LEAN THINKING BY EVALUATION OF OVERALL EQUIPMENT EFFECTIVENESS IN INDIAN BATTERY MANUFACTURING INDUSTRY

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ABSTARCT

In modern era the productivity improvement is biggest challenge for manufacturer to remain competitive. OEE is vital Key Performance Indicator (KPI) joined with lean manufacturing efforts to evaluate performance and productivity of machine. O.E.E. is concept of TPM showing a way of measuring the effectiveness of machine and indicates how effectively a manufacturing operation is utilized. In this paper OEE used to evaluate the OEE index on pasting section of battery manufacturing organization andidentifies the gaps between current performance and desired performance.OEE metric is a key point to understand the main loss elements of the process and define how to get improvement. OEE results are compared with world class level and bottleneck of the process are identified.

Keywords: Key Performance Indicator, Pasting Process, OEE, TPM.

I. INTRODUCTION

In the competitive market industries are facing a critical situation. Lean manufacturing and TPM technologies are improving the productivity in the production industries with minimum use of resources. Lean manufacturing provides the best practices to eliminate the waste from the performance and activities. In turbulent market manufacturing organizations has to deliver their products with high quality in a cost effective manner to remain in competition [1, 2]. Total productive maintenance has objectives of obtaining ideal performance, enhancing product quality, minimizing losses and improving the effectiveness of equipment. These objectives keep equipment producing only good product as fastas possible with no unplanned down time[3]. TPM and OEE both come in the umbrella of lean manufacturing. Lean manufacturing features which are associated with their products and services are:

a. With minimum waste.
b. A head of competitors.
c. On time.
d. Cost effective and faster to market.

OEE is firstly developed by Japan Institute for Plant Maintenance .OEE can be defined as a concept utilizing the lean implementation and a vital component of lean manufacturing.

"If you cannot measure it, you cannot improve it"- Lord Kelvin

So, OEE is well known way of measuring the effectiveness for continues improvement. OEE is considered as a backbone of quality improvement as lean and TQM production.OEE is a methodology for calculating the

overall effectiveness the machine (line, cell). Performance evaluation of the machines is one of the key tools to determine world class companies [4].OEE metric with production losses such as availability, performance and qualitywhich further classified in six big losses was originally described by Nakajima [5]. Losses can be chronic or sporadic. The chronic losses were described as small, hidden and complicated where sporadic losses were ones which occur quickly and large deviation from the normal value [6].It is impossible to reach 100% OEE with in industrial context where world class level of OEE pointed out here is in range of 85% to 92% [7]. Researcher also found that the factory level metriccan be computed by synthesizing the subsystem level metrics, capturing their interconnectivityinformation [8].OEE enables the manufacturer companies to monitor and benchmark their progress.Bottleneck machines which affect the productivity and unproductive time losses were identified by using OEE metric [9].

II. OVERALL EQUIPMENT EFFECTIVENESS

OEE is a method of measuring the efficiency of machine performance.OEE is given by ratio of actual output of equipment divided by maximum output of equipment.OEE makes losses more transparent and highlights the areas of improvement. The goal of this method is to optimize the factory performance.OEE metric is calculated as the product of three components. These components are: Availability, performance, quality.

