENCE TABLE			
Process number	Operation	Standard time in sec	Predecessor
1	One side shoulder attach	78	-
2	Label attachment	234	-
3	Neck binding	117	2
4	Back neck tape overlock	149	3
5	Second shoulder attach	224	1.4
6	Sleeve hem lower	153	-
7	Sleeve attachment	297	6
8	Side seam overlock	455	5.7
9	Bottom hem (full length)	227	8
10	Peak (in sleeve and rib)	224	9

$$\text{Path 2: } 2-3-4-5-8-9-10 = 234 + 117 + 149 + 224 + 455 + 227 + 224 = 1630 \text{ sec}$$

$$\text{Path 3: } 6-7-8-9-10 = 153 + 297 + 455 + 227 + 224 = 1356 \text{ sec}$$

Path 2 is a critical path with a duration of 1630 seconds.

For this particular product, Girls Top total time required for a single unit = 2158 seconds. Existing production = 6 units/hr, therefore Cycle time =  $3600/6 = 600$  seconds. We proposed a target with the cycle time,  $C = 460$  seconds (Production demand is 1250 units). Therefore Per hour production will be =

3600/460 = 8 units, and number of workstations = 2158/460 = 4.69. The theoretical minimum number of workstations will be  $n = 5$ , Bottleneck time = 455 sec, Total task time =  $T = 2158$  sec, Maximum production rate = 3600/460 = 8 units per hour, Cycle time  $C = 460$  sec.

Theoretical number of work station  $N = T/C = 2158/460 = 4.69 = 5$  Station

Takt time

$$T = \frac{\text{Total Available time per shift}}{\text{Demand per shift}} \quad (9)$$

$$T = \frac{25200}{280}$$

$$T = 90 \text{ Sec}$$

The efficiency of the proposed line is calculated to evaluate the current performance of the system

$$\eta = \frac{\text{Total Minutes produced}}{\text{Total Minutes available}} \quad (10)$$

$$\eta = \frac{\text{Output} \times \text{Standard Time}}{\text{Available time} \times \text{Number of Operator}} \times 100$$

$$\eta = \frac{56 \times 2158}{25200 \times 7} \times 100$$

$$\eta = 650 \%$$

Balancing loss

$$B_L = 100 - \text{Efficiency} \quad (11)$$

$$B_L = 100 - 650 = 31.5\%$$

The ranked weight value of an operation is calculated by adding all operation time considered with the time of another precedence in the series. After all of the ranked positional weights of the operations are determined, they are arranged in decreasing order as shown in table 3.

Table 3

RANKED POSITIONAL WEIGHT METHOD			
Process Number	RPW	Standard time in sec	Predecessor
1	2158	78	-
2	2080	234	-
6	1846	153	-
3	1693	117	2
4	1576	149	3
5	1427	224	1,4
7	1203	297	6
8	906	455	5,7
9	451	227	8
10	224	224	9

Then tasks are assigned to each workstation starting from the task with the highest-ranked positional weight as shown in table 4. Before this the operation having the subsequent highest-ranked value should be selected from the other working operations to

assign to the workstation; the precedence constraints are to be noted such that no operation is to be idle, and the operation time and unused workstation time should be controlled. The assignment procedure is continued until one of the conditions below is obtained:

1. If all the processes are assigned to the workstations,
2. If no operations are having either precedence or unassigned time constraints.

Table 4

ASSIGN TASK TO WORKSTATION			
Work station	Process	Standard time in sec	Total time for station (sec)
1	1	78	429
	2	234	
	3	117	
2	6	153	450
	7	297	
3	4	149	373
	5	224	
4	8	455	455
5	9	227	451
	10	224	

The possible improvements are identified in the product upon implementing the proposed line. The significant changes developed after line balancing is a reduction in Takt time, cycle time, balancing loss, workstation and increases in production efficiency as shown in table 5.

Table 5

COMPARISON OF BEFORE AND AFTER LINE BALANCING		
Description	Before	After
Takt Time	120 sec	90 sec
Cycle Time	600 sec	460 sec
Work station	7	5
Balancing Loss	462%	31.5%
Production/ Day	210	280
Line Efficiency	51.38%	65%

## CONCLUSION

The manufacturing system in a garment factory is mostly manual and can be iterated many times over the life of the production of a model. Unfortunately, this manual process is not honed to the degree possible, oftentimes only because of a lack of understanding of line-balancing terminology and techniques. In this work a guideline has been presented to show how efficiently the production line can be

balanced in a garment factory, using a balancing for the production line.

1. The significant achievement is a 2% reduction in Takt time, a 23% reduction in cycle time, a 35%

reduction in balancing loss and a 28% reduction in the number of workstations in lead time.

2. The production line efficiency has been increased by 25%.

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