OEE OPTIMIZATION OF AN ASSEMBLY LINE THROUGH LEAN AND TPM METHODOLOGIES

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Abstract: Lean manufacturing eliminates all kinds of wastes in the production line and delivers what is necessary for a company in order to develop their requirement and make them achieve it.. Lean manufacturing uses various tools for improving processes in every aspect to eliminate what are the wastes involved in it. In this paper mainly the Lean tool TPM is used to calculate the OEE of an assembly line in a battery manufacturing company. In that what are the causes for its low OEE is identified and maximum efforts are put in it for eliminating the root causes. Desperate measures are taken for that causes and reduced it to increase the OEE of the Assembly line.

Index Terms **- Lean Manufacturing, TPM (Total Productive Maintenance), OEE (Overall Equipment Effectiveness), Gemba Walk, Availability, Performance, and Quality.**

I. INTRODUCTION

Lean manufacturing is a method which eliminates all the wastes in production line and produces good results through them. Lean manufacturing has 5 principles which concentrate mainly on the production and customer. It majorly concentrates on the value on which the customer wants and he is willing to pay for but not for unnecessary things that doesn't add to his satisfaction.TPM underscores proactive and safeguard support to utilize the operational productivity of machines. It obscures the refinement between the roles of production and upkeep by setting a solid accentuation on enabling machine operators to help keep up their equipment. The usage of a TPM program makes a common duty regarding equipment that empowers more noteworthy inclusion by shop floor operators. In the correct condition this can be viable in improving effectiveness (increasing up time, diminishing process delaying, and disposing of imperfections).
OEE (Overall Equipment Effectiveness) is a metric that distinguishes the level of outlined manufacturing time that is really beneficial. It was created to help TPM activities by precisely following advancement towards accomplishing "Adept production ". Estimating OEE is a best practice in shop floor manufacturing. By estimating OEE and the insight losses, you will increase significant bits of knowledge on the best way to methodically improve your production process. OEE is the absolute best measurement for distinguishing losses, benchmarking progress, and improving the productivity of equipment in the manufacturing sector (i.e., dispensing with waste).In this project TPM is introduced in assembly section in a battery company and OEE is used as a tool to calculate the effectiveness of the assembly line. Another lean tool Gemba Walk is used to find out the causes for the low OEE in assembly line.

II. METHODOLOGY

2.1. Collecting data

Collecting data in this project may be surveyed directly or from the previous recordings of the report. In here the data is collected from the previous records. Past six months data have been collected to calculate the OEE of the assembly line. After collecting data the Lean tool Gemba Walk is used for identifying losses in the work stations of an assembly line.

2.2. OEE Calculation

$$OEE = Availability \times Performance \times Quality \quad (1)$$

2.2.1. **Availability:** Availability considers Availability Loss, which incorporates any occasions that stop planned production for a calculable time allotted (normally a few minutes; in length enough for a operator to log a reason)

$$Availability=(Run\ time/Planned\ production\ time)\times 100\% \quad (2)$$

2.2.2. **Performance:** Performance take into account the losses in which it makes any machine to run at a low speed when it can be run at optimum level.

$$Performance = (Ideal\ cycle\ time\times total\ count)/Run\ time \times 100\% \quad (3)$$

2.2.3. **Quality:** Quality considers Quality Loss, which records for produced parts that don't fulfill quality guidelines.

$$Quality = (Good\ Count/ Total\ count) \times 100\% \quad (4)$$

2.3. GembaWalk:

Gemba walk is one of the major Lean manufacturing tool used by mangers and leaders to find out what is actually happening in the manufacturing process instead of discussing it without knowing the work process. It helps to identify the problems or losses in production floor and engage them to interact with the employees for opportunities for continuous improvement of the process

