Vol. XV & Issue No. 08 August - 2022
INDUSTRIAL ENGINEERING JOURNAL

MANPOWER OPTIMIZATION IN ASSEMBLY LINE USING MUDA: A CASE STUDY

Dr. Annam Sunny kumar

V Jaya Prasad

B. Divakar

K Tarun Naidu

Abstract:

Our main aim is to understand operations performed concerning the time taken in their assigned station to reduce the overall transportation time by combining different functions or removing machining errors to minimize cycle time and workforce involved. The process improvement activity achievement depends not only on the redesign of the layout but also on the operator's utilization. Their position arrangement was made by taking the manpower occupancy on machinery, minimizing idling time, and changing the work sequence. This study adopts various multi-elimination strategies that combine manpower occupancy on machinery, lean manufacturing, line balancing, and layout improvement to improve the product BUSH315 assembly line of manufacturing company for the automobile industry. A comprehensive methodology is adapted to systematically investigate and analyze the current waste elimination of manufacturing firms. A pilot study of the assembly line is done to estimate line imbalance. This is followed by waste (MUDA) identification and elimination and de-bottlenecking to balance the Line, optimize resource utilization, and promote lean thinking.

Keywords: man power optimization, time study, line balancing technique, TIMWOOD wastes(MUDA).

1. INTRODUCTION

Manpower utilization is a two-phased process because manpower planning analyzes the current human resources, makes manpower forecasts, and draws employment programs. Manpower utilization is advantageous to the firm in the following manner: Shortages and surpluses can be identified to take quick action wherever required. It also reduces the labor cost as excess staff can be identified, thereby overstaffing can be avoided. It also helps identify the available talents in concern, and accordingly, training programs can be chalked out to develop those talents. Efficient utilization- Efficient management of personnel's becomes an essential function in today's today's industrialization world. The setting of large scale enterprises requires the management of large scale manpower. It can be effectively done through MANPOWER utilization. The original seven Muda techniques Transport, Inventory, Motion, Waiting, Overproduction, Over-processing, Defects.

2. LITERATURE REVIEW

The following are the previous research review based on labor optimization and increasing line productivity

S. K. Subramaniam, S. H. Husin [1] studied machine efficiency and manpower utilization on production lines. He stated that production lines' efficiency is crucial as it results in improved Production and utilization of available resources. He stated that the supporting departments play a vital role in maintaining a consistent work pace on the industrial shop floor. He calculated machine efficiency, performance, OEE, quality, manpower utilization, and performance to support the department through an analytical approach. Hence, he concluded that OEE brings to light all valuable information required by the management. Production data should be very well interpreted and fully utilized to optimize available resources within the industrial sector. Through this approach, wastage reduction and increase in production yield are obtained, and by taking these necessary steps, industries can improve and maintain more efficient production lines

Shriram Sane, Varsha Karandikar [2] has conducted a study on Assembly line Balancing: A Case Study in Silencer Manufacturing; He studied that Many industries face many problems like inability to meet production targets, imbalance of work content at work stations, discontinuity in material flow, manpower allotment. In this paper, he proposed designing to evaluate the performance, bottleneck identification, reduction in bottleneck cycle time, minimizing line imbalance, workstations organization, reduction in manpower and space-saving, increasing manpower utilization of industrial production assembly line are discussed. Hence his results are carried out by layout improvement in% is achieved for the line balancing as it reduced to 47%. Also, manpower reduction is possible

Prashant Uttam Bagal and Rahul Desai[3] studied Line Balancing on AUDI B8 Cable Assembly Line using MUDA: A Case Study. This paper adopts various approaches combining lean manufacturing, line balancing, and layout improvement to effective improvements in the HVAC productivity (Heating, ventilating, and air conditioning) AUDI B8 Cable assembly line of cable assembly manufacturing company for the automobile industry. Modification in the layout is affected by switching over from batch and queue system to single-piece flow. The results of the implementation are summarized in the conclusion part of the paper

J.J.Kathiriya, V.D.Amareliya, S.H.Kapadiya [4] has conducted a study on Production Process Analysis on Manufacturing of Hydraulic Gear pump; He did man-machine utilization by using man-machine utilization charts and some brief calculations and also focused on improving the material handling in the industry by implementation of G.T. (Group Technology) layout as they are mainly focused on the manufacturing of Gear Pumps of different specifications with bulk Production

Amardeep, T.M.Rangaswamy Gautham j [5] has conducted a study on Line Balancing of Single Model assembly Line; He proposed that the Line balancing is an effective tool for the throughput of assembly line while reducing non-value-added activities, cycle time. L.B. is the problem of assigning operations to a workstation along an assembly line so that assignment is optimal in some sense. In his paper, he mainly focuses on improving a single model assembly line's overall efficiency by reducing the non-value-added activities, cycle time, and workload distribution at each work station by line balancing.

