

# **OEE (Overall Equipment Effectiveness) global efficiency of equipment as the competitiveness support instrument**

**Glauco Roberto Pereira Silva**

**Milton Vieira Junior**

[mvieirajr@uninove.br](mailto:mvieirajr@uninove.br)

**Universidade Nove de Julho**

## **Abstract**

The manufacturing industries have faced stiff competition from factories in the worldwide, requiring monitoring the crucial factors to remain competitive. This paper aims to make an exploratory evaluation of use OEE (Overall Equipment Effectiveness) indicator in order to analyze the impacts of this indicator on the cost of maintenance.

**Keywords:** OEE, TPM, Maintenance, Cost of maintenance

## **INTRODUCTION**

Manufacturing industries have faced strong competition from factories in Worldwide, demanding alternatives and monitoring of the crucial factors to stay competitive. It is a practice in company management to evaluate the return on investment, measuring the economic viability of a project. As a result, the decades 1990 and 2000 had, as a major phenomenon, the fact that thousands of companies have started to implement the TPM in their units, but only a few hundreds have succeeded in this task (Moraes, 2004). Maintenance professionals have challenged to contribute to increased efficiency in equipment maintenance activities, but they use more technical indicators, making it difficult to measure the financial gains. It is in this framework the OEE indicator can be considered as an indicator of great importance in industry because it allows to quickly point out the performance of a machine by three factors (availability, performance, and quality).

This paper presents the preliminary results of the reflection of the Master that aims to facilitate the understanding and agreements between top management and maintenance, and monitoring of maintenance actions, correlated an industrial indicator (OEE) to a financial indicator (costs). To this end, it aims to make an exploratory evaluation use indicator OEE (Overall Equipment Effectiveness) in order to analyze the impact of this indicator on the cost of maintenance.

## **LITERATURE REVIEW**

Here, we sought to key concepts and definitions to give theoretical support to the discussions and conclusions on which was based the research. Thus, we evaluated how important the development of a brief history of the question of the Industrial Maintenance, clipping that has chosen to be treated in this work, to the specifications specifically linked to the TPM and OEE.

## **Industrial Maintenance**

This service sector has been historically seen as a repair sector, despite the name indicate the direction of "keeping the operating conditions" (Campos and Belhot, 1995).

However, global trends in enterprise productive organization reveal that new and diverse structures stand out in today's globalized markets framework primarily due to: a complexity and improving growing technology; increased demands on the diversification and quality of products and services; need for greater flexibility of businesses against an ever wider and more dynamic market, among others (Pinjala et al., 2006).

Thus, one can say that, in one way or another, the maintenance sector is between the quality and productivity standards, can be analyzed as a point of convergence of several aspects which relate to each other (Pinjala et al., 2006 ).

## **TPM - Total Productive Maintenance**

The National Survey of ABRAMAN - Brazilian Association of Maintenance and Asset Management - (2007), presents the TPM as one of the most used models by Brazilian Companies. Therefore, it is also the importance and updating studies that investigate the way businesses use this management model and how this philosophy, originating in Japan, has adapted to the Brazilian reality.

TPM consists of maintenance activities, with the participation of all company employees, being among the methods considered most effective to turn a factory in an operation has been oriented management for equipment, consistent with the changes in society Contemporary (Takahashi and Osada, 1993).

To Nakajima (1989, p. 9) TPM *"is a global system of industrial maintenance based on human capacity and participation of all to maximize asset utilization."* For the same author, *"TPM is a philosophy of industrial maintenance adapted by Japanese companies as a management system and organization based on small improvement groups through their own initiative."*

## **The Eight Pillars of TPM**

The TPM Program is composed by eight supporting pillars, which are listed below and best explained in sequence (Benelli, Pilatti, Frasson, 2009).

