

Purpose and definition of oee engineering essay



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2. 1 Introduction

These days, in this demanding world, the total elimination of waste is for the survival of the organization. The waste caused due to the failure or shutdown of facilities that has been built with enormous investment, and also waste such as defective products ought to be completely eliminated. In a manufacturing sector, company's facilities have to be functioning efficiently in order to gain desirable productivity, inventory cost, delivery as well as quality. In this context, the motive of OEE analysis and measurement is to reduce the equipment losses to zero and has been recognized as a necessity for many organizations. According to Bamber et al. (1999) [5], the role of teamwork, small group activities and the participation of all employees is crucial to accomplish equipment improvement aims. Hence, OEE is use as metrics to determine the Total Productive Maintenance (TPM) activities. On the other hand, it can also be said that OEE shows a consistency approach to measure the effectiveness of TPM as well as other programs by providing an overall structure for measuring production efficiency.

As explained by (Dal et al., 2000) [6], the role of OEE goes far beyond not only monitoring and controlling, but also takes into consideration of process improvement initiatives/programs, provides a systematic method for establishing production targets, prevents the sub-optimization of individual machines or product lines, as well as incorporates practical management tools and techniques. This ensures the attainment of a balanced view of process availability, quality and performance.

Another statement made by Lesshammar and Patrik (1999) [7], in their case studies, have presented how OEE is being used in industry and as well have reported that this metric forms a useful part of an overall system of measurement. In other words, it provides a useful method to measure the effectiveness of manufacturing operations from a single piece of equipment to the whole manufacturing plant of several manufacturing plants in a group. In doing so, OEE not only provides a complete scenario of where productive manufacturing time and money is being lost, but at the same time uncovers the true , hidden capability of the industry. Thus, it becomes the key manufacturing decision support tool for constant improvement programmes [8].

Apart from that, OEE is an established method of measuring followed by optimizing the efficiency of a machine's performance or that of a whole industry plant. The effectiveness of a plant's production highly depends on the effectiveness with which it makes use of equipment, materials, man and methods as explained by Suzuki (1999) [9]. Besides, OEE can have a significant impact on the productivity of a manufacturing unit. Therefore, through OEE manufacturers may systematically direct their business towards attainment of continuous improvement operating margins, optimized competitive position and maximized utilization of capital. Some of the more prominent firms have benefited from OEE as a measurement gauge for implementing improvement activities that increases company profits and costs.

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2. 2 History of OEE

OEE is an essential metric and basic methodology for manufacturers practicing a 'Lean' manufacturing strategy that is zero waste in their 'value streams'. This metric element follows the well-founded principle: 'If you can't measure it, you can't manage it' [10]. Some advocates are fond of the view 'If you're not taking score, you're only practicing' [10].

In 1972, the Japanese Plant Maintenance Institute (JPMI) developed a theory called Total Productive Maintenance [11]. The preliminary aim of TPM was to eradicate the 'six big losses' and subsequently the 'eight wastes'. It was first implemented and developed in Toyota's automotive plants, soon after evolving into world-renowned Toyota Production System. An organizational culture was formed by Toyota that focused on the systematic identification and elimination of all waste from their production process where the technical / human contributions to production are maximized. Reengineering and organizational change is used to maximize yield, minimize cost and time-compress the supply chain by fully excluding non-value added activities and 'not right first time' events.

The OEE gauge came forward from the Japanese production focused, equipment management framework of TPM [10]. OEE is the key measure of the tangible benefits accessible from TPM by Seiichi Nakajima, the founder of Total Productive Maintenance who initially used OEE to depict a fundamental measure for tracking production performance. He (Seiichi Nakajima) challenged the complacent view of effectiveness by focusing not merely on keeping equipment running smoothly, but on creating a sense of joint

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responsibility between maintenance workers and operators to optimize the Overall Equipment Performance. OEE symbolized in the first of the original pillars of TPM. Guided all TPM activities and measured the results of these loss focused activities. Therefore, the use of OEE had evolved into the current focused improvement pillar, one of eight TPM pillars.