III. RESULTS AND DISCUSSIONS:

3.1. Data collection:

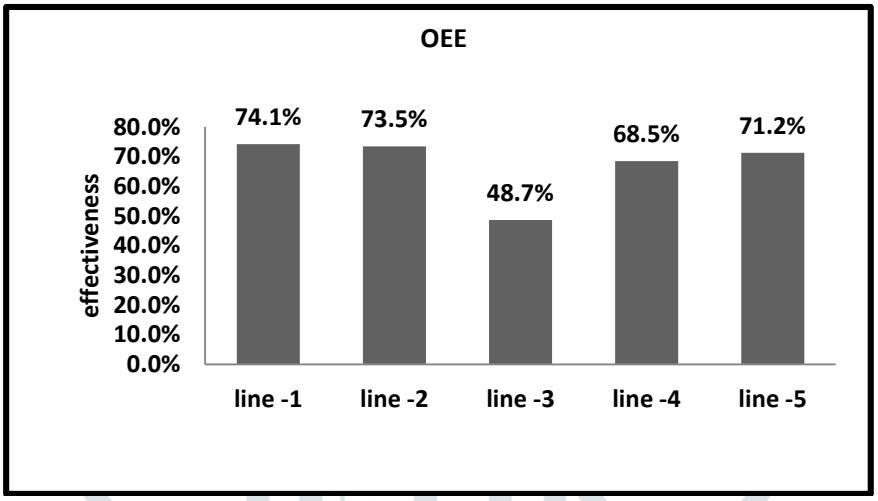


Fig.1: Graph for OEE in Assembly lines

From **Figure 1** Assembly line 3 has less OEE when compared with the other hence line 3 is selected for improvement. Data of OEE for Line 3 is shown below:

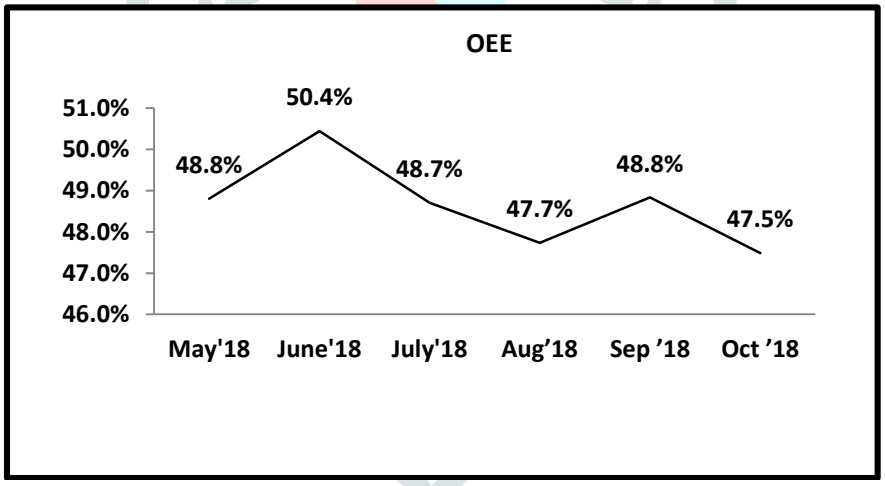
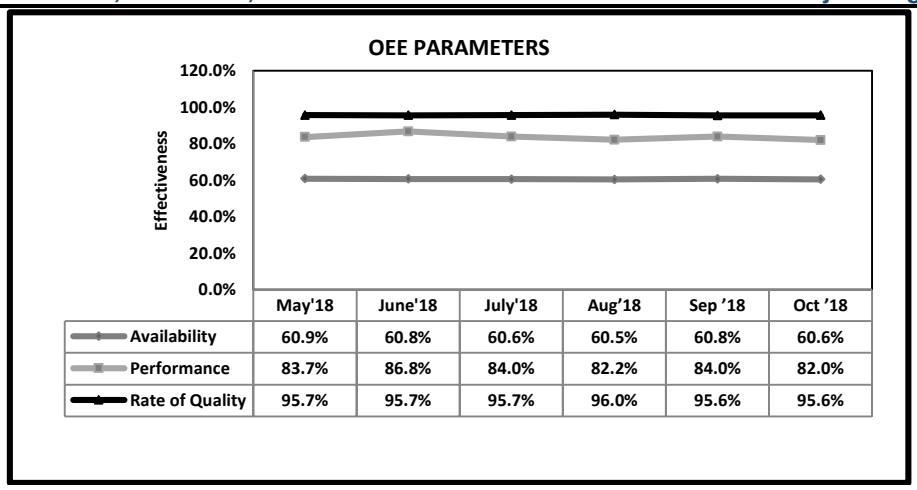


Fig.2: Graph of OEE in Assembly line -3

From the **Figure 2** the data of OEE in Assembly line 3 is given for the past six months. In order to find out the cause for its low OEE .The parameters which are considered are analyzed in detail. The below data is the parameters used in calculating the OEE.