- I- Autonomous Maintenance
- II- Planned Maintenance
- III- Specific Improvements

- IV Education and Training
- V Quality Maintenance
- VI Initial Control
- VII Administrative TPM
- VIII Safety, Health and Environment

## Maintenance and TPM

Due to the detached manner of other active parts of the organization, as it was taken over time, the Maintenance sector suffered from the absence of a more professional vision which, according Belhot and Carvalho (1994), encompass planning for activities,

According Pinjala et al., (2006), was the need to streamline the stages of the business organization, equipment usage administration, coupled with technological complexity that manifested itself since then (in terms of products, processes and equipment), which was taking shape a business plan that could manage a Maintenance System. Figure 1 shows a summarized schematic form the various types of maintenance arranged in the same system

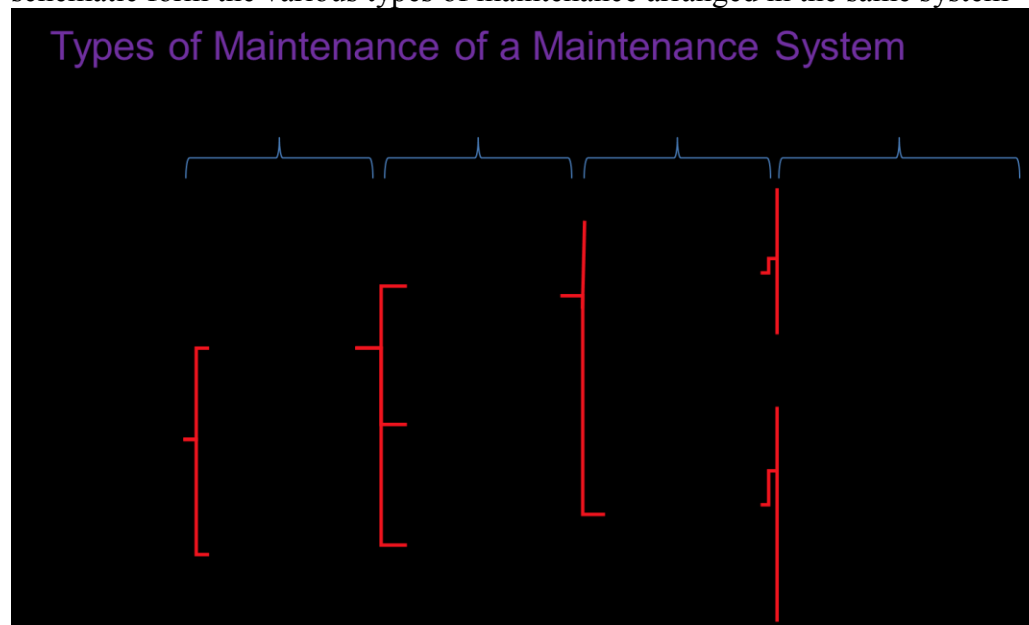


Figure 1 - Maintenance Types (SOURCE: Adapted by Author)

## OEE – Overall Equipment Effectiveness

Overall Equipment Effectiveness - OEE, called an indicator developed by the Japan Institute of Plant Maintenance, to measure the overall effectiveness of equipment and production systems. Santos and Santos (2007) has credited with this concept as a key measure to evaluate the performance of equipment, was being used as one of the fundamental components of TPM methodology, can measure the results that come up this concept.

In practical terms, it was only after the deployment of TPM in the 80s, the maintenance function has gained recognition as the main responsible for improving OEE (Hansen, 2006). Thus, OEE is a measure of aggregation value for a device or an assembly line, identifying also has called "unplanned losses" of a given machine (Figura 2).