During the mid 1990's, coordinated by SEMATECH the semiconductor wafer fabrication industry has adopted to improve the productivity of the fabrication [11]. Since then, manufacturers in other industries throughout the world have embraced OEE ways to improve their asset utilization.

2. 3 The purpose of OEE

The OEE metric can be applied at a number of different levels within a manufacturing environment. First, OEE can be used as a “ benchmark” for measuring the initial performance of a manufacturing industry as a whole. Thereby, the initial OEE measure can be compared with future OEE values, hence quantifying the level of enhancement made. Subsequently, an OEE value calculated for one manufacturing line can as well be used to compare line performance across the industry, thus highlighting any poor line performance. If the machine's processes work individually, an OEE measure can discover which machine performance is worst, and therefore indicate where to focus TPM resources (Nakajima 1988) [5].

Dal et al. (2000) [6] declared that by utilizing largely existing performance data, such as preventive maintenance, absenteeism, accidents, material utilization, conformance to schedule, labor recovery, set-up and changeover data, etc., the OEE measure may possibly provide topical information for

daily decision making. Due to this, the OEE measurement method within a industry becomes the elementary measure of TPM activities, as well as a basis of improvements for the TPM process.

2. 4 Definition of OEE

In the era of globalization today, manufacturers are forced to look for creative ways to maximize additional investment due to the continuous pressure of global competition which results in lower margin. In this state, OEE has becoming a hot topic. In its most basic form, OEE offers a straightforward ways to keep track of manufacturing performance as well as to measure the total equipment performance- the degree to which the asset is doing what it is supposed to do. However, the true power of OEE as a dedicated application lies in the ability to use it as a change-enabler, or tool for continuous improvement and lean manufacturing programs [8].

There are various methodologies to gauge manufacturing efficiency. Generally most companies will have a number of measures already in place. Nevertheless, many now disagree that none of these approaches are as comprehensive or far reaching as the OEE achievement, since OEE provides a way to measure the effectiveness of manufacturing operations from single piece of equipment to the manufacturing plant in entirety, or several manufacturing plants in a group. as a result, OEE can be well thought-out as a central KPI (key performance indicator). It drives an organization to examine all aspects of asset performance in order to ensure gaining the maximum benefits from a piece of equipment that is already bought and paid for [12]. Thus, it is obvious that OEE acts as an approach for monitoring and managing the lifecycle of manufacturing assets.

On the other hand, OEE can be expressed as a commonly accepted set of metrics that bring clear focus to the key success drivers for manufacturing enterprises [13]. In other words, it measures both efficiency (doing things right) and effectiveness (doing the right things) with the equipments. These measurement comprises of three fundamental elements where each one is expressed as a percentage and accounting for a different kind of waste in the manufacturing process.

Thus, it is understood that OEE is a function of the three factors. The three factors mentioned below are briefed as:

Availability or uptime (downtime: planned and unplanned, tool change, tool service, job change etc.)

A measure of the time the plant was in fact available for production compared to the manufacturing requirements. Any losses in this area would attribute to major breakdowns or extended set up time [14].

Performance efficiency (actual vs. design capacity)

The rate that concrete units are produced compared to the designed output. Losses in this area would attribute to slow speed running, minor stoppages or adjustments [14].

Rate of quality output (Defects and rework)

A measure of good quality, saleable product, minus any waste. Losses in this element would attribute to damage rejects or products needing rework [14].

Measuring OEE can be done simply by capturing the five basic pieces of information as stated below:

Planned Production Time – the planned amount of time in which production is planned for a specific line.

Down Time – specify as the amount of time the process is not running during the planned production time (interrupts to production).

Ideal Cycle Time – represent as the theoretical minimum of time needed to produce a single piece of product.

Total Pieces – denote as the total number of pieces produced during the planned production time.

Good Pieces – signify as the total number of pieces produced that meet quality standards.

Figure 2. 1 The Overall Equipment Effectiveness flow chart

2. 5 Objectives of OEE

Overall Equipment Effectiveness records and data information's are used to categorize a single asset (machine or equipment) and/or single stream process related losses in order to improve total asset reliability and performance. Besides, the information is useful and essential as it helps to identify and categorize major losses or reasons for poor performance.