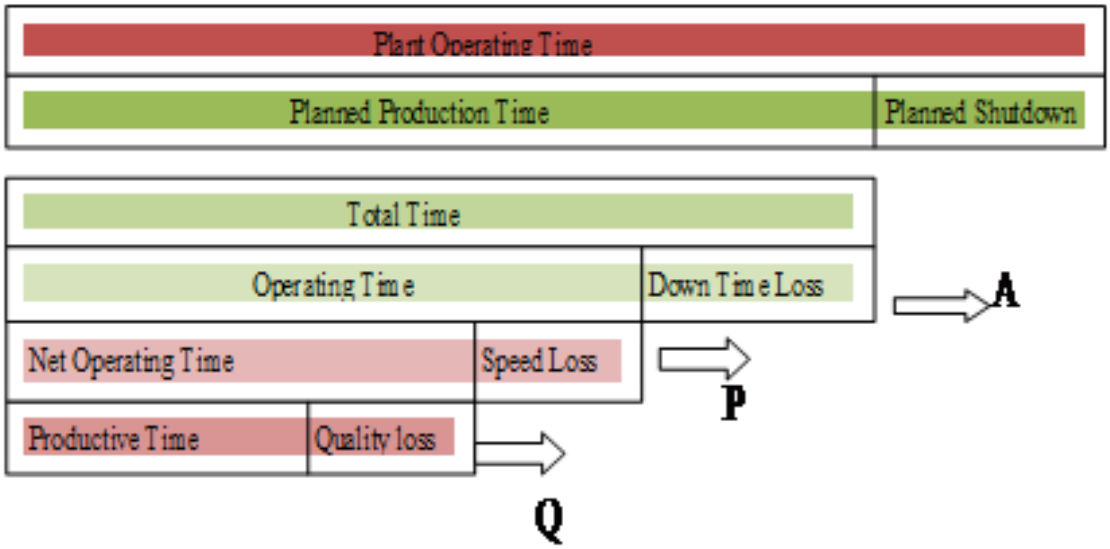

Figure1. Graphical Representation of Components and Losses

2.1 Six Big Losses

To optimize the factory performance, organization has to eliminate the losses present in the production system. OEE provides the framework of six big losses and these losses are grouped in three major categories: Down time, Speed loss, Quality loss.

Table1. Six Big Losses of OEE

Six big losses	O.E.E. loss category	Event example
Breakdowns	Down time loss	• Tooling • Failures • Unplanned • Maintenance • General • Breakdowns • Equipment • Failure
Setup and Adjustment	Down time loss	• Setup/Changeover • Material • Shortages • Operator • Shortages • Major Adjustments
Small stops	Speed loss	• Obstructed • Product Flow • Component Jams • Misfeeds • Sensor Blocked • Delivery Blocked Cleaning/Checking
Reduced speed	Speed loss	• Rough Running • Under Nameplate Capacity • Under Design Capacity • Equipment Wear • Operator Inefficiency
Startup rejects	Quality loss	• Scrap • Rework • In-Process Damage • In-Process Expiration • Incorrect Assembly
Production rejects	Quality loss	• Scrap • Rework • In-Process Damage • In-Process Expiration • Incorrect Assembly

2.2 Three Components of OEE

1. Availability (A).
2. Performance (P).
3. Quality (Q).

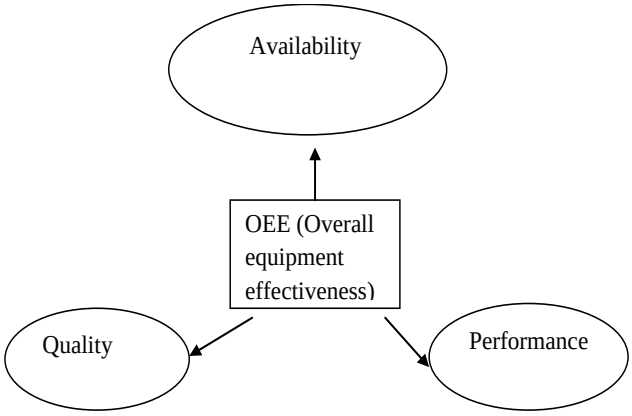

Figure 2.Components of OEE

III. CASE STUDY

The case study was carried out in a battery manufacturing company. The overall equipment effectiveness has been measured to know the present situation of the battery industry. Pasting machine has been identified as a bottleneck machine. Overall equipment effectiveness calculations give the best understanding of the issues. Calculation of availability of pasting machine denotes how effectively the machine is operating. Performance gives how efficiently a machine running to operating time. Quality rate gives how efficiently the machine is utilized.