## OEE (Overall Equipment Effectiveness)

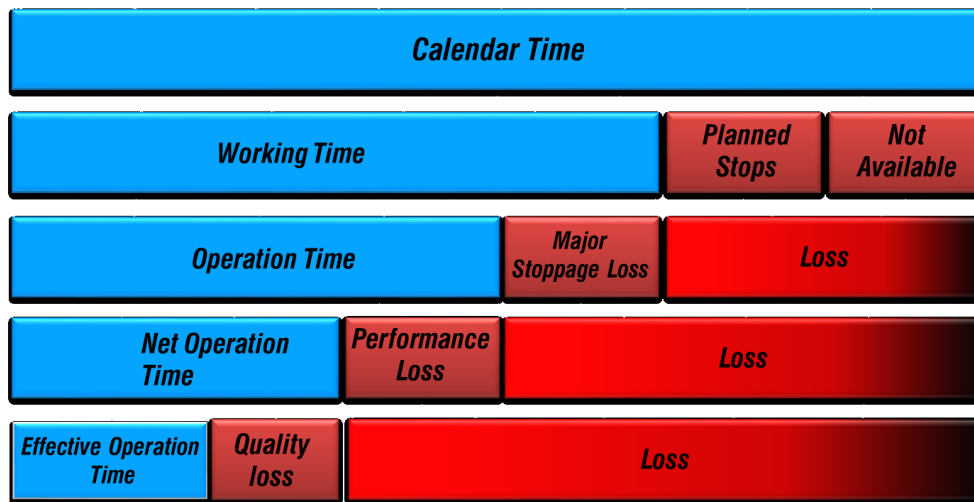


Figure 2 – Unplanned losses of a given machine

According to Nakajima (1988), the OEE results from direct multiplication of indicators related to three factors: availability of equipment, Performance and Quality.

$$\text{OEE} = \text{Availability} \times \text{Performance Factor} \times \text{Quality Factor} \times 100\% \quad (1)$$

As the OEE is the product of availability factors, performance and quality, the calculation from the equation (1).

## METHODOLOGY

Part of this study was conducted among the actors who work directly or indirectly in the place where such phenomena (TPM / OEE) occur naturally. Starting from some observations have been developed a questionnaire interview that made possible the collection of the data and its subsequent systematization for analysis / reflections and conclusions.

### Data Collection Procedures

Instruments such as forms / questionnaires and interviews were produced by this researcher based on the relationship between the theories and the subject matters of this dissertation.

First, a pilot study was conducted to shape the final questions. The pilot has undergone improvements from observations punctuated by the evaluators and responders.

The final version of the form was sent via email to the respondents that were chosen by the criteria of greater accessibility and availability.

Initially, 12 completed forms returned, with which was carried out the preliminary systematization and analyzes for the development of the text.

## **The Questions**

The proposed form can be divided in different parts: A, B, C, D and E. The first part (A) regards to information concerning the respondent. Stand out identification issues such as age, position, industry and working hours, as well as aspects related to the respondent's familiarity with the TPM (knowledge, implementation alternatives, OEE and level of involvement). The second part (B) refers to information about the company (sector, size, nationality).

The third part (C) comes to gather information on the impact of TPM and OEE in the company, while the fourth part (D) depicts information regarding the restrictive barriers the implementation of TPM. Finally, (E), addresses the beliefs relating to the main results in the use of TPM and OEE methodology.

## **Characteristics of Respondents**

### **PROFESSIONALS**

The 12 respondents have university level all aged between 56 and 27 years, and 50% are between 30 and 39 years, 25% are between 50 and 56 years, 16% between 40 and 49 years and between 8.33% 25 and 29 years.

Professionals are divided into occupations and 1 manager, 2 analysts, engineers 2, 3 and 4 supervisors / coordinators. They are distributed among the production sectors (3), maintenance (3), continuous improvement (2) Manufacturing (2), industrial (1).

### **COMPANIES**

The 12 respondents working in 12 different companies located in Brazil, being 5 Brazilian and 7 Multinational (3 Swedish, 3 Americans and 1 Dutch). Among the Brazilians, all are large (have more than 500 employees), one in each segment: appliance, automotive, textile, pulp and rubber.

Among the Swedish multinationals, two are medium sized (between 100 and 499 employees) in the vehicle segments and tooling for machinery, and a small (20-99 employees) also in the tooling segment. From the US, two are medium sized, in the fields of cosmetics and oil and gas; the other is a large metallurgical. The Dutch company is large and, in turn, operates in the food industry.

