A Case Study of Service Firm to Optimize the Cycle Time – Advanced Lean Techniques to Design Plant Layout

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Abstract

Plant layout and design plays a very important role in the design and engineering phases of any industrial facility. Implementation of lean manufacturing principles and believing in continuous improvement are the tools which help industries to sustain global competition. With the escalation in population, the demand for technology is increased more than ever. This leads to the steady increase in production rates of existing models and even introduction of new product models. These factors often results in "layout modification" of manufacturing industries. This study simplifies the application of systematic layout planning in the development of new layout. It is a technique used for layout development and material flow improvement. The results include five possible rearrangements of production departments. These layout alternatives are evaluated on basis of improved accessibility and material flow efficiency criteria. Hence in order to study and modify a service sector plant (Zonal Workshop APSRTC Vizianagaram) has been chosen to carry out the project further.

The main aim of study is to understand operations performed with respect to time taken in their assigned station in order to reduce the overall transportation time by either combining different operations , removing machining errors or removing idle stations to reduce the cycle time as well as man power involved. The process improvement activity achievement not only depends on the redesign of the layout but also involves operators' utilization and their position arrangement. The relation between them was computed by taking the man power occupancy on machinery calculations, minimized idling time and changing the work sequence. This study adopts a multifarious approach combining manpower occupancy on machinery, lean manufacturing line balancing and layout improvement in productivity on the product. A comprehensive methodology is adapted to systematically to investigate and analyzes the current situation of wastes elimination of the manufacturing firms. This is followed by waste identification (MUDA) and elimination of unnecessary resources to balance the line and optimize the cycle time and promote lean thinking

Keywords : Lean framework, Plant design, cycle time

INTRODUCTION

Production improvement in the any sectors depends upon 5M like man machine material, methods and management. To balance all 5M in the way of customer satisfaction is very important. Basic terms to reduce wastage of cycle time study with various parameters and standard work formats is used by Toyota production system (TPS), TPS is the world's one of the best production improvement method. The production system developed by Toyota Motor Corporation to provide best quality, lowest cost, and shortest lead time through the elimination of waste. Waste ("muda" in Japanese) is 'anything other than the minimum amount of equipment, materials, parts, space, and worker's time, which are absolutely essential to add value to the product.' by shoichiro toyoda founder of Toyota

Cycle time is one of the important data for the line balancing at any production line. Cycle time is the time it takes to finish one product or the total of time takes before the product leaves the workstation and move to the next workstation. The cycle time required to process a customer order might start with the customer order and end with the order being delivered. The overall process is made up of many sub-processes such as order entry, assembly, inspection, packaging, and delivery.

Line Balancing

Line balancing can be defined as the process of assigning tasks to work stations in such a way that the work station have approximately equal time requirement. The task that assign to each workstation must fulfil the equal time requirement. In other words the workloads at each work station must be same and the time consuming during the assembly line process is also equal to at each work stations. Productions departments can be gladly satisfy with the assembly line if the line can be achieving higher level of line efficiency. The higher the level of efficiency indicate that the line implemented by the company are the best line for production process and also produce higher outputs in the specific given time. Meanwhile, the line that had lower line efficiency need to be study and troubleshoot to find the causes of the problem. Once the root cause was found, the corrective and improvement action such as redesign the assembly line layout or re-arrange the work sequence must be done.

Line balancing and sequencing is one of the core area for optimization study in operations management. The main aim of this analysis is to improve layout in a manufacturing unit with clear focus on improving productivity.

Thus, we used line balancing technique to achieve:

1. The minimization of the number of workstations 2. The minimization of cycle time 3. The maximization of workload smoothness 4. The maximization of work relatedness.

Research Questions

- How does the work station design process work today in the different plants?
- Which actors are involved in the work station design processes?
- What different aids are available throughout the work station design process?
- What are the limitations of the workstation design process as of today?

•Which factors are measured in workstation? Safety, Quality, Delivery, 3M (Muri, Mura, Muda)

Purpose and Goal

The purpose of this research is to map what formal and informal design processes that exist within the organization regarding work station design and investigate to what extent they can be rectified. The Goal is to propose a structured Lean Work station Design Process where the operator is put in focus, to produce sound quality of products with optimum travel time and cycle time.

- Improve quality: To stay competitive in today's market place, a company must understand its customer's wants and needs and design processes to meet their expectations and requirements.
- Elimination of wastes: Waste is an activity that consumes time, resources, or spce but does not add any value to the product or service.
- Reduce time: Reducing the time takes to finish an activity from the start to its finish is one of the most effective ways to eliminate waste and lower the costs.
- Reduce total cost: To minimize cost of product as well as the cost of labour also plays a very important role in reduction of total cost.

