OPEN ACCESS
Journal of Integrated Engineering & Applied Sciences
Volume 2, Issue 1, pp. 40-47, 2024
ISSN: 2960-2661 DOI: https://doi.org/10.5281/zenodo.10652276
Received 10 January 2024 / Accepted 12 February 2024

The Influence of Line Balance on Efficiency in Garment Production

Silva Spahija[1*], Elmira Dumishllari[1], Albana Leti[1], Klodian Dhoska[2]

[1] Department of Textile and Fashion, Polytechnic University of Tirana, 1001 Tirana, Albania.
[2] Department of Production and Management, Polytechnic University of Tirana, 1001 Tirana, Albania.
* **Corresponding Author**: sspahija@fim.edu.al

Abstract

This study is realized with the purpose to analyse the impact of line balancing on the efficiency of the production in garment companies. A line is defined as a group of operators under the control of production supervisors. Balancing of the production line means maintaining the same level of inventory at each and every operation at any point of time to meet the production targets, to produce garments of acceptable quality and to increase the efficiency of the line. The study is realized in a garment company in Tirana, which produces swimwear for an Italian customer. The paper presents the analysis of line balance and its efficiency. In this study it is analyzed the actual layout and line balance plan, and it is compared with the calculated one. Also, there are done time measurements for every work operation to calculate Standard Allocated Minutes and to get better production targets.

Keywords: Line balancing, layout, efficiency, standard allocated minutes.

1. Introduction

For being competitive in the market, garment companies need to focus on productivity improvement through systematic and effective line balancing and layout planning [1].

A sewing line is considered a group of operators working under the control of one production supervisor [2]. It is a function of management to help the company to improve efficiency and increase productivity and one of these responsibilities is line balancing.

Generally, line balancing is the allocation of sewing machines according to garment style. A good line balance increases the rate of production, reduces production times, reduces faults in the finished product and helps to achieve the delivery terms [3].

Line balancing is a key element to improve the productivity of the sewing line, while reducing costs and the use of manpower. The primary objective of line balancing is to improve productivity, minimize time loss, balance the workload, avoiding the creation of bottlenecks and ensure that all operations within the production line are completed within a specified time frame [4].

Also line balancing aims to reduce the waiting time of the operators to achieve a high utilization of workforce and machines. It has a positive impact in achieving operational excellence and meeting customer expectations.

Some of the steps in line balancing include calculation of the labour requirements, layout planning, operation breakdown, skills inventory analysis, etc [4].

Related to line balancing it is important to note that it should be a continuous process that requires continuous monitoring, analysis, and adjustment to improve efficiency and meet customer demands in the garment industry. It is also important to balance the line every time a new product/style enters in the production line or every time the style changes [5].

Layout is one of the main components of line balance and its importance would be better appreciated if everyone understands the influence of an efficient layout on the manufacturing system; it makes it smooth and efficient [6].

Layout planning is a method of planimetric position of machines, processes, and other services in a systematic way within the company to achieve the right quantity and quality of output at a lowest manufacturing cost. A good plant layout increases good workflow in production route. It is necessary to design and implement effective layout in a plant from the beginning applying systematic approaches and tool [1].

Layout is an arrangement of everything needed for production of goods or delivery of services [7]. Layout design generally depends on the products' variety and the production volumes.

An efficient layout has the flexibility to be changed to meet the requirements of the product lines and delivery schedules. Layout planning and line balancing are closely related to line efficiency and productivity.

In this study it is analysed the correlation between line balancing and efficiency of the line. For this reason, it is studied the actual plan of sewing line of the company, and it is compared with the calculated plan for this sewing line. The product analysed is knitted fabric swimwear and the main accessories used are fillet, label, linen, etc. The order comes from the Italian customer. The quantity of order is 1000 pieces, and the delivery deadline is 18 days.

The production starts after receiving the order with a specific target for pieces. Raw material and accessories are imported from Italy. Cutting and modelling processes are realised in the company, where the styles are ready, and this department can intervene through computer CAD/CAM programmes.

In the table 1 there are shown the main machines used in the sewing line to produce the swimwear analysed.