OEE offers the basis for setting enhancement priorities as well as for the root of measurement and analysis. In addition, the percentage determined is used to track and trend for improvement, or decline, in equipment

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effectiveness over a period of time. Hidden or untapped capacity in a manufacturing process can be pointed out through these percentages and lead to balance flow.

On top of that, OEE can be used to develop and enhance collaboration between asset operations, maintenance, purchasing, and equipment engineering to jointly identify and reduce (or eliminate) the 2 major causes of poor performance since “ maintenance” alone cannot improve OEE.

2. 6 The use of OEE

The root why companies' uses OEE is to avoid making inappropriate purchases, and help them focus on improving the performance of machinery and also plant equipment they already own. Companies should also start with the area that will provide the greatest return on asset because OEE is able to find the greatest areas of improvement. These OEE formula with the major factors involves will show how improvements in quality, changeovers, machine reliability improvements, working through breaks and more.

In business world today, when many manufacturers strive towards world class productivity in their facility, this simple method will perform an excellent benchmarking tool [15]. Besides, the simple derived OEE percentage makes a great motivational system as it is easy to understand and this single number is displayed where all facility personnel can view it. By giving employees such as operators and workers an easy way to see how they are doing in overall equipment utilization, production speed, and quality, in return they will strive for a higher number instead.

2. 7 Defining Six Big Losses

One of the major goals of TPM and OEE programs is to reduce and/or eliminate what are named as the Six Big Losses, the most common causes of efficiency loss in manufacturing sectors. This was put forwarded by Nakajima in 1989 [16].

There are basically 3 categories of OEE loss which include: Down Time Loss, Speed Loss and Quality Loss. Each of these types has been divided into two sub-losses. They are known or called the Six Big Losses. Basically, OEE is generally measured in terms of these six losses as showed below.

They are categorized as stated below:

Breakdown Losses

Setup and Adjustments Losses

Small Stops Losses (Idling and Minor Stop Losses)

Reduced Speed Losses

Startup Rejects (reduced yield losses)

Production Rejects (quality defects and re-work)

Categorizing these data makes addressing the Six Big Losses much easier, and a key goal should be fast and efficient data collection, with data put to used throughout the day in the real time.

2. 2 Addressing the Six Big Losses

Measurement is essential to establish appropriate metrics. It is important necessity of continuous improvement processes.

As stated by Nakajima (1988), an efficient way of analyzing the efficiency of a single machine or an integrated manufacturing process is through OEE measurement [17]. It is a function of availability, performance rate, and quality rate. In fact, the three dimensions are measures in terms of equipment losses. Following this, Nakajima (1988) defined these losses into six major categories as follows [17]:

2. 7. 1. 1 Availability Losses

Based on the mechanism principle, a machine most likely is available 24/7/365. However, this comes from an ideal perspective, from which one can measure true machine availability. There are few genuine factors that affect on availability, some of which are planned, and some unplanned. For planned downtime, it takes into account of holidays, scheduled maintenance and vacation. While for unplanned downtime, it includes equipment failures and setup and adjustments. It is possible to factor in the planned downtime; however it is the losses due to unplanned downtime that can negatively affects machine availability.

Breakdowns

Breakdown Losses are classified as by far the biggest of the “ Six Big Losses”. These losses are significant due to the fact of its sudden, dramatic failure in which the equipment stops completely [18]. In the view of the fact

that there is no production therefore this unexpected breakdown are undoubtedly elements of losses. The breakdown can cause all equipment functions to be terminated even though the source lies in a single specific function. Nevertheless, deterioration related to problem and losses are also regard as break down losses.

It is important to improve OEE by eliminating unplanned downtime. But if the process is down, other OEE factors cannot be dealt with. Therefore, it is not merely important to know how much downtime your process is experiencing (and when) at the same time to be able to attribute the lost time to the specific reason or cause for the loss [19].