LITERATURE REVIEW

S.K Subramanian et.al. aims to improve the production and utilization of available resources by combining all the supporting departments. He considered factors contributing to production line efficiency are manpower utilization and machine efficiency which should be on line, accurate and truthful, By measuring machine efficiency and manpower utilization he calculated their individual supporting department performances which are involved in the production process helps in optimizing and reducing wastages and hence increase in the production yield. Amardeep,T.M.Rangaswamy, (2013)[2] In this paper they stated the Line balancing is an effective tool to improve the throughput of assembly line while reducing non value-added activities, cycle time. This paper mainly focuses on improving overall efficiency of single model assembly line by reducing the non-value added activities, cycle time and distribution of work load at each work station by line balancing. Identifying the non-value added activities in cycle time, calculating total work load n station and distribution of work load on each workstation by line balancing, in order to improve the efficiency of line. **Prashant Uttam Bangal and Rahul Desai (2015)[3]**This paper adopts a multifarious approach combining lean manufacturing, line balancing and layout improvement a effective improvements in the productivity on the HVAC (Heating, Ventilating and Air Conditioning) AUDI B8 Cable assembly line of cable assembly manufacturing company for automobile industry. This is followed by waste (MUDA) identification and elimination and de-bottlenecking to balance the line and optimize

utilization of resources. Modification in layout is effected to switch over from batch and queue system to single piece flow. **Shriram Sane,Varsha Karandikar (2014)[4]**Many Industries are facing lot of problems like inability to meet production targets, imbalance of work content at work stations, discontinuity in material flow, manpower allotment. In this paper, the design 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. The silencer assembly line is studied in this paper which assembles four products. For line improvement purpose, various Lean Manufacturing tools are employed such as cycle time study, line imbalance calculation, bottleneck identification, Kaizen, Space Utilization throughout layout change. **Daram virsinh Parmar, DR.Prashant Makwana(2012)** Humans are considered as the most crucial, volatile and potentially unpredictable resource which an organization utilizes. Manpower planning seeks to make the links between strategy, structure and people more explicit. The purpose of manpower planning is to get a better matching between manpower planning is particularly suitable for the application of statistical techniques. The aim of this paper is to review the models which have been developed, concentrating on their assumptions and applications. **J.J.Kathiriya, V.D.A.Amareliya (2014)[1**]In this paper study on Manufacturing Firms sometimes suffers from Productivity, Low Production rate and Delivery problems. Production times are the top priority at every manufacturing firm, and each firm wants to minimize it as much as possible to deliver their products on time to time their valuable customers. Some of the biggest times eaters in the industry are setup time, Manufacturing time, Material handling time, and wait time. **Aasheet Kumar, Gaurav Chaudhary (2014)[3]**As the customer needs products at higher quality, shorter delivery time, higher customer service level and lower price, companies adopt continuous productivity and quality improvement to survive in the increasingly competitive world market. To cater to this, line balancing and kaizen are effective approaches to improve the productivity and quality. This paper has made use of these approaches to improve the productivity on a wire harness assembly line of a company manufacturing wire harness for automobiles. Here, the balance rate has been calculated before and after improvement to show the reduction in manpower requirement and increase in output. **M. Mohd Hafizuddin, N.K Ahmad Nazif(2012)** In this paper he stated about the Assembly line need to be design properly base on the types of product, workloads required, numbers of daily production as well as others element. This paper focuses on the line balancing study in one of the automotive component manufacturer company located in Selangor, Malaysia. Data obtained from the observation of the assembly process parallel with the time study. The existing assembly line layout is straight line. Then the company redesigns their assembly line layout to U-shape as part of the process improvement activity. Cycle time for each assembly process for both before and after improvement is taken and been analyzed to get the line efficiency value. From the result, company may

compare and identify which type of assembly line suit with their target and provide better performance. **P.Vidyut Chandra, Medisetty Sai Charan (2013)[1]**In this paper he stated that the line balancing and sequence are most useful techniques for conducting optimization study on shop floor production layout. In today's technological production environment all organizations are striving to implement lean manufacturing system on the shop floor to achieve productivity enhancement to global benchmarks. He concluded that any trial and error approach during line balancing may provide initial results but any further scope for improvement in future is not possible. So the main aim to study is to understand operations performed with respect to time by either combining different operations or any removing machining errors to reduce cycle time as well as manpower involved. This also provided an opportunity on shop floor for better space utilization with better organized look. **Khalil A. E1-Namrouty, Mohammed S. Abu Shaaban (2013)** The research paper aims to investigate and analyze the current situation of wastes elimination of the manufacturing firms in Gaza Strip and its important role for reducing the production cost, in addition it aims to promote lean thinking through studying the seven wastes that are targeted by the lean manufacturing philosophy. Waste Relation Matrix was implemented to analyze the effect of each waste on the other six wastes.

