Balancing of Production Line in a Manufacturing Industry to Improve Productivity

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Abstract: Excessive cycle time and uncontrolled idle time increases waste of time and reduce the productivity of a firm. This work makes a speciality of productivity improvement of an assembly line by the usage of operational analysis and assembly line balancing. The existing standard time in the assembly line is greater due to unusual idle item and non-productive time. A proposal of new standard time has been given to reduce the ineffective time. A heuristic technique called Ranked Positional Weighted approach is used for assembly line balancing. After the evaluation of the existing time required for every tasks non value added time and production time has been discovered the use of stop watch time study. Micro motion take a look at is carried out to locate the ineffective time in every operation. The main aim of this study is to reduce production cost and improve productivity, determine number of feasible workstation and machinery and equipment according to assembly mechanism and to optimize the production functions through construction of mix form of automation assembly and manual assembly. The main purpose of this work is to represent use of RPW technique to develop the assembly line and balancing that line. With this study it is found that RPW method is useful while the much less facts are to be had. Once more with the help of RPW technique, one could find out the way to synchronise the work stations for the work flow and sequencing. So the bottlenecking of the assemblies can be decreased.After implementation of line balancing, it was found that Line efficiency is improved from 79.36 to 83.33 % after implementing RPW.

Keywords: Line efficiency, cycle time, RPW technique, idle time, bottlenecking

1. INTRODUCTION

Assembly line defines that manufacturing technique in which a product is carried with the aid of some form of mechanized conveyor among stations at which the diverse operations important to its assembly are finished. It is used to gather quickly large numbers of a uniform product. At first, Assembly line were evolved for a fee efficient mass manufacturing of standardized merchandise, designed to take advantage of an excessive specialization of labour and the related mastering effects. Assembly Line Balancing can be defined as assigning range of work factors to numerous workstations to be able to maximize Balancing performance (BE) or to reduce range of workstations (N) or to accomplish another given objective function for a given volume of output without violating the precedence relationship. Line balancing is a critical tool to decrease production time, maximizing the output or minimizing the cost of a product. In different phrase, line balancing is one of the critical component to the design stage for go with the flow-line manufacturing systems.

In line balancing the crucial statistics is the info of the process goes with the flow and the cycle time at each workstation [13]. Enhancing bottleneck workstation is the principle objective the line balancing tool. To reap the goal, the cycle time records at every workstation want to be taken in making the evaluation. There are varieties of parameters that can be balanced on the workstations which might be balance through time, stability through work content, stability material, and stability by using inventory. Stability by using time is relating to the cycle time of the workstation. In this time period one wants to utilize time study method for records series. Assembly line balancing (ALB) is the problem of assigning duties to successive workstations through pleasing some constraints and optimizing an overall performance degree. This performance degree is generally the minimization of the quantity of workstations utilized over the assembly line [20].

2. LITERATURE SURVEY

Joyal George Mathew and Biju Augustine. P (2017) minimized workloads and people at the assembly line at the same time as assembly a required output. The production charge is relying on how nicely the line is working. A new layout will be proposed to make the assembly line acquire its required manufacturing rate **[1]**.

Mahmud Parvez et al (2017) focused on improving overall efficiency of single model assembly line by means of lowering the bottleneck activities, cycle time and distribution of work load at every work station by means of line balancing; using line balancing strategies specifically work sharing technique **[2]**.

Pratik Anil kumarDudhedia et al (2017) founded productivity is immediately effects on cost and growth of an organization so, productivity development is very vital for any employer to acquire organizational goal. In industries all through production many issues occur like breakdown of production line, slow rate of manufacturing, improper managing of material, intellectual fatigue of employees, and many others **[3]**.

PrabhulingUmarani& Keshav Valase (2017) focused specially on line balancing and layout work. The aim of assembly line stability in stitching lines is to assign obligations to the workstations, in order that the machines of the computing device can carry out the assigned obligations with a balanced loading. The primary goal of line balancing is to distribute the assignment over the every work station so that idle time of labour work can be minimized. Line balancing problem at grouping the resources or labour in an efficient and best pattern if you want to attain a premier or proper balance of the resources and flows of the production or assembly strategies. **[4]**.

Mohd Salman Khan & Saurabh Jha P (2017) studied assembly line balancing is one of the important problem as a long way as a production plant is taken into consideration. The plant productiveness entirely relies upon in this parameter and for this reason balancing and figuring out the idle time in a manufacturing waft becomes very mandatory. **[5]**.

Sudharsan Sridhar et al (2017) approached a bearing production enterprise in Coimbatore, India, and proposed an answer in growing the production of bearing by the approach of line balancing **[6]**.

