Measurement of Overall Equipment Effectiveness (OEE) of a Manufacturing Industry: An Effective Lean Tool

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Abstract- Overall equipment effectiveness (OEE) is a concept where the bottleneck operations of a particular process are reduced to certain extent. A study is under taken in the product manufacturing industry and OEE concepts are examined in the different lines (assembly, housing, pinion etc.). The three parameters such as availability, performance and quality of the process are taken up for this purpose. From this effect of factors effecting OEE are examined.

Keywords- Overall Equipment Effectiveness (OEE), Total Productive Management (TPM), Availability, Quality, Performance, Lean Manufacturing.

I. INTRODUCTION

Some of the great challenges faced in the industrial environment regard the correct and efficient use of the resources available both operational and manpower for the production. In continuous production systems high productivity through appropriate distribution of these resources and adequate operational procedure becomes a priority.

If you want to sustain in the market you have to increase the productivity with efficient use of the resources available. By this way you can optimize the cost of production and quality of products will improve. However productivity in such production systems depends directly on the efficiency of their operations or bottlenecks.

Overall equipment effectiveness (OEE) plays vital role in enhancement of productivity. Effectiveness is measure of doing it the right job – the extent to which requirements are met.

Overall Equipment Effectiveness (OEE) provides a systematic process to easily identify common sources of productivity losses so you can effectively apply resources to improve your manufacturing performance. It is simple measurement with enormous value.

OEE is comprehensive measurement how well equipment is actually performing versus a given design capacity. It is common TPM metric and key component in lean manufacturing.

OEE calculation is based on a composite six big wastes (losses) of equipment, which are also termed as TPM six losses.

II. LITERATURE REVIEW


Shamsuddin Ahmed and Hj. Hasaan et al. (2005) concluded that by implementation of total productivity maintenance improvement in equipment effectiveness and efficiency as well as acceptable improvement in other areas of manufacturing plant can be achieved.

P Gibbons and S Burgess (2010) introduced enhancement to OEE which very useful for OEE measurement framework by providing benchmark. Enhanced OEE framework as an indicator of lean six sigma capability is introduced.

F Castro and F Araujo (2012) identified how to reduce wastes and assuring compliance production process as key variable in the beverage industry. They applied OEE in the plant production line which fills beverage in bottles.

P Puvanasavaran and Y.S. Teoh (2013) focused on Takt time integration into OEE for constant cycle time of Autoclave. They said shortage of production and overproduction is not allowed for highly utilization of equipment.

Domingo R and Aguado S (2015) stated that OEE is associated with lean and green manufacturing. They considered OEE for environmental issues and gave term overall environmental equipment effectiveness (OEEE).

In this work calculation of overall equipment effectiveness for different lines in manufacturing industry is done and effect of factors associated with OEE is examined

### III. PROBLEM DESCRIPTION

The problem described in this paper is taken from industrial case. The company works on different lines such as assembly line, pinion line, housing line etc. Here production for different products on different lines is executed. For this to improve the productivity of different lines company needs to efficient use of resources, manpower as well as equipment. In aid to increase productivity overall equipment effectiveness approach applied and cause and effect analysed.

### IV. FACTORS OF OEE

- Availability
- Quality
- Performance

#### 4.1. Availability

- Ability of an item to perform its intended function whenever required.
- Availability takes into account downtime loss.

\[
\text{Availability} = \frac{\text{Net Available Time}}{\text{Total Available Time}}
\]

Where,

- Net Available Time = NAT
- NAT = Total Time − Total Down Time

#### 4.2. Quality

- Degree to which a product meets the requirements.
- Quality takes into account quality loss, which includes any product that is off specifications and is either reworked or discarded.
- Time remaining from discarded production time is known as fully productive time.

\[
\text{Fully Production Time} - \text{Quality Loss}
\]
Where,
- Ok Parts = Production
- Total Parts = Production + Rejection
- FTR = first time run

4.3. Performance
- The performance is based around the total number of parts that are produced within available time compared to how many should have made if produced at planned (designed) rate.
- Performance takes into account speed loss that causes the process to operate at speeds lower than the maximum design capacity.

\[
\text{Performance} = \frac{\text{Total Parts} \times \text{NMCT}}{\text{Net Available Time}}
\]

Where,
- NMCT = Neck Machine Cycle Time

\[
\begin{array}{|c|c|c|}
\hline
\text{Planned Production Time} & \text{Down Time Loss} \\
\text{Net Operative Time} & \text{Speed Loss} \\
\text{Fully Production Time} & \text{Quality Loss} \\
\hline
\end{array}
\]

\text{Figure 1. Availability, performance and quality from up to down}

\[
\text{OEE} = A \times Q \times P
\]

Where,
- A = Availability
- Q = Quality
- P = Performance

V. TPM SIX BIG LOSSES

\[
\begin{array}{|c|c|c|c|c|}
\hline
\text{AVAILABILITY} & \text{BREAKDOWNS} & \text{CHANGEOVERS} \\
\text{PERFORMANCE} & \text{MINOR STOPAGES} & \text{REDUCED SPEED} \\
\text{QUALITY} & \text{DEFECTS} & \text{SETUP SCRAPS} \\
\hline
\end{array}
\]

\text{Figure 2. TPM Six Big Losses}

These are the six big losses of TPM which are shown in the red zone. These losses are undesirable for manufacturing industry. These losses are also associated with overall equipment effectiveness as OEE factors involve these losses.
Due to these losses, the rate of availability, quality, and performance decreases, and with the effect of these
losses, the overall equipment effectiveness of the system decreases. That is the reason these losses are considered as big losses and production units need to take care of these losses for enhancement of the performance.