Case Study

The thesis is carried out in ZONAL WORK SHOP (APSRTC) which is a government organization and one among the oldest work shops of the firm. There are around two such service firms in Andhra Pradesh one of which the project is carried out is in Vizianagaram and the other one is in Vijayawada.

Brief account of Vizianagaram Zone (APSRTC): Andhra Pradesh State Road Transport Corporation (APSRTC) is the major public transport system operated by fleet of buses. Vizianagaram is one of the 7 zones and one of the 23 administrative regions headed by General Manager of APSRTC. Keeping in mind the need to decentralize the authority, the zonal setup was introduced in November 14, 1994, which is the second level in the hierarchy. The APSRTC has been divided into seven zones with head quarters at Hyderabad, The total number of zones like Hyderabad, Greater Hyderabad Vijayawada, Karimnagar, Cuddapah, Nellore and Vizianagaram. Each zone consists of 3 to 5 regions the Vizianagaram zone is sixth zone in APSRTC mostly in this covered rural areas like Vizianagaram zone consists of 3 regions i.e. East Godavari region, Visakhapatnam region and North East coastal region (VZM, SKLM). The Vizianagaram zone has its head quarters located in a historical city called Vizianagaram. Vizianagaram district is one of the Northern Coastal districts of Andhra Pradesh. The zone is bounded on the North East by the Odisha state, on the Southwest by Vijayawada RTC zone, on the SouthEast by the Bay of Bengal. The jurisdiction of Vizianagaram zone covered the

districts of East Godavari, Visakhapatnam, Vizianagaram and Srikakulam of Costal Andhra Pradesh. 91

There is a zonal advisory committee appointed by the state government, which not only reviews the implementation of various policy decisions taken by the corporate board but also takes decisions in respect of the items falling within its purview. The Chairman of the Zonal Advisory committee shall automatically become a member of the corporate board.

What is actually happening in the plant?

1. The major work that is carried out in the plant was Body Building & Retrieving of the vehicles under service and maintenance.
2. Vehicle gets dismantled and sent to various departments to get the parts conditioned, assembled finally followed by testing

Departments existing in the plant:

- Engine section
- Fuel injection pump setting section
- Machine shop
- Units section
- Stores
- Tyres retrieving section
- Body building section
- Electrical section
- Body painting
- Dumping yard

Since the tyres section is decentralized it is not dependent on number of vehicles that come for its service. As mentioned above there are many depots under its maintenance tyres from various places come in a bulk and gets retrieved. To carry out the project further tyres retrieving phase1 has been taken into account and layout has been modified to decrease the travel time and few operations where combined in one particular station.

Initially as per the life and condition of the tyre inspection is done and tyres are sent for the retrieving process and rest which are damaged completely meant to scrap.

Classification of scrap:

S1-Concussion burst, Impact burst

S2- RF Run flat burst

S3- Non Removal in time

S4- Bead Damage, Bead Crack

S5- Side wall Burst

S6-Patch Burst, major repair Burst/Injury extension

S7-Channel Cracks, Radial Cracks

S8-Thread Separation, Ply Separation

S9-1) Scoring Burst

2) BC Burst

3) Aging

4) Hard casing

5) Inner Cracks

6) Wires, Ply damage

3.12 Tyres retrieving operations:

3.12. i (Phase-I)

a) Buffing Section:

The older rubber on crown of the tyre is removed so as to build the new rubber thread uniformly on the surface. The Air pressure on the tyre should be maintained around 20PSI/1.4Kg/cm^2.Select the arc to buff the tyre as per the type of material such as nylon, radial and tube less.

b) Rasping:

Level the surface and deep cuts on the length of the tyre with the help of the rasper soon after the buffing operation. Clean the tyre with the help of the brush.

c) Filling:

Apply the bonding gum on the surface of the tyre thoroughly by place a new threaded rubber and allow the tyre to dry in air for about 35 to 45 min depending upon the atmospheric condition. Select the rubber thread as per the crown material.

d) Setting:

Setting of the tyre helps to set the position of the threaded surface accurately.

e) Body Building:

See that the pressure in the tyre is about 20PSI/1.4Kg/cm^2 and allow the tyre to penetrate into the machine so that the surface of the tyre would be firmly attached. Affix the bonding gum in low speeds only. Do not overlap the bonding gum over joint. Roll the bonding gum in high speed at low pressure. Roll the tyre for three times for firm fixation of the threaded surface.

f) Inspection: Helps to find the errors if any and tried to rectify in phase-I itself.

3.12. ii.Phase-II

Chamber Curing:

Cover the tyre with the help of the envelope. Be sure that the envelope used is in cool atmospheric condition. Check the curing rims and monitor chains for every two rounds. The pre inflation in the tyre should be around 15-20PSI and check the envelopes thoroughly. Maintain the air pressure 90kg/cm^2 in the curing chamber. After attaining chamber temperature of 125^{0}c retain the tyres for about 1 hr: 45 min. Check the pressure in the chamber for every 20min. open the valve after the mentioned time so that the excess air is released to the atmosphere through pipes. Open the chamber and unload the tyres to remove the envelope covers and let the tyres get cooled and finally sent for the inspection followed by dispatch.