W. Grzechca (2016) approached for layout of assembly line for modular merchandise is proposed. Assembly line layout of the subassembly line for basic operations can be viewed as a single model product assembly line balancing problem and be solved by way of existing line balancing strategies. **[7]**.

Katkuri Srikanth and Basawaraj. S. Hasu (2016) targeted on enhancing ordinary performance of single version assembly line by using decreasing the, cycle time and distribution of labour load at each work station through line balancing. The method followed consists of calculation of cycle time of process, calculating total work load on station and distribution of labour load on every computer by using line balancing, in order to improve the performance of line. **[8]**.

Gourav Kumar and Praveena Gowda (2016) considered the manufacturing procedure of a product wherein manufacturing is specified in terms of a sequence of duties that need to be assigned to workstations. The assembly line balancing trouble arises and has to be solved when an assembly line has to be configured or redesigned **[9]**.

Chirag K. Deotare& Uday A. Dabade (2015) focused directly to reduce the bottleneck areas with the aid of making use of necessary techniques. It is observed that foremost areas wherein bottleneck occurs are, head sub-assembly work station, tappet line and hot checking out of the engines. **[10]**.

Amith J Prakash and Aneesh K S (2015) targeted on productivity development of a tiller assembly line by way of the usage of operational evaluation and assembly line balancing. The prevailing preferred time within the assembly line is simply too antique and erroneous. An offer of recent well known time has been given to reduce the ineffective time. **[11]**.

Santosh Kulkarni and G.R. Naik(2015) studied on the overall performance development may be completed on 4 important parameters. First is aid enter requirement, second throughput requirement or process efficiency, 1/3 is output requirement which known with the aid of cost, great and functionality and fourth is outcome requirement. **[12]**.

3. METHODOLOGY

3.1 EXISTING LAYOUT OF BEARING RETAINER PRODUCTION LINE

Last 4 months facts are taken for preliminary analysis. In a corporation the production of bearing retainer is executed according to month-to-month call for from clients. Once the client's location order, the manufacturing planning and manipulate department time table for monthly production. They divide monthly manufacturing requirement into weekly manufacturing requirement and weekly into day by day manufacturing requirement.While casting of bearing retainer product is finished from foundry unit the products come to the raw materialvendor, in which the inspections of casting products are finished. If the products comes with a few defects like blow holes, bloodless shuts, more fabric and so on. Then products are ship it to foundry department with proper reason. After those inspections of products, they're despatched it to workshop, with ok tag. The bearing retainer product is machined on four distinctive machining centres (CNC and VMC), one leakage checking out centre (LTM), one laser coding centre (LCM) and rotary cleansing machine (RCM).

Table 3.1 Performance measuring parameters (Source: company sales department record)

Performance Parameters	Avg. % of OTD	Avg. WIP	Avg. Revenue
Bearing Retainer	63 %	920	Rs. 27,738/-

3.2 TOTAL AVAILABLE CAPACITY OF EACH RESOURCE IN THE PRODUCTION LINE

Table 3.2 Total available capacity of each resource in the existing production line

Machine Name	Workstation	Element	Cycle Time (min)	Idle Time (min)
CNC 1	1	1	5	3
CNC 1		2	3	1.5
CNC 2	2	3	4	2
VMC 1	3	4	3	2
VMC 1		5	6	4
VMC 2	4	6	5	2.5
VMC 2		7	2	1
LTM 1	5	8	6	3
LTM 1		9	1	1
LCM 1	6	10	4	2.5
LCM 1		11	4	3
RCM 1	7	12	7	3.5
Total task time			**50**	**29**