In summary, therefore, twelve companies were analyzed, being a small, four medium-sized and large seven.

## **IMPACTS**

The analysis shows the perception of the twelve respondents businesses compared with five statements about the impact of TPM:

- Question 1: The TPM is a management tool that allows for greater competitiveness;
- Question 2: In my company TPM is an important management tool for productivity;
- Question 3: In my company TPM is an important management tool for quality;
- Question 4: In my company TPM is an important management tool for maintenance;
- Question 10: I believe there was a reduction of maintenance costs after implementing TPM.

Grouped responses (5 questions of 12 respondents → 60 replies) indicate that for the topics competitiveness, quality, maintenance and maintenance costs 79% agree that the TPM brings contributions.

Regarding to the perception of the twelve responding companies over the five form the statements that refer to the impact of OEE:

- Question 5: The use of OEE in your company is critical to performance of operations;
- Question 6: The OEE is a management tool that allows for greater competitiveness;
- Question 7: In my company OEE is an important management tool for productivity;
- Question 8: In my company OEE is an important management tool for quality;
- Question 9: In my company OEE is an important management tool for maintenance;
- Question 11: I believe there was a reduction of maintenance costs, after measuring the OEE;

From the obtained 72 grouped responses, which indicates that for all threads competitiveness, quality, service and maintenance cost 82% agree that brings OEE contributions.

The question #12 of the form intended to obtain what was the percentage reduction from the use of TPM and OEE indicator. From 10 replies, a large number of respondents did not have knowledge or access these values (60% answered restricted information).

## **BARRIERS**

This analysis brings the issues 15-27, and grouped with use of Likert scale. It seeks to identify the barriers to implementation of TPM, where 1 = not significant; 2 = little significant; 3 = fairly significant; 4 = significant; 5 = very significant.

It could be observed that the questions referring to "lack of funds", "High complexity in implementation" and "Implementing TPM programs" are considered not significant barriers to most respondents.

On the other hand, questions related to "Ignorance about the TPM" and "internal resistance to organizational changes" were identified as very significant for almost half of the respondents.

## **SUCCESS**

This topic seeks to demonstrate the successful application of TPM and OEE indicator, drawing the perception of respondents with regard to issues related to people, assets and

operating results. The results bring as average 4.06, indicating quite an agreement of respondents as discussed positive results.

## **COSTS**

Regarding to the percentage of reduction of maintenance costs with the use of the TPM / OEE, the results were:

- None → 0%;
- Up to 4% → 10%;
- From 4% up to 8% → 0%;
- From 8% up to 12% → 20%;
- More than 12% → 10%;
- Do not have access to the data → 60%.

A question regarding to where there were major reductions of the five items was proposed, with the following order of prevalence:

1. Internal Labor;
2. Third Part Labor;
3. Parts;
4. Tools;
5. Energy.

The results also indicates that the Mean Time Between Failure (MTBF) and Mean Time To Repair (MTTR) are the ones which best expresses the needs of both sides of the mentioned company:

1. Cost of Maintenance x MTBF and MTTR;
2. Cost of Maintenance x Billing;
3. Cost of Maintenance x Availability;
4. Cost of Maintenance x Productivity;
5. Cost of Maintenance x produced parts.

## **CLOSING REMARKS**

From the obtained data of this research, it was possible to observe that TPM and OEE bring effective contributions to increase productivity, quality and competitiveness, and to reduce maintenance costs.

The lack of resources and of the complexity of implementation of TPM and OEE were not considered as barriers by the respondents. However, the lack of knowledge about TPM and OEE and the internal resistance to changes were considered the more significant barriers by the respondents.

Most of the respondents considered that the implementation of TPM and OEE bring positive results over the people behavior, assets and operational results.

Despite the major part of the respondents affirm that they could not access the information about maintenance costs, most of them said that reductions between 8% and 12% of the maintenance costs were obtained, mainly referring to internal labor expenses (better expressed by MTBF and MTTR indicators).

This research has the limitation given by the number of studied companies, so the results refer to these companies.

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