The layout in phase I is chosen to be modified hence the project is concerned only with Phase-I operations and departments included in them.

METHODOLOGY

Since it is a service firm the damaged product is retrieved as a usable product. The firm consists of many departments and I have particularly chosen Tyres Retrieving section Phase (I) as it is decentralized and not dependent on the organization requirement, but instead dependent on the individual bus depots. There are various Depots under Zonal Workshop Vizianagaram region and repaired tyres are distributed to various depots under its control as per schedule mentioned by the organization. In order to know the optimum usage of workmen the line balancing techniques must be used to know the no of workstations along with workmen required to repair the product from its initial stage to final stage. The operation and travel times of the product from the present layout is taken and modified in order to optimize the total cycle time of product and provide better efficiency in the rate production.

4.1Outline process chart

An Outline Process Chart is a process chart which gives an overall view of a process by recording only the main operations and sequences in proper sequence. So it's obvious that such a chart requires only symbols for 'Operations' and 'Inspection'. A brief note of the nature of each inspection and operations is given below.

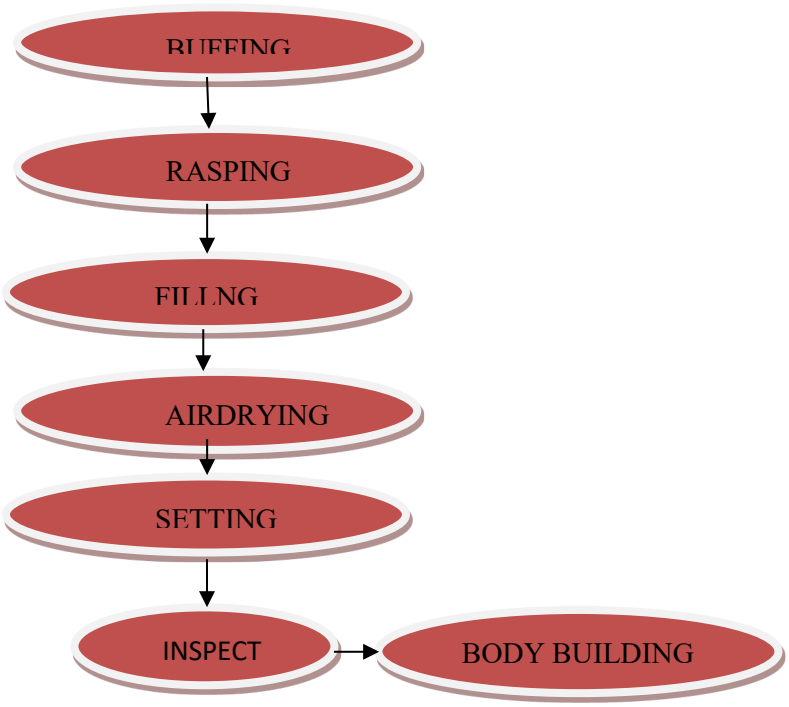

Figure.1: Nature of each inspection and operations

Time Study

Time study is a direct and continuous observation of a task, using a time keeping device (Example: Decimal minute stopwatch, Computer -assisted electronic Stopwatch and Video Tape Camera) to record the time taken to accomplish a task and it is often used. There are repetitive work cycles of short to long duration and wide variety of dissimilar works is performed.

i) Time Study Equipments

- Timing device time study observation sheet
- Time study observation additional equipments(Pencil, Easer, device like Tachometer etc)
- Stop Watch: It is the most widely used timing device used for time study.
- Electronic timer is also sometimes used as timing device.

ii) Time Study Observation Sheet:

- Name of Operation
- Drawing number
- Name of the worker
- Name of time study person
- Date and Place of study
- Spaces are also provided in the format for writing detailed description of the process (Element Wise).
- Recorded time/Stop watch readings

iii) a)Cycle time study: Cycle time study is done for five repetitive cycles of a particular operation. The overall operation's Cycle time are taken and then divided into manual time and machine time.

b)Operators Cycle time: Total time required for a worker to complete once cycle of operation.

c)Machine Cycle time: Total time for a machine to finish one complete cycle includes, loading and unloading time.

