Lean-Sigma Training Material Sample

OEE-brief

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1. What is OEE?

1.1 Overall Equipment Effectiveness

Overall Equipment Effectiveness is a measure of how well a manufacturing operation, or equipment, is being used as compared to its full potential. It can be applied to measure the existing gap between the actual manufacturing operation and the ideal. OEE is a “best practices” metric that identifies the percentage of planned manufacturing time that is truly productive.

> R OEE values range from 0 to 100%.

An OEE score of 100% represents perfect production: manufacturing only good parts, as fast as possible, with no downtime. OEE is useful as a benchmark and baseline.

- As a benchmark, you can compare the performance of an asset vs industry standards, versus other similar assets in the facility, or against different shifts.
- As a baseline, OEE can track improvements made over time when eliminating non-value added activities from an asset.

OEE is also commonly used as a key performance indicator (KPI), in conjunction with lean efforts, to provide an indication of success.

1.2 OEE Benchmarks

For manufacturers of discrete items the following scores are usually used for process improvement efforts:

- An OEE value of 100% is the ideal state: No waste planned production time, at maximum machine rate, and zero defects.

- An OEE value of 85% is generally *World Class* and can be a challenging but attainable target.
- OEE values around 60% indicate the need for focused process improvement projects in production.
- If the OEE value falls below 50% it is imperative to obtain substantial gains with focused projects.

1.3 OEE estimation: Rapid Method

One quick way to obtain OEE is:

$$OEE = \frac{(Good\ Units) \times (Ideal\ Cycle\ Time)}{(Planned\ Production\ Time)} \times 100 \tag{1.1}$$

where:

- *Ideal Cycle Time* is the theoretical or best ever minimum time needed to produce a part. It is sometimes called *Design Cycle Time*, *Theoretical Cycle Time* or *Nameplate Capacity*.
- *Good Units* are units produced without any defects.
- *Planned Production Time* is *Plant Operating Time* minus any *Scheduled Loss* or time where we do not have any intention of producing.(*e.g.*, plant shutdowns, breaks, lunches, periods without orders, etc.). *Plant Operating Time* is the total time that a facility is open and available for equipment operation.

■ **Example 1.1** Data to calculate an ampoule filling machine are presented in the following table:

Data Type	Value
Shift Duration	8 hours= 480 min.
Short Breaks	3 @ 15 min. =45 min.
Meal Break	30 min
Down Time	47 min.
Ideal Run Rate	200 ampules per min.
Total ampules produced	47,600
Rejected ampules	567

Table 1.1: Ampule Filling Machine Data

Ideal Run Rate is the inverse of *Ideal Cycle Time*. Good units produced are $47,600 - 567 = 47,033$. The *Scheduled Loss* for this shift is $45 + 30 = 75$ minutes.
Thus, OEE is:

$$OEE = \frac{47,033 \times \frac{1}{200}}{480 - 75} \times 100 = 58.07\% \tag{1.2}$$

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1.4 OEE Estimation for Process Improvement

When we want to get a very good idea on how to maximize OEE it is better to use the approach that estimates the following factors: *Availability*, *Performance*, and *Quality*.