Setup and Adjustments

Whenever the production of one product stops and the equipment is adjusted to meet the requirements of another product, this is where setup and adjustment take place. The loss of time due to this delay is known as setup and adjustments

Basically, setup and adjustments period of time is normally measured as the time between the last good parts produced before setup to the first consistent good parts produced after setup. In order to constantly produce parts that meet the quality standards, it should generally include substantial adjustment and/or warm-up time.

Various innovative ways have been used by companies to reduce setup time. These comprises assembling changeover carts with all tools and supplies necessary for the changeover in one place, pinned or marked settings so

that coarse adjustments are no longer necessary, and use of prefabricated setup measures [20].

2. 7. 1. 2 Performance Losses

Machine performance referred to as the net production time during which products are produced. The more the machine produces, the greater the OEE metric. However, speed losses and small stops will inhibit the overall performance of machine. If such losses is not recognized and addressed, the machine performance cannot be fully optimized.

Reduced Speed

Reduced Speed can be classified as one of the most difficult of the Six Big Losses to monitor and record. This is due to the reason that there is a significant difference between the theoretical maximum speed and what people think the maximum speed is. In most cases, in order to prevent other losses such as quality rejects and breakdowns, the production speed needs to be optimized. Losses due to reduce speed are therefore, often ignored or underestimated [21]. It happens when the equipment runs slower than its optimal or maximum speed.

Apart from that, reduced speed is the difference between designed speed and the actual operating speed [21]. There are various reasons where equipment may be running at less than its designed speed, for instance non-standard or difficult raw materials, history or past problems, mechanical problems, or fear of overloading the equipment. This loss of speed is actually converted into time during the OEE calculation.

Small Stops

We can also assume small stops as one of the most difficult of the Six Big Losses to monitor and record. Whenever a machine shows short interruptions and does not have a constant speed, this will not result in a smooth flow of production. Minor stoppages and the subsequent loss of speed can be the cause from products blocking sensors or products getting stuck in the conveyor belts. The machine's effectiveness will be diminished drastically if these hitches occur frequently [21].

The occurrence of these losses happens whenever equipment stops for a short time as the result of a temporary problem. As an example, a work-piece is jammed in a chuck or when a sensor activates and shut down the machines, this will definitely result in a minor stoppage. As soon as someone removes the jammed work-piece or resets the sensor instantly, it operates normally again. These losses also include idling losses that occur when equipment continues to run without producing. Thus, since idling and minor stoppages interrupt jobs, therefore they can also be categorized as breakdowns. Despite that, the two are fundamentally different in that a minor stoppage and the duration are usually less than 10 minutes.

2. 7. 1. 3 Quality Losses

A scrap is when the final product is not saleable, and the entire process has been wasted on product that will never make it to the customer. Thus, it is very essential to take into account the quality of the product while evaluating OEE. Availability and speed often has been the main focus, and quality is left behind. The key to keep in mind is that without a good product, <https://assignbuster.com/purpose-and-definition-of-oe-engineering-essay/>

the rest of the operation is a white elephant. Generally, quality losses are generated during startup while the machine is ramping up, during adjustment, or during normal production, as rejected/unwanted product due to process instabilities.

Startup Rejects

Products that do not meet the quality standards are called scraps, even if they can be sold as ' sub-spec'. A specific type of quality loss is the startup losses where these losses occur due to when:

Starting up of the machine: the production is not stable as soon as the machine starts and the first products do not meet the quality standards.

The process of the machine at the end of a production run is no longer stable and the products no longer to be able to meet the specifications require.

Quantities of products are no longer counted as part of the production order and consequently are considered as loss.

These are usually hidden losses, which are often considered to be unavoidable. The scale of these losses can be surprisingly large [21].

Certain adjustments and warm-up time is required for several equipments to obtain optimum output. Losses that happen in the early stages of production during machine setup to stabilization of product quality are called the startup losses. The losses differ with degree of stability of processing condition, operator's technical skill, maintenance level on equipment, and many more.

Production rejects

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A product that does not meet the quality specifications/standards for the first time, but can be reprocessed into good products is known as rework products. Reworking products is not a disadvantage as the product can be sold to fit other demand needs. However, the product was not right first time and is therefore a quality loss just like scrap [21].