Man power occupancy on machinery

Measuring man power utilization sufficient production data is used in assisting operator of their performance to date. Apart from the data will also be able to guide the operator to maintain a consistent pace throughout the day will also be able to guide the operator to maintain a consistent pace throughout the day and this will result in a better implementation of work morale among the employees. Once the operators have been tuned to react according to the management's set goals, this will automatically eliminate wasted time and hence produce more units per hour. Essentially human capitalize nearly all the process on the industrial shop floor from the management to the layman. Visualizing an industrial environment which includes a big number of people from various departments working together in meeting the set goals. When it comes to unmet goals, fingers are not to be pointed to an individual, whereby the supporting departments in industries are another factor which should be taken in account for improving the production performance. By knowing their performance, the departments can be aware of the problems arising and counter measures can be taken to further improve their working quality.

Operators or workers utilization

Operators or workers utilization falls under man power utilization which includes any factors that cause the production process to operate at less then the maximum possible speed base on the time study or cycle time. The major factor on measuring the performance of human workers is the operators' inefficiency. Man power utilization is measured from the duration of actual operation time. For manual process lines, man power utilization is the ration of actual production output. For semi automated process lines, man power utilization is slightly different from where by the operators ideal cycle time is the minimum cycle time that the process can be expected to achieve under optimal conditions for a given process can be expected to achieve under optimal conditions for a given process. This is due to the combination of humans and machine to perform a specific task on the same work station. Man power utilization should be separated from the machine.

Man power actual production output

Manpower utilization is good 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 exactly the same, in other words, it is possible to achieve one hundred percent manpower utilization, because there are always factors not included in the schedule, such as breaks, time to prepare to leave the job site, unexpected delays such as evacuations, accidents, bad weather, etc..

$$\text{Man total output} = \frac{\text{total production output} * \text{manual time per piece}}{\text{Hour}} * 100$$

$$\text{Man occupancy on machine} = \frac{\text{mantotal output}}{\text{Total shift time}} * 100$$

Line Balancing

Line balancing is the process of assigning tasks to workstations, so that workstations have. approximately equal time requirements. We use line balancing to.
- minimize idle time.
- balance bottlenecks.

$$\text{Line balance ratio} = \frac{\text{Summation of each station average time}}{\text{Max avg time} * \text{no of stations}} * 100$$

DATA COLLECTION FOR TIME STUDY ANALYSIS

Table.1: Time study analysis ofPresent Layout

Dated : 24/07/2016 Operation : Buffing Shift : General Section : Tyres Retriving (Phase 1)						
Contents	t1,sec	t2,sec	t3,sec	t4,sec	t5,sec	Average
Receive & Pick Up	2.6	1.95	2.6	1.89	1.73	2.134
Loading	3.2	2.95	2.91	3.3	3.6	3.192
Operation time	8.61	8.26	8.11	8.14	8.16	8.256
Unloading	2.51	2.48	2.61	2.78	2.9	2.656
Cleaning	-	-	-	-	-	-
De Burring	-	-	-	-	-	-
Self-Inspection	0.228	0.281	0.271	0.254	0.259	0.258
Placing In	0.133	0.141	0.152	0.128	0.132	0.1372

Table.2: Time study Analysis of Proposed Layout

Dated : 12/10/2016 Operation : Buffing Shift : General Section : Tyres Retrieving (Phase 1)

Contents	t1,sec	t2,sec	t3,sec	t4,sec	t5,sec	Average
Receive & Pick Up	0.865	0.921	0.769	0.812	0.814	0.8362
Loading	3.2	2.95	2.91	3.3	3.6	3.192
Operation time	8.61	8.26	8.11	8.14	8.16	8.256
Unloading	2.51	2.48	2.61	2.78	2.9	2.656
Cleaning	-	-	-	-	-	-
De Burring	-	-	-	-	-	-
Self-Inspection	0.228	0.281	0.271	0.254	0.259	0.258
Placing In	0.135	0.136	0.157	0.124	0.139	0.1382

DATA ANALYSIS AND INTERPRETATION

Present Method

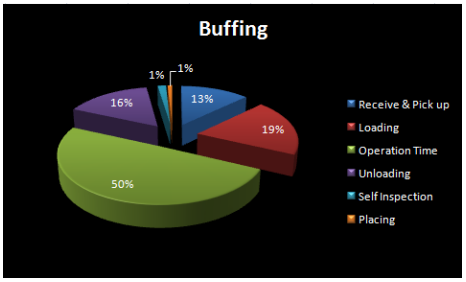

Figure.2: Cycle time distribution among sub-activities

Calculation of manpower occupancy: After the time study cycle time is categorized into manual time and machinery time in order to calculate products per shift.