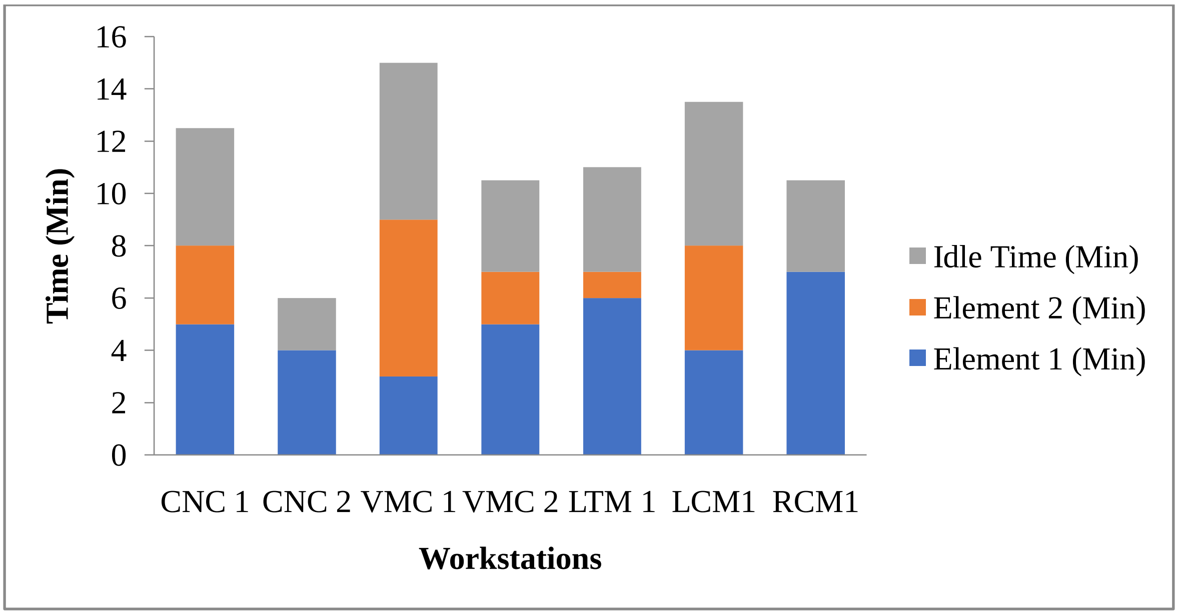

Fig. 3.1: Cycle Time Consumed on Each Workstation

5. IMPLEMENTATION OF RANKED POSITION WEIGHTED METHOD

The Rank Positional Weight technique may be used to balance an assembly line. On this approach, work elements are divided amongst workstations depending on the length of work elements and their precedence role. It's far the maximum efficient technique because the cycle time may be determined first and for this reason the number of workstations required can be calculated.

6. RESEARCH FINDINGS AND DISCUSSIONS

6.1 CYCLE TIME

From table 5.4, cycle time C = 10 min in keeping with unit every work station ought to have cycle time of 10 or less than 10 minutes. So on each work station process have to be in this kind of way that summation of time required to process the elements ought to be equal or much less than cycle time 10 mins. As shown in above tables after application of RPW method. As a result cycle time is 10 min after line balancing.

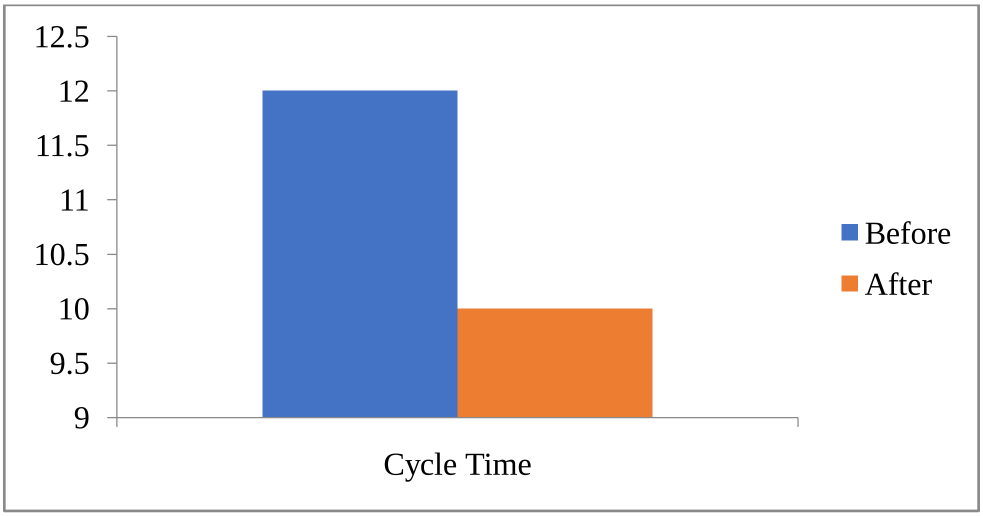

Fig. 6.1: Cycle time before and after line balancing

6.2 IDLE TIME

From the cycle time of numerous operations, the corresponding idle times are calculated and listed below. It is crucial to emphasize that the records below changed into recorded earlier than balancing the manufacturing line.