3. METHODOLOGY

The methodology used for the Improvement is given below

- A pilot study of the BUSH38 assembly line.
- Bottleneck identification and elimination.
- Line balancing and resource optimization.

3.1 Pilot study of the BUSH38 assembly line

The line balancing technique must know the no for workmen in product operations from raw material to finished goods to know the optimum usage of workmen. As there are 122 varieties of bushes are produced for months, I have taken BUSH38 as a part of my study. The operation chart with cycle times is taken and Takt time calculated to know the theoretical workmen obtained for that product to be delivered. The operations of BUSH38 for study are shown in table 3.1.

Table 3.1: Operations of BUSH38 in all the stages with cycle times.

Operations	Task Description	Cycle Time(Min)
20	Blanking	0.8
30	Drilling	3.5
40	Facing-boring-turning-chamfer	1.9
50	Facing-turning-boring-grooving-chamfer	2.1
60	Induction hardening	0.4
70	Tempering	0.13
80	Od Grinding	0.6
90	Hard boring	1.3
100	Final inspection- packing	1
	Total time	11.73

The operations of the BUSH38 were given in the above table to know the one by one process to be performed at different stages of the product to be completed. The pilot study of BUSH38 was taken, and the overall distances and time study has done to know the cycle times of each workstation and remaining times to identify the wastages and workmen utilization on that particular Machine are observed to understand the desired optimization of resources.

In this process, when the product moves from one operation to another operation, large waiting times are observed. It leads to a large inventory and works in process(WIP). Mainly, the operator's ideal times are more observed in the whole assembly line. To optimize manpower, the study is undergone. Time study is a direct and continuous observation of a task, using a timekeeping device (e.g., decimal minute stopwatch, computer-assisted electronic stopwatch, and videotape camera) to record the time taken accomplish a mission, and it is often used. There are repetitive work cycles of short to long duration, a wide variety of dissimilar work is performed, or process control elements constitute a part of the cycle.

3.2 Bottleneck Identification & Elimination

In time study the observations. First of all, to know each station's production capability, a detailed cycle time study at each workstation is carried out. A cycle time study is done for five repetitive cycles of a particular operation. In this manner, the overall operations cycle time are taken then divided into machine time and manual time.Then, activities are sorted in V.A. (Value added), NNVA (Non-Value added activity)/PNVA (Partially nonvalue added activity) activities. NNVA activities are focused on eliminating or reduce, and NVA activities are focused on eliminating. A walk-through on the BUSH38 assembly line enabled us to understand the process of work content (manual and Machine), the sequence of operations, and cycle time on each workstation. A detailed time study accurately estimated production possibility and the extent of line imbalance. Cycle time was recorded for five cycles. Based on the monthly demand, Takt time for present demand and target rate (Takt time for future demand) were calculated are shown in Table 3.2

3.3 Line Balancing & Resource Optimization

Line balancing is a common technique to solve problems that occurred in the assembly line. Line balancing is a technique to minimize imbalance between workers and workloads to achieve the required run rate. This can be done by equalizing the amount of work in each station and assign the smallest number of workers in a particular workstation. Here the job is divided into a small portion called job element .for that. The time study was done to know each operation's overall cycle times with all the necessary activities shown in table 3.3.

Manpower utilization is useful when the actual manpower from time cards/time sheets is very close to the "earned" man-hours calculated for the same period as the time cards. These two numbers will never be the same; in other words, it is not possible to achieve one hundred percent manpower utilization because there are always factors not included in the schedule, such as lunch breaks, time to prepare to leave the job site, unexpected delays such as evacuations, accidents, bad weather, etc.