IV. CALCULATION OF OEE

1. Shift length (Total available time) [12hour]	720min
2. Planned down time (Short breaks) [30min lunch + (10min tea×2)]	50min
3. Unplanned Down time [20 min start cleaning and setting+20 min cleaning after lunch + 50 min approximate other reasons]	90
4. Ideal run rate [Ideal cycle time]	60pieces per min
5. Total pieces [Total production]	24500
6. Rejected pieces [Rework and scrap]	450pieces

4.1 Calculation of O.E.E. Based on Three Factors

A. Availability: Availability takes into account Down Time Loss

Availability = Operating Time / Planned Production Time

Planned Production Time = Shift Length – Breaks

=720min-50min

=670min

Operating Time = Planned Production Time – Unplanned down Time

=670min-90min

=580min

Availability=80.59%

B. Performance: Performance takes into account Speed Loss.

Performance = (Total pieces / Operating Time) /Ideal Run Rate

= (24500/580)/60 =0.7040

Performance Efficiency=70.740%

M.I.A (Missing in action) Time= Actual operating time – (Total parts run × Ideal cycle time)

=580-(24500×0.01666)=172min

C. Quality

Quality takes into account Quality Loss.

Quality=Good pieces/total pieces

=24050/24500=0.9816

Quality Rate=98.16%

Quality losses = Net operating time- (Ideal cycle time × Good pieces produced)

= 408 - (0.01666×24050)=7.5min

D. Overall equipment effectiveness

O.E.E. = Availability x Performance x Quality

=0.8656 x 0.7040 x 0.9816 = 0.60=60%

V. RESULT AND DISCUSSION

OEE tool is used to calculate the OEE for pasting process.OEE breaks the performance in three factors: Availability, Performance and Quality. OEE for pasting process is 60%.

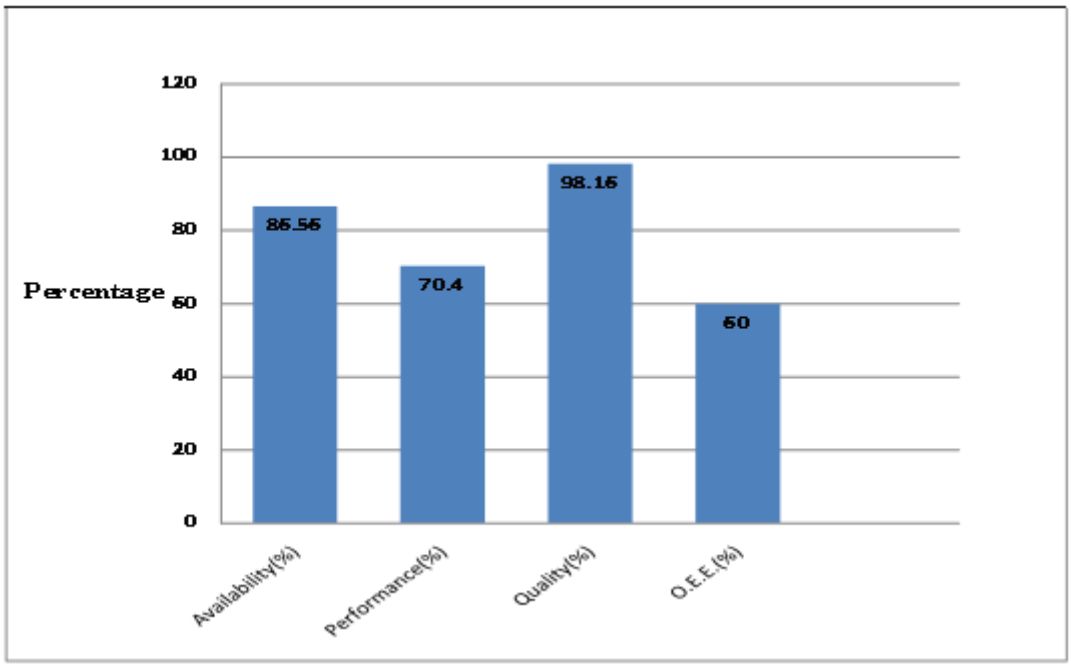

Figure3. Graphical Representation of OEE and its Components

O.E.E breaks downs the losses into downtime losses, speed losses, quality losses and show where the biggest time losses are.