	May'18	June'18	July'18	Aug'18	Sep '18	Oct '18
Availability	60.9%	60.8%	60.6%	60.5%	60.8%	60.6%
Performance	83.7%	86.8%	84.0%	82.2%	84.0%	82.0%
Rate of Quality	95.7%	95.7%	95.7%	96.0%	95.6%	95.6%

Fig. 3: Graph of OEE parameters in Assembly line -3

So from the above the data there is a chance of improvement in the assembly line. The world class OEE is 85% and average is 60% but the line isn't performing well based on the data. So there is a chance of improving the assembly line from given figure 2 and 3.

3.2. Finding the areas of Improvement:

By doing a Gemba Walk the problems are identified in the two workstations in the assembly line. The problems in workstations are identified their impact on the efficiency of the assembly line are analyzed.

Table 1 Problems in stacking machine

Problem Description	**Time in min**
Separator roll change	44.3
Double plate	24.9
Plate miss	22.2
Plate bend	10.6
Plate pick up problem	7.1
Suction band adjustment	4.6
Separator wrapper adjustment	3.4
Guide track adjustment	3.1
Suction cup adjustment	2.9
Suction cup and suction band adjustment	2.7
Feed track adjustment	1.7
Unknown reason	0.6
Total	**127.9**

Table 2 Leak testing activities

Activity in leak testing	**Time taken**
Loading	6sec
Adjustments	4 sec
Pressure head jig down	1 sec
Pressure build up	15 sec
Dipping time	5 sec
Testing time	30 sec
Battery lifting time	5 sec
Pressure head jig up	1 sec
Unloading	6 sec
Total	73 sec

3.3. OEE calculation:

From the above data OEE is calculated for Line 3 in assembly **OEE** is 48.7% only, because of Performance is 83.8 % and Availability is 60.7% Rate of Quality is 95.7%.

Availability is 60.7%, the other 39.3% lost by the following problems:

1. Separator roll change (10.18%)
2. Double plate (5.72%)
3. Plate miss (5.10%)

4. Plate bend (2.43%)
5. Suction band and suction cup adjustment (2.33%)
6. Plate pickup (1.63%)
7. Separator wrapper adjustment (0.78%)
8. Guide track adjustment (0.71%)
9. Feed track adjustment (0.39%)
10. Leak testing (0.04%)
11. Others (0.13%)
12. Other station reasons (8.91%)

Performance is only 83.8%, the balance 16.2 %was loosed by the problems:

1. Stacking machine speed (5.18%)
2. Others (11.02%)

Rate of Quality is 95.7%, the other 4.3% loss due to the following are the problems

1. Others (4.3 %)

3.4. Suggested Improvements

Table 3 Suggested improvements

Problem description	Present method	Suggested method
1. Separator roll change 2. Separator wrapper adjustment	The roll is inserted inside the machine and made some adjustments until the wrap is correctly placed on the battery	Extend the length of the roll and place tape to attach the two roll with help of sensor
1. Double plate 2. Plate pick up 3. Plate bend 4. Feed track adjustment	Suction plate is design problem	New suction plate design based on the plate specifications
1. Guide track adjustment 2. Suction cup and suction band adjustment 3. Plate miss	Not sufficient vaccum cups	Change vaccum cups based on the on suction band design
1. Leak testing loading	There was euro conveyor before the leak testing its takes around 6 to 7 sec for loading	Conveyor to power drive rollers which takes 3 sec to loading
1. Leak testing process time	Loading Adjustments Pressure head jig down Pressure build up Dipping time Testing time Up time Pressure head jig up Unloading	Reduce the pressure build up time and build up during the dipping time which reduces 5 sec.