MACHINEST NO : 114208	OPERATION :Buffing
Machinery time = 3.192+8.256+2.656 =14.104min	Manual time = 2.134+0.258+0.1372 =2.5292min
Cycle time/product= 14.104+2.5292 =16.63min	Products/shift(430min)=25.85 ≈ 26
Man total output = 26*2.5272 = 65.7	
Man occupancy = $\frac{65.7 * 100}{430}$ = 15.27%	

Table no: 6.1 Calculation of Manpower Occupancy in Buffing Section

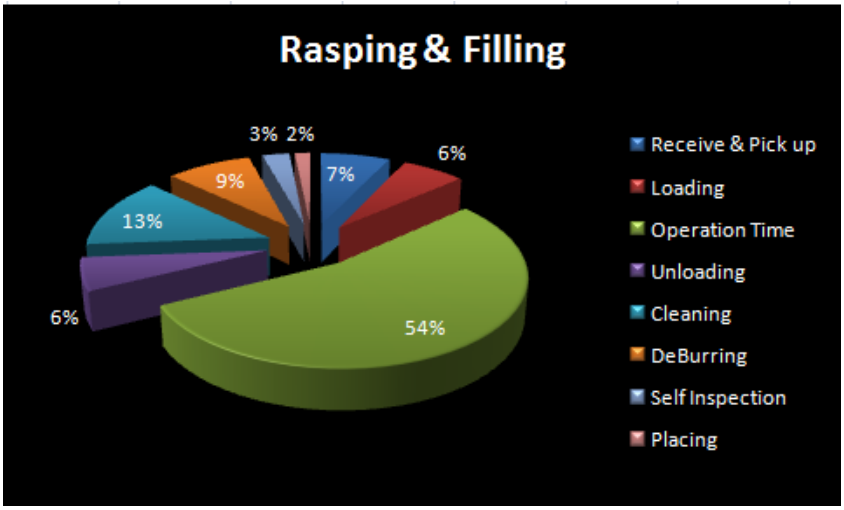

Figure.3: Pie diagram representation of the activities involved

Calculation of manpower occupancy: After the time study cycle time is categorized into manual time and machinery time in order to calculate products per shift.

Table.3: Manpower Utilization for present layout

<table>
<tr><td colspan="2">MACHINEST NO : 114208 OPERATION: Rasping & Filling</td></tr>
<tr><td>Machinery time = 1.828+15.342+1.714
+2.46
=21.34min</td><td>Manual time = 2.0106+3.74+0.786+0.4438
=6.9804min</td></tr>
<tr><td>Cycle time/product= 21.34+6.9804
=28.32min</td><td>Products/shift(430min)=15.18
≈ 15</td></tr>
<tr><td colspan="2">Man total output = 15*6.9807 = 104.71
Man occupancy = $\frac{104.71 * 100}{430}$ = 24.35%</td></tr>
</table>

RESULTS

Table no.4: Time study Analysis in present method

S. No	Operation	Employee ID	Cycle time (min)	Machine time(min)	Operation	Manual time(min)	Waiting time(min)	Machine time(min)	Manual	Man power Occupancy on machine (%)	Man power Occupancy on machine (%)
1.	Buffing	459741	15.334	14.104	Buffing	459741	16.63	14.104	2.5292	16.45	15.27
2.	Rasping & Filling	459743	19.55	15.62	Rasping & Filling	459743	28.22	13.24	6.904	35.710	24.35
3.	Air Drying	459737	38.61	-	Air Drying	459737	38.61	-	0.53	3.4	3.09
4.	Setting	108122	13.24	-	Setting	459741	13.24	-	14.428	0	46.97
5.	Body Building	450345	16.36	15.53	Body Building	450345	16.36	15.53	0.8392	0	12.73
6.	Inspection	114208	2.646	-	Inspection	459737	2.646	-	2.646	0	14.04