Man total output = (real production output x manual time per piece) × 100

Man occupancy on machine = {(Man total output) /(total shift time) } *100

Table 3.2 Present Method Time study analysis for total operations in line balancing

S.No	Machine No	Part No	Operation	Cycle Time(Sec)	Machine Time(Sec)	Manual Time(Sec)	Man Power occupancy on Machine (%)
1	11101	BUSH38	20	49.94	48	5.146	10.45
2	11809	BUSH38	30	216.6	210	62.4	28.64
3	11803	BUSH38	30	217.2	210	60.3	24.03
4	11812	BUSH38	40	117	114	23.458	18
5	11813	BUSH38	50	129.6	126	26.678	20.39
6	20201	BUSH38	60	27.75	24	6.33	15.2
7	20205	BUSH38	70	8.47	7.8	2.64	17.27
8	14401	BUSH38	80	38.94	36	15.778	34.72
9	11811	BUSH38	90	88.74	78	45.12	48.02
10	Inspection PMP	BUSH38	100	68.4	60	77.4	49.63

The above table shows the overall summary of the present data taken from the time study of the product BUSH38. The manpower occupancy on machinery is calculated and listed in the percentage form is shown in the above table. Hence, in this study, men's utilization can be better by combining the operator's two operations activities. The research is done in the proposed method.

Table 3.3 Present Method MUDA identification has been listed in a table by listing out the overall cycle times

Operation Sequence	No of Operators	Machinery Workstations	(Cycle time(Sec			(Wastages(MUDA							Utilization (%)
			VA	NVA		T	I	M	W	O	O	D	
			C.T	M.T	T.T								
20	1	1	48	5.146	53.146	x		x					10.45
30	1	1	210	54.03	264.03	x							28.64
30	1	1	210	48.5	258.5	x	x					x	24.03
40	1	1	114	53.2	169.45	x			x				18
50	1	1	126	38.67	164.67	x	x		x				20.39
60	1	1	24	28.33	52.33	x	x	x		x			15.2
70	1	1	7.8	12.61	20.414		x				x		17.25
80	1	1	36	47.77	83.77	x	x		x				34.72
90	1	1	78	63.12	141.12	x			x			x	48.02
100	1	1	60	32.13	92.13								49.63
Total	10	10	703.8	595.45	1299.25								
Maximum cycle time					264.03								
Through output time					1299.25								
Line of Balance					49.20%								

In this muda technique, the wastages TIM WOOD are identified mainly the transportation takes more time in these assembly lines from one operation to other and some waiting times are observed in the above table and carried by unnecessary motions, overproduction, and manpower consumption are kept in the above table.

3.4 Layout Modification

After identifying the wastages in the present method, the Muda technique is implemented to determine the wastages and bottleneck operations, as shown in table 3.3. The reduction in wastages by using a line balancing technique to improve productivity and line balancing efficiency.

Table 3.4 Proposed method time study is carried out the total operations in line balancing