Table 1: Main machines used to produce the swimwear analysed.

Types of machines	Quantity
Transfer Manual	2
4-needle sewing machine	4
2 needle collarette	5
Linear	3

There are in total 20 machines used in the sewing line and there are 25 operators working on this sewing line: 20 machine operators, 2 helpers, 2 quality controllers and one is the line supervisor.

2. Methodology

The study is divided into four steps:

- Literature review to be familiar with the different terms and processes used in garment production.
- Collecting data from the garment company where the study was conducted.
- Analysing the actual plan and the calculated one for the line balancing.
- Discussing the results and recommendations for improvement.

During our analysis we have taken under consideration some important issues; line planning, number of the operators, number of processes, number of machines, evaluation of Standard Allocated Minutes (SAM) and line efficiency.

Time study is considered as the most used technique for line balancing and avoiding bottlenecks. At ANSI in 1982 Institute of Industrial Engineers state time study as, "A work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to allow adequate time for such items as foreign elements, unavoidable or machine delays, rest to overcome fatigue, and personal needs." One problem of time study is the Hawthorne Effect where it is found that employees change their behaviour when they know that their being measured [8, 9].

As the operation breakdown is one of the main steps of line balancing, there are done time measurements for every work operation. The time study is conducted using stopwatch, judgment of operator's performance through BSI, allowances considering [5].

The following steps to calculate standard minutes values are:

SAM is the standard value of minutes that is the multiplier of all the processes, multiplied by performance rating, considering the allowances. To calculate the SAM, we have followed three steps:

Step 1: choose a qualified and experienced operator.

Step 2: measure cycle time for every operation using chronometer (time cycle is the total time needed to realize all the works needed to finish an operation). Calculate the average value for 10 cycles, which is the time cycle.

Basic time = Cycle time * performance rating

The performance rating is done based on the BSI (British Standard Institution) which consider the speed of the operator (in which the work is being completed). The performance rate shows what level of performance the operator is doing the work, considering its movement and speed of work.

Step 3: calculate standard minutes allocated (SAM) = (basic minutes + allowances). Allowances are considered 7% in every process.

The daily production rate is calculated based on the equation 1:

$$Daily\ production\ rate = \frac{\text{Quantity of order}}{\text{Delivery deadline}} \quad (1)$$

Efficiency of the production line is calculated based on the below equation 2:

$$Line\ Efficiency = \frac{\text{Total number of}\frac{\text{output}}{\text{day}} * SAM}{\text{Total manpower in the line} * \text{total working minute /day}} \quad (2)$$

Time delivery is calculated based on the equation 3:

$$Time\ of\ delivery = \frac{\text{Quantity of order}}{\text{Production daily rate}} \quad (3)$$

3. Results and Discussion

Table 2 shows the results of time measurements for every process with the method described above

Table 2. Calculation of SAM for every work operation

Work Operations	Time measurements for 10 cycle					Average sec/ cycle	Rating	Norm sec/ cycle	Basic sec /Garment	Standard sec/garment
The mono-plastic application of Logo	13	14	14	13	15	14	70	9,8	14	9,87
	14	14	15	14	14					
Joining of two parts of swimwear in the bottom	24	25	25	26	24	25	75	18,8	25	18,82
	24	25	26	25	26					
Joining of two parts up to back side	58	57	56	56	57	57	80	45,6	57	45,67
	58	57	59	56	57					
Joining of the liner with the fabric	24	24	25	25	24	25	85	21,3	25	21,32
	25	26	25	24	26					
Joining of leg part with fillet	96	97	95	97	96	96	85	81,6	96	81,67
	95	95	96	96	96					
Closing of fillet	15	16	16	17	15	16	70	11,2	16	11,27
	16	16	15	16	17					
Cutting of fillet	15	14	14	13	15	14	75	10,5	14	10,57
	14	14	13	14	14					
Reinforcement of seam inside and outside	25	25	24	25	25	25	65	16,3	25	16,32
	25	26	25	24	26					
Placing the fillet in the side part of shoulders	82	83	83	84	83	83	80	66,4	83	66,47
	82	83	83	83	84					
Cutting of fillet in the side part of shoulders	18	19	19	17	18	18	85	15,3	18	15,37
	18	18	17	18	18					
Joining of the back side with fillet	144	145	145	144	145	145	80	116,0	145	116,07