The above suggested methods and improvements are implemented in the assembly line and after trail run the present observed results are shown in below

3.5. Implementations and Observations

From the above implementations we observed that

1.The Availability has improved from 60.7 % to 81.9%

2.The Performance has improved from 83.8% to 88.9%

3.The Quality rate has improved from 95.7% to 96.9%

4.The OEE of the assembly line from 48.7% to 70.5 %

The data given are the results from the above implementations for three months

Table 4 Observations after implementations

LINE3				
Process parameters	**Jan'19**	**Feb'19**	**Mar'19**	**Average**
Production per shift	349	350	347	349
Production per month	30363	30450	30189	30334
Availability	81.3%	82.9%	81.5%	81.9%
Performance	89.0%	88.9%	88.8%	88.9%
Rate of Quality	96.9%	96.9%	96.9%	96.9%
OEE	70.1%	71.4%	70.1%	70.5%

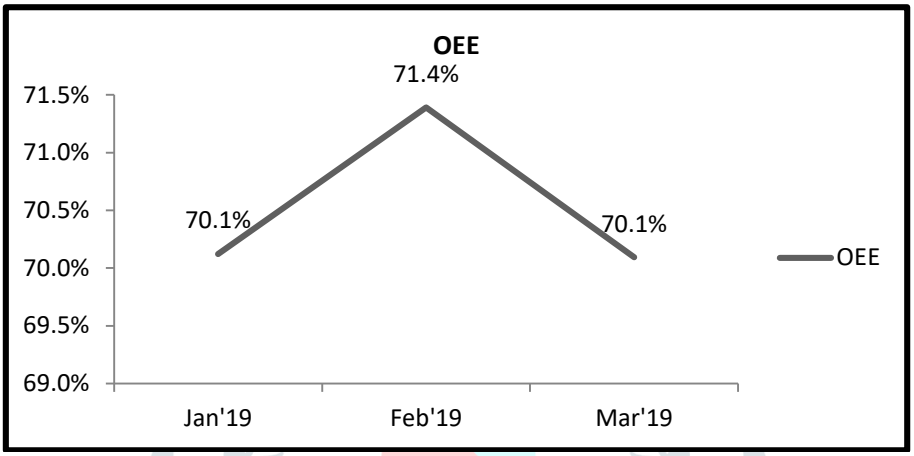


Fig 4: OEE after implementation in Assembly line 3

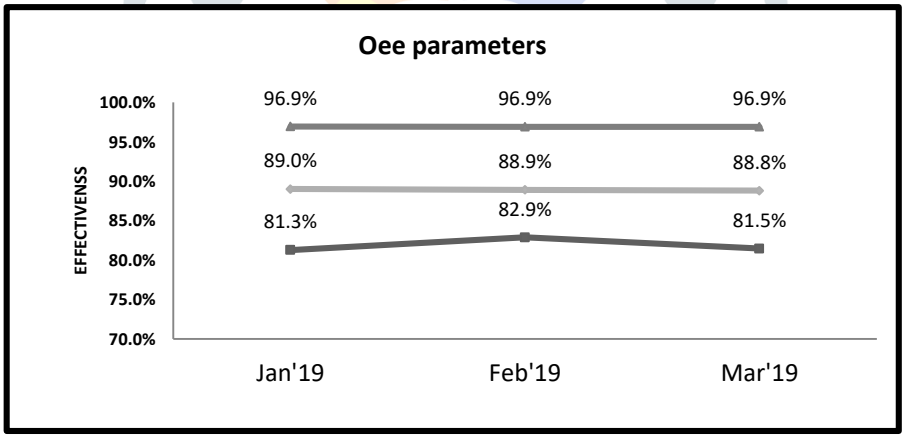


Fig 5: OEE parameters in assembly line 3 after implementation

IV. CONCLUSIONS

By considering the above inputs, the following parameters are improved.

1. Improvement in Machine Availability.
2. Improvement in Performable Efficiency of the Machine
3. Improvement in Quality rate of the Products.

Table 5 Difference between before and after implementation

GLANCE			
Process parameters	**Before**	**After**	**% of improvement**
Availability	60.7%	81.9%	21.2%
Performance	83.8%	88.9%	5.1%
Rate of Quality	95.7%	96.9%	1.2%
OEE	48.7%	70.5%	21.8%

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