VI. CALCULATION WORK AND RESULT

**Table 1. Data collected from the company for different lines**

<table>
<thead>
<tr>
<th>LINE</th>
<th>ASSY-1</th>
<th>PINION-1</th>
<th>HSG-1</th>
<th>R/B-1</th>
<th>ASSY-2</th>
<th>PINION-2</th>
<th>HSG-1</th>
<th>R/B-2</th>
<th>ASSY-3</th>
<th>PINION-3</th>
<th>R/B-3</th>
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</table>

**Result Table 2. OEE For Different lines**

<table>
<thead>
<tr>
<th>LINE</th>
<th>ASSY-1</th>
<th>PINION-1</th>
<th>HSG-1</th>
<th>RACK/ B/R-1</th>
<th>ASSY-2</th>
<th>PINION-2</th>
<th>HSG-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVAILABILITY</td>
<td>93.31%</td>
<td>99.63%</td>
<td>96.38%</td>
<td>78.85%</td>
<td>80.74%</td>
<td>92.25%</td>
<td>89.27%</td>
</tr>
<tr>
<td>QUALITY</td>
<td>99.48%</td>
<td>99.97%</td>
<td>94.33%</td>
<td>99.78%</td>
<td>99.76%</td>
<td>99.79%</td>
<td>98.99%</td>
</tr>
<tr>
<td>PERFORMANCE</td>
<td>99.88%</td>
<td>99.85%</td>
<td>99.99%</td>
<td>99.85%</td>
<td>98.01%</td>
<td>99.88%</td>
<td>99.96%</td>
</tr>
<tr>
<td>OEE</td>
<td>92.71%</td>
<td>99.46%</td>
<td>90.90%</td>
<td>78.56%</td>
<td>78.94%</td>
<td>91.94%</td>
<td>88.33%</td>
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</table>
Result Table 3. OEE For Different lines

<table>
<thead>
<tr>
<th>LINE</th>
<th>HSG-3A</th>
<th>HSG-3B</th>
<th>HSG-3C</th>
<th>RACK/BAR-2</th>
<th>ASSY-3</th>
<th>PINION-3</th>
<th>RACK/BAR-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVAILABLITY</td>
<td>97.05%</td>
<td>97.91%</td>
<td>99.33%</td>
<td>91.19%</td>
<td>68.45%</td>
<td>91.55%</td>
<td>83.14%</td>
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<tr>
<td>QUALITY</td>
<td>99.90%</td>
<td>100%</td>
<td>99.74%</td>
<td>99.90%</td>
<td>99.46%</td>
<td>99.85%</td>
<td>99.85%</td>
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<tr>
<td>PERFORMANCE</td>
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<td>99.96%</td>
<td>99.93%</td>
<td>99.88%</td>
<td>99.81%</td>
<td>93.78%</td>
<td>99.66%</td>
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<tr>
<td>OEE</td>
<td>96.91%</td>
<td>97.87%</td>
<td>98.99%</td>
<td>90.99%</td>
<td>68.18%</td>
<td>85.68%</td>
<td>82.72%</td>
</tr>
</tbody>
</table>

Figure 3. OEE, Availability, Quality and Performance Result for different lines
Figure 4. Availability and Performance relationship

Result Table 4. OEE for whole plant

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability</td>
<td>89.93%</td>
</tr>
<tr>
<td>Quality</td>
<td>92.91%</td>
</tr>
<tr>
<td>Performance</td>
<td>99.31%</td>
</tr>
<tr>
<td>OEE</td>
<td>88.72%</td>
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</tbody>
</table>
VII. CONCLUSION

- Even performance is maximum and quality is good, but due to less availability OEE gets affected and its value ended nearly to the value of availability.
- It is observed from the result that performance is always higher than or equal to that of availability because availability takes into account downtime loss.
- Whole plant OEE is 88.72% which is acceptable as per world class OEE it should be more than 85%.
- It is observed from the calculated data that if we want to increase OEE from calculated value we need to improve availability and quality.
- OEE can be increased by minimizing the breakdowns and changeovers losses which are associated with availability and by minimizing the defects and setup scraps losses which are associated with quality.

REFERENCES

[7] Suresh Kumar, G.Sujatha and D.Thyagarajan, “Assessment of Overall Equipment Effectiveness,