	145	145	145	146	146					
Reinforcement of the fillet in the back side	8	9	8	8	7	8	80	6,4	8	6,47
	8	8	8	7	9					
Cutting of the fillet	9	10	10	10	10	10	80	8,0	10	8,07
	10	10	10	10	9					
Placement of the travete inside and outside	10	10	9	8	10	10	80	8,0	10	8,07
	10	10	10	10	10					
Placing the travete in the upper part	15	14	16	15	14	15	85	12,8	15	12,82
	15	16	15	15	15					
Placing the travete in the base	17	19	17	19	18	18	85	15,3	18	15,37
	18	18	18	18	18					
Placing the travete back up	18	18	19	19	19	19	85	16,2	19	16,22
	19	19	19	19	20					
Preparing to place the label	13	13	14	13	14	13	85	11,1	13	11,12
	13	12	13	13	13					
Preparing to place the label	20	19	20	20	20	20	85	17,0	20	17,07
	19	20	20	20	20					
Fixation of the label with stitches	9	10	9	10	9	10	70	7,0	10	7,07
	10	10	10	11	11					
Total Standard Seconds						**641**		**530,7**	**641**	**529**
Total Standard Minutes						**10,68**		**8,84**		**8,82**

After completing the time measurements for every work operation, it is made a comparison between actual time and calculated time of the operations for swimwear analysed and the results are shown in table 3.

Table 3. Comparison between actual and calculated time of production operations for swimwear.

	Operations	**Actual time (s)**	**Calculated time (s)**	**Machinery**
1	The monoplastic application of logo	22	9.87	Calender
2	Joining of two parts of swimwear in the bottom	31	18.82	4 needle
3	Joining of two parts up to back side	61	45.75	4 needle
4	Joining of the liner with the fabric	32	21.32	Linear
5	Joining of leg part with fillet	105	81.67	2 needle
6	Closing of fillet	22	11.27	Linear
7	Cutting of fillet	21	10.57	Scissors
8	Reinforcement of seam inside and outside	30	21.32	Travete
9	Placing the fillet in the side part of shoulders	90	74.77	2 needle
10	Cutting of fillet in the side part of shoulders	21	15.37	scissors
11	Joining of the back side with fillet	150	116.07	2 needle
12	Reinforcement of the fillet in the back side	14	6.47	Linear

13	Cutting of the fillet	10	8.07	Scissors
14	Placement of the travete inside and outside	17	8.07	Travete
15	Placing the travete in the upper part	22	12.82	Travete
16	Placing the travete in the base	22	15.37	Travete
17	Placing the travete back up	21	16.22	Travete
18	Preparing to place the label	18	11.12	Linear
19	Preparation of label placement	27	17.07	Zig-Zag
20	Fixation of the label with stitches	17	7.07	Linear
21	Placing the hygenic part and label	-	-	Manual
22	Cutting of threads	-	-	Manual
23	Control	-	-	Manual
24	Packaging	-	-	Manual
	Total in minutes	**12.6**	**8.81**	

It is evident that the actual time of production for swimwear is higher than the calculated time, which means that in the actual plan there is needed more time to produce one piece than in the calculated plan.

By applying the method of time measurements, we can have a lower time of production which means the sewing line can produce more output in shortest time and in this way, it can be more efficient and productive.

Based on the SAM for both plans we have calculated other important elements of line balancing, which are shown in table 4.

Table 4. Comparative table between actual and calculated plan

Analysed data	Actual Plan	Calculated Plan
Number of machines	20	20
Number of operators	25	22
Production operations	Determined by the customer	Must be done
Line balance	It is not considered important	Must be done regularly
SAM of one unit	12.6	8.18
Daily production	38 pieces	55 pieces
Total minutes of work	480	480
Quantity of production for 18 days	684	1044
Delivery in time	Not possible (26 days)	Delivered in time (18 days)
Line Efficiency	25%	31 %

We can notice that there are many differencies between actual and calculated plan, which makes the actual plan more suitable for the swimwear production line.