From table 5.3, **Idle time = 18 min**

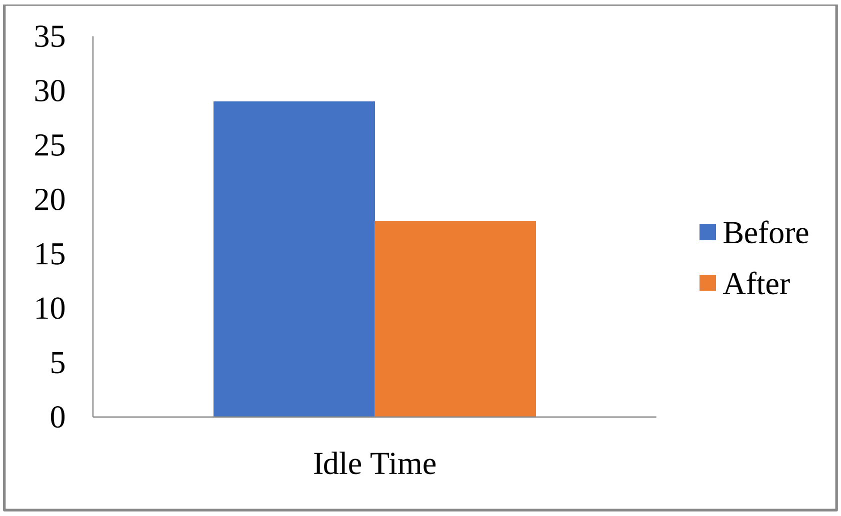

Fig. 6.2: Idle time before and after line balancing

From above fig it is clear that idle time is reduce from 29 min to 18 min after implementing RPW.

6.3 MINIMUM NO. OF WORKSTATION REQUIRED

The actual number of workstations is 7 however the ideal number of workstations is 5. It approach that preferably we will work with theoretical minimum workstations as five but we're unable to convert into 5 workstations due to some constraints. It is going up to 6.

So, **N= 6**

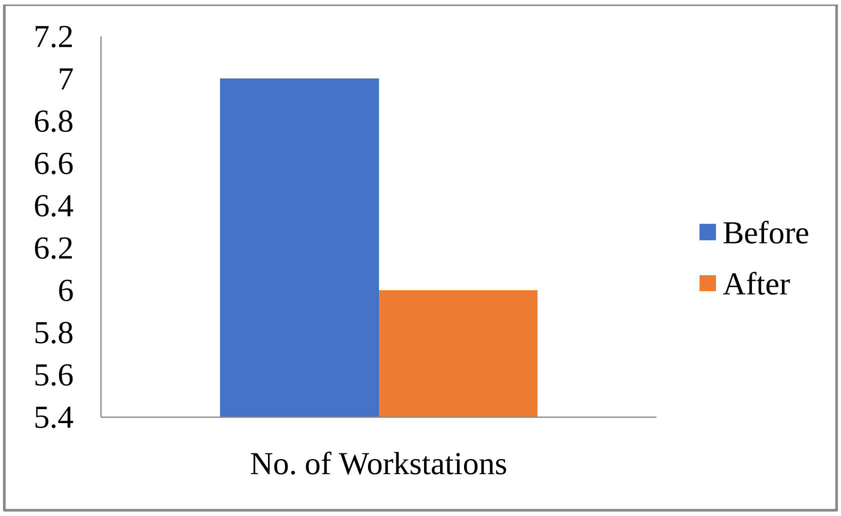

Fig. 6.3: No. of workstation before and after line balancing

6.4 BALANCE DELAY AND LINE EFFICIENCY

Balance delay define as, it is a measure of line efficiency which result from ideal time due to imperfect allocation of work among station.