Production rejects are classified as quality losses that are not caused by startup. These losses arise only when products produced are not conforming to the specifications. Parts that require rework of any kind should be considered reject and this happens during steady state production.

Example of the Downtime loss, Speed loss, and Quality loss is depicted in the following page.

The Six Big Losses with three categories are shown in figure below. The following table shows how this Six Big Losses are categorized with examples given.

Figure 2. 3: Classification of Six Big Losses.

The table below lists the Six Big Losses, and show how they are relate to the OEE Loss categories. A typical major loss, the categories of OEE as well as examples of events is shown as follow:

OEE Loss

Category

Six Big Loss

Category

Event Examples

Down Time Loss

Breakdowns

- Tooling Failures
- Unplanned Maintenance
- General Breakdowns
- Equipment Failure

Setup and Adjustments

- Setup/Changeover
- Material Shortages
- Operator Shortages
- Major Adjustments
- Warm-Up Time

Speed Loss

Idling and Minor stops

- Obstructed Product Flow

- Component Jams
- Misfeeds
- Sensor Blocked
- Delivery Blocked
- Cleaning/Checking

Reduced Speed

- Rough Running
- Under Nameplate Capacity
- Under Design Capacity
- Equipment Wear
- Operator Inefficiency

Quality Loss

Start-up Losses

- Scrap
- Rework
- In-Process Damage
- In-Process Expiration
- Incorrect Assembly

Defect Losses

- Scrap

- Rework

- In-Process Damage

- In-Process Expiration

- Incorrect Assembly

Table 2. 1 : The Six Big Losses in OEE

2. 8 OEE factors

As explained in previous subsequent chapter, the OEE calculation is based on the three OEE factors. This comprises of Availability, Quality and Performance. They are as well referring as Effectiveness Factors. Here is how each of these factors is calculated.

Availability

The Availability part of OEE represents the percentage of scheduled time that the equipment is available to function [18]. This Availability element is a measurement of the uptime that is designed to exclude the effects of performance, quality, and scheduled downtime events.

Since Availability takes into account of Downtime loss, the formula is calculated as:

20

Availability = Operation time

Planned Production time

Where, Operation time = Planned production time – Unscheduled Downtime

Production time = Planned production time – Scheduled Downtime

Downtime losses zero indicates the availability is 100%, where the gross operating time equals the available time for production. i. e. Operation time equals Planned Production time. Therefore, it can be said that 100% Availability means the process has been running without any recorded stops.

Performance

Performance can be denoted as the ratio between Net Operating Time and Operating Time. Since Performance takes into account of speed loss, the formula is calculated as:

22

Performance = Net Operating Time

Operating Time

The Performance portion of OEE corresponds to the speed at which the machine runs as a percentage of its designed speed. This Performance element is a measurement of speed that is designed to exclude the effects of availability and quality [18]. Performance does not penalize for rejects, which imply even if the work is rejected or rework, it will still be included in the planned and actual hours accordingly. Since Performance takes into account Speed Loss, the formula is calculated as:

Performance = Ideal Cycle Time

Operating Time / Total Pieces

23

Where, Ideal Cycle Time = the minimum cycle time that the process can be expected to achieve in optimal circumstances. It is at times called, Theoretical Cycle Time, Nameplate Capacity or Design Cycle Time. Since Run Rate is the reciprocal of Cycle Time, Performance can also be calculated as:

$$\text{Performance} = \text{Total Pieces} / \text{Operating Time}$$

Ideal Run Rate

24

Performance is limited at 100%, to make sure that if an error is made in specifying the Ideal Cycle Time or Ideal Run Rate, the effect on OEE will be limited. Therefore, it can be said that 100% Performance means the process has been consistently running at its theoretical maximum speed.