Referring to the sewing line we have considered the same number of machines in both plans. But in the calculated plan we have reduced the number of the operators. So, while receiving the product from the material opening table, it passes through four linear machines and four employees respectively. In this case we can avoid some linear machines used as a result of a bad planning.

Before the balancing process, operations 7, 13 and 21 must be eliminated, giving the higher contribution the machine and the operator, which has the higher capacity in the line.

Also, line balance is not considered important in the company, but it is a necessity. It must be done regularly in periodic way in order to avoid all bottlenecks of production. In the calculate layout plan it is found out that the line balance is a very important process, which should be done regularly and sistematically from the line managers. Referring to the table, it is noticible that there is nedeed more time to produce one unit in the actual layout plan than in the calculated one.

The efficiency of the production line, is lower in two cases, but in the calculated plan is higher than in the actual plan.

4. Conclusions and Recommendations

The operator capacity is in a low level and many of the operators taking more time for one process that the time needed. The capacity of the operator is unused as a result of an unbalanced production line. There is a lot of space created by the operators, which means loss of time or unproductive time.

In the calculated layout plan, we can produce more output in a shorter time. And in this way the company has the possibility to deliver in time the product.

Due to the fact that line efficiency is low even in the calculated plan, it is recommended to the managers of the company to:

- analyze operator's psychology and working conditions in the sewing line.
- train the operators,
- ensure that the operators have properly understand the method of work,
- motivate the operators to work with responsibility and high efficiency.

If the operators are trained and motivated, they will work faster, with responsibility and could increase their productivity.

References

[1] Islam A., Rashed C.A.A., Hasan J. Productivity improvement through the application of systematic layout. Department of Industrial and Production Engineering, Shahjalal University of Science & Technology, Sylhet-3114, Bangladesh, *Review of General Management*, 2017; 25(1); 36-51.

[2] Kiron M.I. Line Balancing in Apparel Production: Objectives, Importance & Limitation. Available at https://textilelearner.net/line-balancing-in-apparel-production/. Accessed on 1 January 2024.

[3] Syduzman Md. and Golder A.S. Apparel analysis for layout planning in sewing section. International Journal of Current Engineering and Technology, 2015; 5(3); 1736-1742.

[4] Line balancing in garment industry. Available at https://www.textileblog.com/line-balancing-in-garment-industry/#:~:text=Line%20balancing%20in%20the%20garment,excellence%20and%20meeting%20customer%20expectations. Accessed on 1 January 2024.

[5] USAID. Productivity Toolkit for garment manufacturers Available at: https://pdf.usaid.gov/pdf_docs/PDACM718.pdf. Accessed on 1 January 2024.

[6] Chen C.W., & Sha D.Y. A literature review and analysis to the facility layout problem, Journal of the Chinese Institute of Industrial Engineers, 2001; 18(1); 55-73.

[7] Islam M., Mohiuddin H.M., Mehidi S.H. and Shuman N.S. An Optimal Layout Design in an Apparel Industry by Appropriate Line Balancing: A Case Study. *Global Journal of Research in Engineering*, 2014; 14(5); 35-43.

[8] Harish Kumar. M., Galagali N., Tiwari T., Archana M.S. Line balancing in sewing assembly line of garment industry. International *Research Journal of Modernization in Engineering Technology and Science*, 2020; 2(4); 1341-1348.

[9] Shumon M.R.H., Zaman K.A., Rahman, A. (2010) Productivity Improvement through Line Balancing in Apparel Industries, a Thesis of Dept. of Industrial Engineering and Management, Khulna University of Engineering and Technology, Khulna, Bangladesh.

Cite this article as: Spahija S., Dumishllari E., Leti A., Dhoska K. The Influence of Line Balance on Efficiency in Garment Production. Journal of Integrated Engineering and Applied Sciences. 2024; 2(1); 40-47.