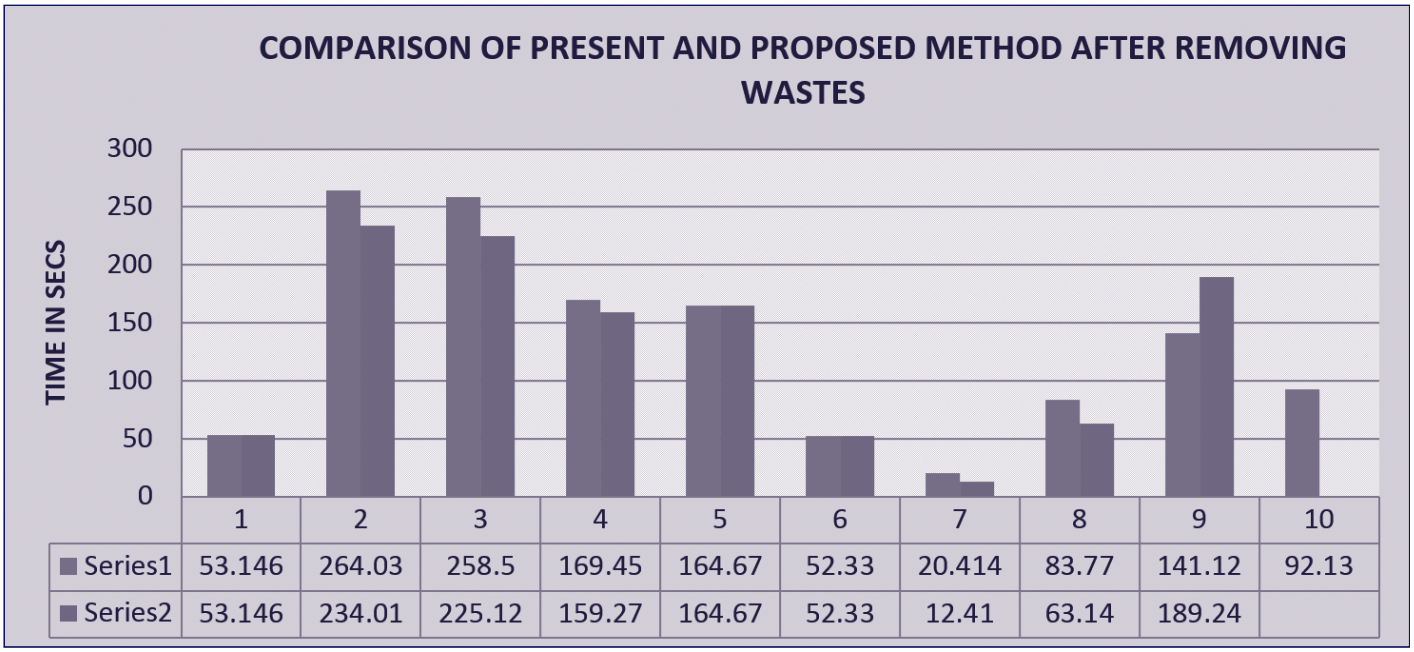
S.No	Machine No	Part No	Operation	Cycle Time(Sec)	Machine Time(Sec)	Manual Time(Sec)	Target output per shift	Man Power occupancy on Machine (%)
1	11101	BUSH38	20	49.994	48	5.146	216	10.28
2	11809	BUSH38	30 & 30	216.6	210	60.6	113	56.92
3	11810			217.2	210	60.3	113	
4	11811	BUSH38	40 & 50	117	114	23.458	216	53
5	11814			129.6	126	26.678	216	
6	11823	BUSH38	60 & 70	27.758	24	6.33	216	44.09
7	11826			8.47	7.8	2.64	216	
8	14401	BUSH38	80	38.94	36	15.778	216	40.28
9	11824	BUSH38	90 & 100	88.74	78	45.12	216	98.2

The main wastages are observed while transporting material from one function to another operation and other wastes identified in the TIM WOOD technique. The time study analysis is done on each process, and the distance between is shown in table 5.1.3 identification of the wastages. An improvised method is done after implementing the line balancing, and the muda technique is shown in table 5.5 by assigning TIM WOOD. The reason for the waste occurred, and the improved code is given as in table 5.5

Table 3.5 Proposed Method MUDA identification has been listed in a table by listing out the overall cycle times

Operation Sequence	No of Operators	Machinery Workstations	(Cycle time(Sec			The action was taken Improvement in codes	Elimination of wastes	Manpower (%) Utilization
			VA	NVA	T.T			
20	1	1	52.13	1.016	53.146	B	I,W	10.19
& 30 30	1	1	219	15.01	234.01	B,C	T,M,I,W	56.92
		1	217	8.12	225.12	A		
& 40 50	1	1	134.2	25.06	159.27	A,B	T,M,I,W	40.25
		1	146.52	10.15	164.67	C		
& 60 70	1	1	30.12	8.13	52.33	A	T,W	53.15
		1	8.2	4.21	12.41	B,C		
80	1	1	51	12.14	63.14	B	W	40.13
& 90 100	1	1	147	42.24	189.24	A,B,C	T,M,I,W,D	98.13
Total	6	9	1005.18	126.07	1131.25			
Maximum cycle time					234.01			
Through output time					1131.25			
Line of Balance					53.71%			
Improvement code								
A: Elimination of unnecessary motions								
B: Reduction in material handling and distances								
C: Relocation of Machinery for continuous operations balancing								

3.5 Comparison of present and proposed methods by implementing Muda Technique in line balancing



The bar diagram showing the comparison of the before and after the Line balancing total cycle times by eliminating the wastes are shown in the chart

The cycle times of each operation are taken, and the related activities in this process are also taken, such as transportation, waiting, and inventory. The present method throughout put times is 1299.25secs. Bottlenecking workstation 30 operation cycle time is 264 sec identified, which is a major cause for the whole assembly line to maximize it by eliminating unnecessary wastes in that particular operation and getting the target of 650 per shift operation 30 is identified as bottleneck workstation. Two machines, the unnecessary motions, and transportation waiting times are reduced and increased productivity by implementing one operator. Similarly clubbing is done for operations 30 & 30, 40 & 50, 60 & 70, 90 & 100 here work content can be added & no. of workstations can be reduced. After line balancing technique implementation and Muda technique to eliminate wastes are applied in proposed method gives the results in an increase in productivity as the through output time comes down to 1131.25 sec and in operation 30 is 234secs where maximum cycle time is reduced to some extent to get the best results out of it. Particularly in 90 and 100 operations, the 100 operation consists of final inspection and packing, eliminated in the Line by arranging all the inspection tools in the last preceding operation 90. In this way, 52.3 sec are detected, and similar activities are eradicated in 90 operations.