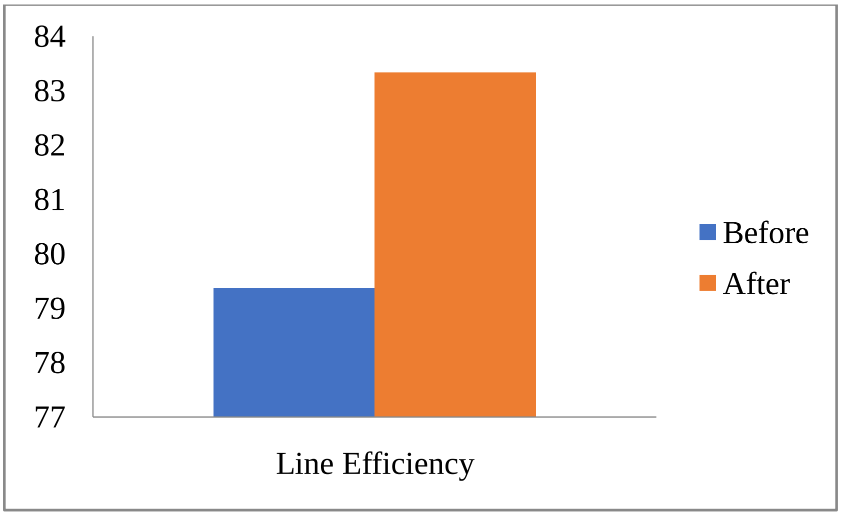

Fig. 6.4: Line Efficiency before and after line balancing

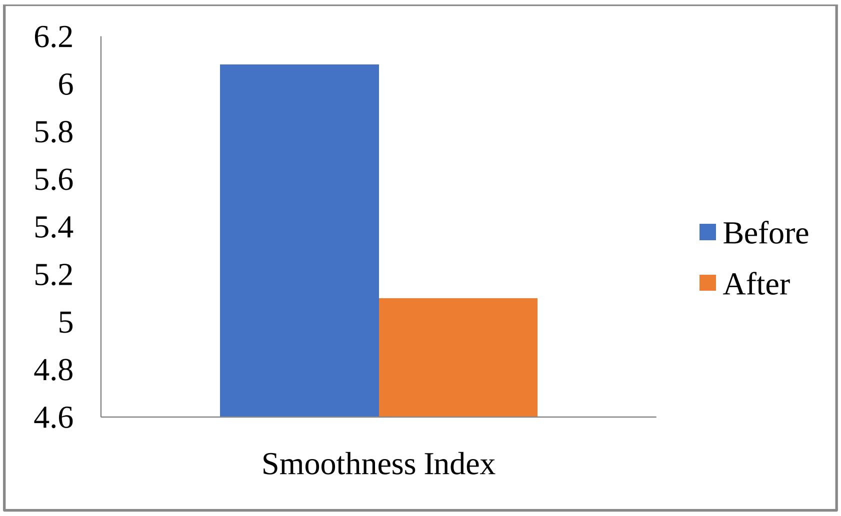

Fig. 6.5: Smoothness index before and after implementing RPW

6.5 PRODUCTION DATA FOR THE EXISTING ASSEMBLY LINE BEFORE AND AFTER IMPLEMENTING RPW

We have compiled the entire data of the existing assembly line.

Table 6.1: Comparison of results before and after line balancing using RPW

S.No	Parameter	Present assembly line	RPW method
1	Cycle time (min)	12	10
2	Idle time (min)	29	18
3	Line efficiency %	79.36	83.33
4	Smoothness index	6.08	5.099
5	Balance delay %	20.64	16.67
6	Production rate per day	35	40
7	No. of workstation	7	6

6.6 PRODUCTIVITY MEASUREMENT

After the analysis of performance parameters such as on time deliveries, the productivity measurement has carried out for selected housing component. Productivity has measured in terms of labour, machine and material. The table 6.2 indicates analysis of labour productivity, machine productivity and material productivity. After measurement of productivity it is observed that, labour productivity improved by 20 %, machine productivity improved by 14.06 %.

Table 6.2: Analysis of Productivity

Type of Productivity	Before Line Balancing	After Line Balancing	Percentage of Improvement
Labour Productivity	5	6	20 %
Machine Productivity	5.26	6	14.06 %

7. CONCLUSION

Line Balancing brings a new measurement to control philosophy and affords a followed inside an extensive type of organizations and settings; it seems that organizations using line balancing has determined that it can assist them acquire some of management objectives, inclusive of continuous improvement. With the aid of application of line balancing it's far viable to enhance productivity by means of improving on time offers, reducing inventory degrees and better utilisation of sources.

The main purpose of this work is to represent use of RPW technique to develop the assembly line and balancing that line. With this study it is found that RPW method is useful while the much less facts are to be had. Once more with the help of RPW technique, one could find out the way to synchronise the work stations for the work flow and sequencing. So the bottlenecking of the assemblies can be decreased

After implementation of line balancing, the analysis gives following results.

1. As the calculated cycle time C = 10 min per unit every work station should have cycle time of 10 or less than 10 minutes. So on each work station process should be in such a way that summation of time required to process the elements should be equal or less than cycle time 10 minutes. Hence cycle time is 12 min before and after it is 10 min.
2. Idle time is reduced from 29 min to 18 min after implementing RPW.

3. The actual number of workstations is 7 but the ideal number of workstations is 5. It means that ideally we can work with theoretical minimum workstations as 5 but we are unable to pack the individual work elements into 5 workstations due to their individual values. It is going up to 6.
4. Line efficiency is improved from 79.36 to 83.33 % after implementing RPW.
5. Smoothness index is proved from 6.08 to 5.099 after implementing line balancing
6. After implementation of line balancing the labour productivity increased by 20 %, and machine productivity increased by 14.06 %

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