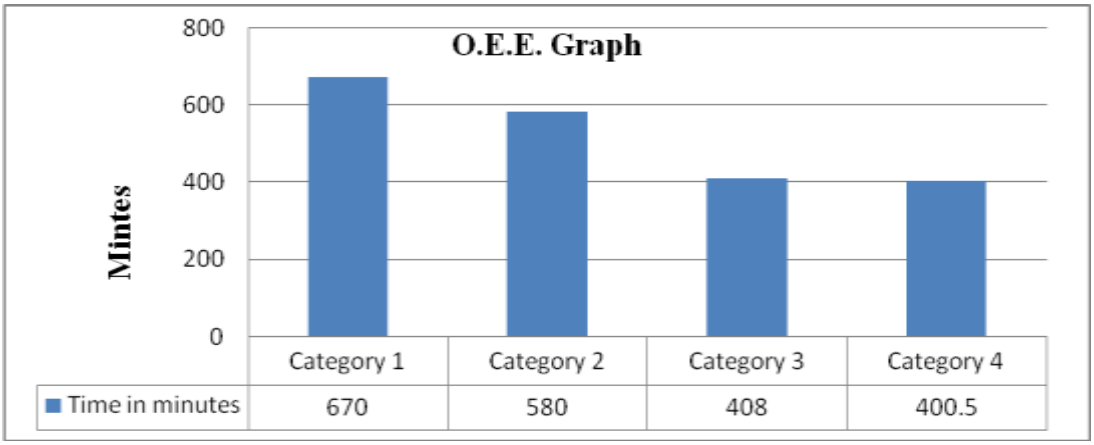

Figure4.O.E.E. Graph Showing Time Losses in Minutes

The three components of O.E.E. Availability, Performance, and quality clearly showed the percentage of losses given in below diagram**.**

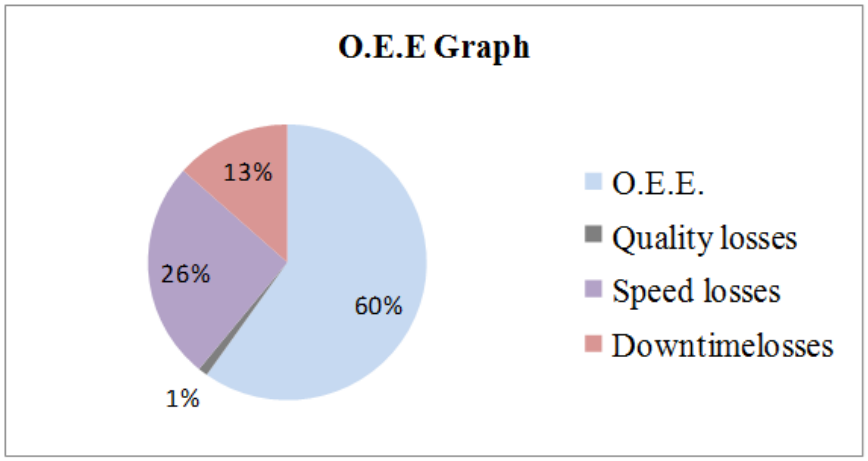

Figure 5.4 O.E.E. Graph Showing Time Losses in Percentage

VI. CONCLUSION

Comparison of world class O.E.E. factor and pasting process O.E.E. factor

Table2. Comparison of O.E.E of Pasting Process with World Class Factor

O.E.E. Factor	World Class	Pasting Process
Availability	90.0	86.56
Performance	95.0	70.40
Quality	99.9	98.57
OEE	85.0	60

O.E.E calculated for pasting process is 60%. In practice, the generally accepted world class goal for each factor is quite different from each other. The table given above has provided a comparison between world class factor and pasting process factor. The comparison clearly showed that there is room for improvement in manufacturing section of pasting. The events which are responsible for loss of production in pasting process are:

1. Almost every hour production is stopped due to storage of pasted plates on the skid.
2. Fork lifter availability hamper to production.

3. Model changeover per shift frequency lead to production loss.
4. Absenteeism cross the limit.
5. Unplanned maintenance.

To increase the effectiveness and efficiency of machine it is important to decrease the nonproductive events. This can be done by skilled labour, proper inventory, increasing speed, using new techniques etc. Proper collection of data and real time display of metric is very important for managers. Visual display can be used for getting meaning fill information and can identify root causes of inefficiency.

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