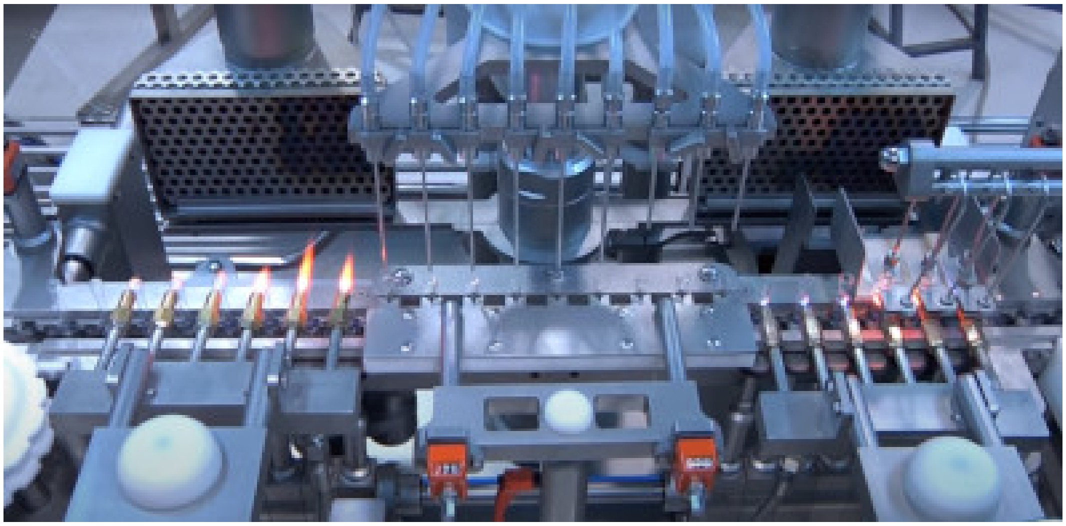

Figure 1.1: Ampule Filling Machine

Figure 1.2: OEE components

- *Availability* takes into account *Down Time Loss*, which includes any Events that stop planned production for an appreciable length of time (usually several minutes or a time long enough to log as a trackable *Event*). Examples of *Down Time Loss* include equipment failures, material shortages, and changeover time. Changeover time is included in OEE analysis since it is a form of down time. While it may not be possible to eliminate changeover time, in most cases it can be reduced. The remaining available time, after deducting *Down Time Loss* from *Planned Production Time*, is called *Operating Time*. Thus, we can calculate Availability by the following formula:

$$\textbf{Availability} = \frac{(Operating\ Time)}{(Planned\ Production\ Time)} \tag{1.3}$$

- *Performance* considers *Speed Loss*, this is: any issues that cause the machinery, or process, under study to operate at less than the maximum possible speed or *Ideal Run Rate*. Examples of issues that cause *Speed Loss* are: machine wear, low quality raw materials, faulty feeding, and operator inefficiency. We can calculate *Performance* with the formula:

$$\textbf{Performance} = \frac{\frac{(Total\ Pieces\ Produced)}{(Operating\ Time)}}{(Ideal\ Run\ Rate)} \tag{1.4}$$

Since *Ideal Cycle Time* is the reciprocal of *Ideal Run Rate*, Performance can also be calculated as:

$$\textbf{Performance} = \frac{(Ideal\ Cycle\ Time)}{\frac{(Operating\ Time)}{(Total\ Pieces\ Produced)}} \tag{1.5}$$

Performance has a maximum value of 1.

- *Quality* takes into account *Quality Loss*, which accounts for the time spent producing pieces that do not meet quality standards, including pieces that require rework. *Operating Time* minus *Quality Loss* is called *Fully Productive Time*. Then, a way to calculate *Quality* is:

$$\textbf{Quality} = \frac{(Fully\ Productive\ Time)}{(Operating\ Time)} \tag{1.6}$$

However, *Quality* is easily calculated as the ratio of *Good Pieces* to *Total Pieces Produced*:

$$\textbf{Quality} = \frac{(Good\ Pieces)}{(Total\ Pieces\ Produced)} \tag{1.7}$$

After each factor is calculated, OEE is obtained by the formula:

$$\textbf{OEE} = \textbf{Availability} \times \textbf{Performance} \times \textbf{Quality} \times 100\% \tag{1.8}$$

■ **Example 1.2** Calculate the *Performance*, *Availability*, *Quality*, and *OEE* of a ampoule filling machine whose data are presented in the following table:

Data Type	Value
Shift Duration	8 hours= 480 min.
Short Breaks	3 @ 15 min. =45 min.
Meal Break	30 min
Down Time	47 min.
Ideal Run Rate	200 ampules per min.
Total ampules produced	47,600
Rejected ampules	567

Table 1.2: Ampule Filling Machine Data

From the table, *Planned Production Time* is Shift Length minus Breaks which is $[480-45-30] = 405$ minutes; *Operating time* is planned production time minus *Down Time* $[405-47] = 358$ minutes; The total number of *Good Pieces* is Total ampules produced minus Rejected ampules $[47,600-567] = 47,033]$ pieces. Therefore,

$$\textbf{Availability} = \frac{358}{405} = 0.8840 \tag{1.9}$$

$$\textbf{Performance} = \frac{\frac{47{,}600}{358}}{200} = 0.6648 \tag{1.10}$$

$$\textbf{Quality} = \frac{47,033}{47,600} = 0.9881 \tag{1.11}$$

and:

$$\textbf{OEE} = 0.8840 \times 0.6648 \times 0.9881 \times 100 = 58.07\% \tag{1.12}$$

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