Further reduction in cycle time at various operations can be achieved by eliminating waste at individual workstations. For instance, shifting the sub-assembly station next to workstation 1 eliminates material handling and operator movement. All such improvements at all workstations are summarized in the Line's current layout and the manpower utilized at each workstation with a double exit. As the demand is high, it cannot cater to the single door (10 operators); hence, this Line always runs dual entry (10+10 operators) the proposed line layout after modifications. After clubbing BUSH38 and manpower activities' operations, the design is modified to reduce material handling and operator movement. After studying and analyzing the initial state, a line balancing tool is used. It is made sure that line imbalance is reduced and seven wastes (TIM WOOD) have been taken care and line balance efficiency has been increased to 4 %. Also, Manpower optimization is possible, and material handling and operator movement are reduced.

Improvements	Before	After	Saving	% Improvement
Manpower	10	6	4	40
Production per shift	199	227	28 (increased)	14
No of workstations	10	9	1	9
Total cycle time in sec	1299.25	1131.25	168	12.93
Maximum cycle time in sec	264.03	234.01	30.02	11.34
Line of balancing	49.20	53.71	4.51	4.51
Monthly cost of labour	95000	57000	38000	39.9

Hence by implementing the line balancing technique and MUDA principles, the workmen optimization is shown in the above table 5.7, which reduces manpower from 10 to 6. By implementing MUDA (TIM WOOD), the maximum cycle is reduced from 264.03 to 234.01, and also by eliminating all the wastes in the total trough output time reduced from 1299.25 to 1131.25. the line balance efficiency also increased by 4%.

4. CONCLUSION

The manpower utilization in the Assembly line is very crucial in the manufacturing sector nowadays. The assembly line needs to balance so that the Line has a high value of efficiency. The higher value of line efficiency indicates that the Line has approximately equal cycle time between operators. Besides that, the workload between operators is also distributed equally, which makes higher line efficiency. In this study, the time consuming to assemble the product of overall operations are entirely taken. This study shows that the value of line efficiency has increased after the redesign of the machinery line layout takes place. It is evident from the improvements effected that practical Line balancing problems often need an in-depth investigation of work content on the entire Line to find practical solutions that are usually found by rearranging the work content across workstations, merging the workstations. The basic principles of lean such as waste (MUDA) identification/elimination, cellular approach, and layout modifications, further supplement the productivity improvements. The benefits derived from all improvements are Continuous material flow, Reduction in WIP onLine, Improved workstation condition, Reduction in Manpower, Achieving Target Production Rate, Minimizing Line imbalance. The total operation time per component was reduced, contributing to a slight increase in the total number of members completed per month. Another aspect that was significantly reduced was the transportation time of the component from one station to another. This was mainly done by changing the plant layout. Once the plant layout was altered, manual transportation was eliminated, eliminating the manpower needed for the vehicle. Hence the overall resource optimization can be done in assembly-line by these techniques implementation.

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AUTHORS

Dr. Annam Sunny Kumar, Asst. Director, Directorate of Academic Affairs & Assistant Professor, Department of Mechanical Engineering, GITAM UNIVERSITY, Gandhi Nagar, Rushikonda, Visakhapatnam -530 045, (AP)
Email: sannam@gitam.edu

V Jaya Prasad, Department of Mechanical Engineering, Jawaharlal Nehru Technological University, Kakinada - 533 003, (AP)
Email: prasad.vjp@gmail.com

B. Divakar, Department of Mechanical Engineering, GITAM UNIVERSITY, Gandhi Nagar, Rushikonda, Visakhapatnam – 530 045, (AP)
Email: divakar.iitg@gmail.com

K Tarun Naidu, Department of Mechanical Engineering, GITAM UNIVERSITY, Gandhi Nagar, Rushikonda, Visakhapatnam -530 045, (AP)
Email: tarunnaiduk0@gmail.com,