Comparison of cycle time from present method to proposed method

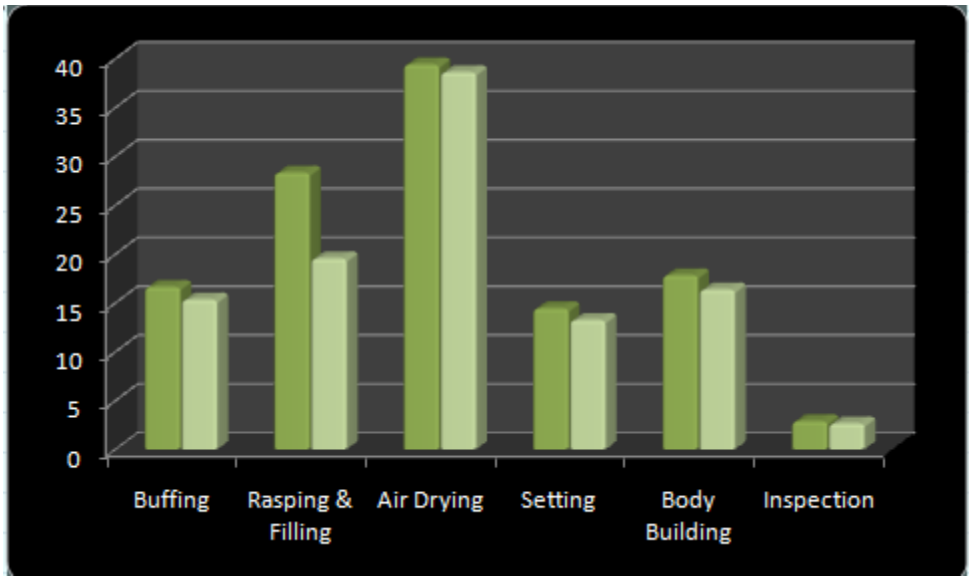

Figure.4: Graphical representation of the decrease in cycle time

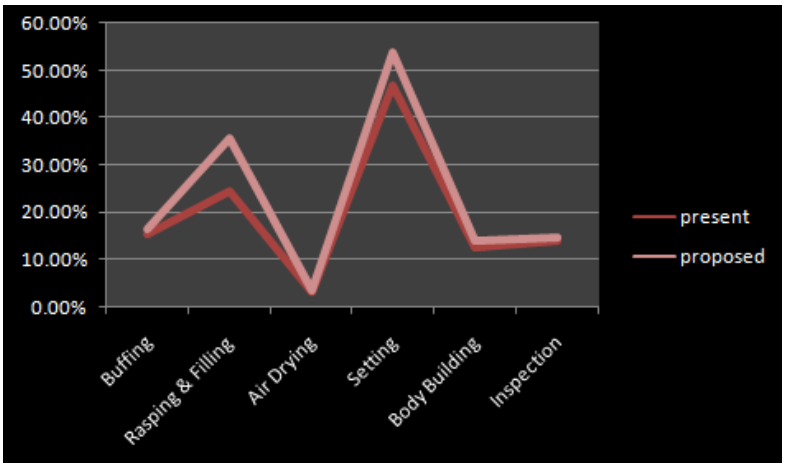

Figure.5: Graphical representationof the increase in Man Power Utilization

LINE BALANCING

Table no.5: Present Method of Line balancing observing wastes using MUDA

Operation sequence	No of Operators	Work Stations	Cycle time(min)			Wastages (MUDA)							Utilization (%)
			VA	NVA	T.T	T	I	M	W	O	O	D	
Buffing	1	1	8.256	8.374	16.63	●	●				●	●	15.27
Rasping	1	1	15.342	12.978	28.32	●		●			●		24.35
Filling	1	1											
Air Drying	1	1	38.08	1.3293	39.4	●			●				3.09
Setting	1	1	12.29	2.138	14.428	●			●				46.97
Body Building	1	1	12.79	5.024	17.814	●							12.73
Inspection	1	1	2.24	0.635	2.875	●							14.04
Total	7	7	88.998	30.478	119.47								
Maximum cycle time					39.4								
Throughout Output time					119.47								
Line Balance Efficiency					42.89%								

8.1 Calculation of Line balance efficiency

Maximum cycle time (min) = 39.4

Through output time (min) = 119.47

No of work stations = 7

$$\text{Line Balancing} = \frac{\text{Total cycle time}}{\text{No of work stations X Maximum cycle time}} \text{ X } 100$$

$$= \frac{119.47 \text{ X } 100}{7\text{X}39.4}$$

$$= 42.89\%$$

Table no.6: Proposed Method of Line Balancing

Operation sequence	No of Operators	Work Stations	Cycle time(min)			Elimination of Wastes	Utilization (%)
			VA	NVA	T.T		
Buffing	1	1	8.253	7.081	15.334	T	16.45
Rasping Filling & Air Drying	1	1	9.528	10.022	19.55	T,M	35.71
	1		38.08	0.53	38.61	T	3.4
Setting	1	1	12.29	0.95	13.24	T	53.87
Body Building	1	1	12.79	3.57	16.36	T	13.87
Inspection	1	1	2.24	0.406	2.646	T,D	14.70

Total	6	5	83.181	22.559	105.74		
Maximum cycle time					38.61		
Throughout Output time					105.61		
Line Balance Efficiency					54.7%		

8.2Caluculation of Line Balance Efficiency

Maximum cycle time (min) = 38.61

Through output time (min) = 105.61

No of work stations = 5

$$\text{Line Balancing} = \frac{\text{Total cycle time}}{\text{No of work stations X Maximum cycle time}} \text{ X } 100$$

$$= \frac{105.61 \text{ X } 100}{5\text{X}38.61}$$

$$= 54.7\%$$

LAYOUT DESIGN

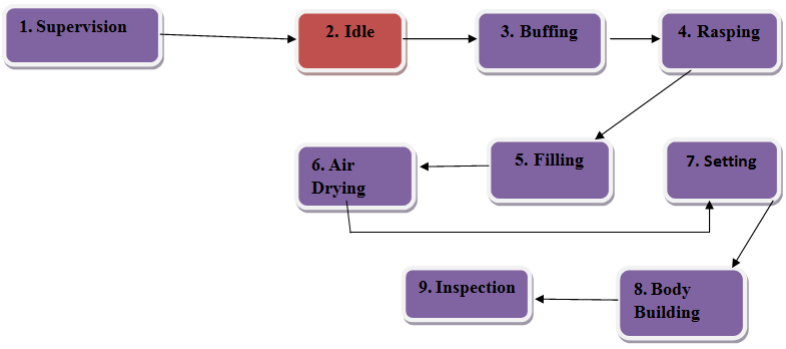

Figure.6: Diagrammatic representation of present layout

Distance (mts) between the departments:

1-2 = 4.8

2-3 = 5.43

3-4 = 4.5

4-5 = 4.9

5-6 = 4.9

6-7 = 8.4

7-8 = 4.6

8-9 = 4.8

From the above layout its clear that department 2 is found to be idle and it can be eliminated and the further operations can be placed forward so that the travel time gets optimized. Departments 3 and 4 can be combined since both the operations can be done simultaneously which in turn can reduce the cycle time of operation and can optimize the loading times. Later the operations can be followed one after the other as shown in the modified layout.

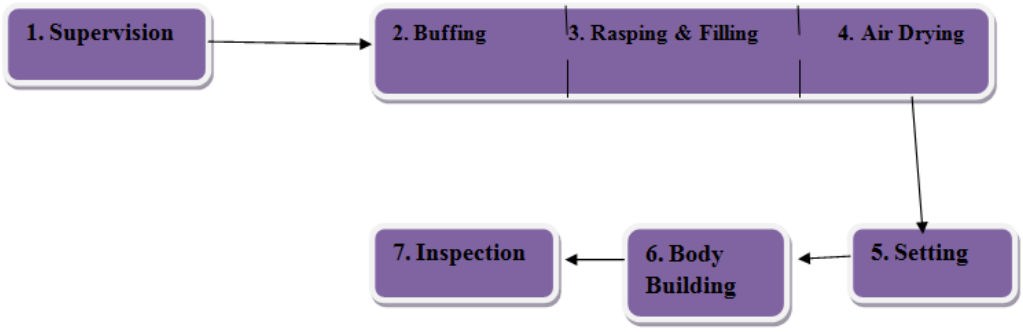

Figure.7: Diagrammatic representation of Modified Layout

Distances (mts) between each Department

1-2 = 4.8

2-3 = 3.5

3-4 = 3.5

4-5 = 4

5-6 = 4

6-7 =4

CALCULATION OF PRODUCTION RATE

10.1Increase in rate of production can be evaluated as follows:

- Total no of tyres produced initially = 64
- Cycle time (present) =119.47min
- Cycle time (Proposed) =105.61min
- Difference in cycle time=13.86min
- % of Cycle time saved=$\frac{13.86*100}{119.47}$ =11.60%
- Increase in percentage of production =$\frac{11.60*64}{100}$
  =7.424
- Increase in production per shift =7.424
- Increase in production per day =7.424*3=22.272
- Hence production per day can be increased to 22 tyres

CONCLUSION

The manpower utilization is very crucial in a sector now days. The line needs to get balanced so that it has high value of efficiency. Higher value of line efficiency indicates that the line have the approximately equal cycle time between the operators along the line. Besides that, the workload between operators also distributed equally which make the higher line efficiency. In this study, the time consume to complete the product of over all operations are taken. Results from this study shows the value of line efficiency has increase after the redesign of the machinery line layout take place. It is evident from the improvements effected that practical line balancing problems often needs in depth investigation of work content on the entire line in order to find practical solutions that are often found by rearranging the work content across workstations by merging the workstations. The basic principles of lean such as waste (MUDA) identification/elimination and layout modification further supplement the productivity improvements. The benefits derived as a result of all improvements are continuous material flow, reduction in WIP on line, improved workstation condition, Reduction in manpower, Achieving Target Production Rate and Minimizing Line Imbalance.

At the end, the operation time per component was reduced, which would hence contribute in aslight increase of the total number of components per month. Another aspect which 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 changed, the need for manual transportation was eliminated, which thereby also eliminated the need of manpower for carrying. Hence the overall resources optimization can be done by using the above mentioned techniques.

FUTURE SCOPE OF PROJECT

The concepts and ideas in the project can be applied in various manufacturing industries to maximize the workers and to eliminate the wastage in the line of operation. Though there are many aspects in the manpower optimization the operator should be well trained and skillful for the existing techniques.

Future research need to be attempt on the other aspects of improvement activity in order to increase the line efficiency. Besides that, the company may try to use other types of line layout for study the line efficiency value so that the company may have more options in choosing the most suitable line for their product and simulating those concepts can be done through software which gives the exact results regarding the manpower optimization percentages and no of operators required per production etc. The application of line balancing technique may have adverse results in the optimization of all the resources in firm.

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