Quality Rate

The Quality portion of the OEE signifies the good units produced as a percentage of the total units produced [18]. The Quality metric is a measurement of process yield that is designed to exclude the effects of availability and performance. Quality is the ratio of Fully Productive Time to Net Operating Time.

$$\text{Quality} = \text{Fully Productive Time} / \text{Net Operating Time}$$

25

Quality = Good Pieces / Total Pieces

Since Quality takes into account of Quality Loss, the formula is calculated as:

26

(Total no of units of processed products- No of units of no good products)/(total no of units of processed products). Thus, it can be said that 100% Quality means there is no rework or reject pieces. Therefore, since OEE takes into account all three OEE factors, the formula is calculated as:

27

OEE = Availability x Performance x Quality

Therefore OEE is the product of its effectiveness factors; Availability, Performance and

Quality.

The study of each of these effectiveness factors will improve the Overall Equipment Effectiveness. Below diagrams shows the three major elements of OEE together with formula calculated .

Figure 2. 4.... Shows the formula on how to calculate OEE

Figure 2. 5...Shows the OEE Factors

Loss

OEE Factor

Planned Shutdown

Not included in OEE calculation

Down Time Loss

Availability is the ratio of Operating Time to Planned Production Time (Operating Time is Planned Production Time less Down Time Loss).

Calculated as the ratio of Operating Time to Planned Production Time.

100% Availability means the process has been running without any recorded stops.

Speed Loss

Performance is the ratio of Net Operating Time to Operating Time (Net Operating Time is Operating Time less Speed Loss).

Calculated as the ratio of Ideal Cycle Time to Actual Cycle Time, or alternately the ratio of Actual Run Rate to Ideal Run Rate.

100% Performance means the process has been consistently running at its theoretical maximum speed.

Table 2. 1 indicates the 3 main factors of OEE

Quality Loss

Quality is the ratio of Fully Productive Time to Net Operating Time (Fully Productive Time is Net Operating Time less Quality Loss).

Calculated as the ratio of Good Pieces to Total Pieces.

100% Quality means there have been no reject or rework pieces.

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2. 9 OEE Components of Plant Operating Time

2. 9. 1 Components of Plant Operating Time

In order to establish an accurate measurement, OEE analysis begins with Plant Operating Time. Basically, this Plant Operating Time implies as the amount of time the facility is open and available for equipment process. It can also be refer as the maximum amount of time and is a constant. One day consists of 24 hours of 60 minutes. While, for one week, it consists of 7 days of 24 hours. Whereas, in one year consists of 52 weeks. At times, Plant Operating Time is also referred to as Theoretical Production Time. It consists of different losses like speed and quality loss as well as fully productive time

2. 9. 1 Plant Production Time

Once a category of called Planned Shut Down is subtracted from Plant Operating Time, the remaining available time is called Planned Production Time. The Planned Shut Down shall include any events that should be excluded from efficiency analysis since there was no intension of running production [22]. For example, tea breaks, lunch breaks, scheduled maintenance or periods where there is nothing to produce. Nevertheless, Planned Production Time is also known as Available Production Time. OEE initiates with Planned Production Time and analyze efficiency as well as productivity losses that occur, with the aim of eliminating or reducing these losses. OEE starts with Plant Operating Time and end up with Fully Productive Time, screening the source of productive loss that occur in between.

2. 9. 1. 1 Operating Time

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From Planned Production Time, the downtime loss is subtracted to gain Operating Time. The downtime losses inclusive of any events that stop planned production for an appreciable length of time (normally several minute-long enough to log as a traceable event) [22]. Examples of these include material shortages, equipment failures, and changeover time. Since it is also includes as type of downtime, the changeover time is included in OEE analysis. Even though it may not be possible to reduce 9 changeover times, however, it can be reduced in most cases. The remaining available time is called Operating Time and also known as Gross Operating Time [22].

2. 9. 1. 2 Net Operating Time

From the Operating Time, the speed loss is deducted to obtain Net Operating Time. The speed losses take account of any factors that cause the process to operate less than the maximum possible speed while running. Examples of these include machine wear, substandard materials, miss-feeds, and operator inefficiency.

2. 9. 1. 3 Fully Productive Time

As for Net Operating Time, the Quality Loss is subtracted and the remaining available time is called the Fully Productive Time. These quality losses accounts for produced pieces that do not meet quality standards, together with pieces that require rework. The goal here is to maximize Fully Productive Time w