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A Systematic Approach towards Implementation of TPM in an Automobile Industry

Rachin Goyal*
Associate Professor,
Department of Mechanical Engineering,
Chandigarh Engineering College,
Landran, Mohali (Punjab) India

Dr. Sandeep Jindal
Professor,
Department of Mechanical Engineering,
Chandigarh Engineering College,
Landran, Mohali (Punjab) India

***Abstract*—**

It is evident that a well drawn TPM implementation plan not only improves equipment efficiency and effectiveness but also brings appreciable improvements in other areas such as reduction of manufacturing cycle time, size of inventory, customer complaints, and creates cohesive small group autonomous teams and increases the skill and confidence of individuals. The resulting system is found to be more productive in terms of both partial and total productivity measures. The Purpose of this paper is to evaluate the success of TPM on the basis of improvement in overall equipment effectiveness (OEE) as it has been found to be a very important parameter for success of TPM implementation.

Keywords*— *Total Productive Maintenance, Overall equipment effectiveness, Inventory

I. INTRODUCTION

Maintenance is undertaken to preserve the proper functioning of a physical system, so that it will continue to do what it was designed to do. Recent trends indicate that many systems in use are not performing as intended, so far as effectiveness in terms of their operation is concerned. Manufacturing systems in particular often operate at less than full capacity, with low productivity and the cost of producing products are high. Recent study [1] shows that 25-30% of total production cost is attributed to maintenance activities in the factory. The quality of maintenance significantly affects business profitability. The importance of maintenance functions has increased due to its role in keeping and improving the availability, product quantity, safety requirements, as maintenance costs constitute an important part of the operating budget of manufacturing firms [2]. In response to maintenance problems encountered in manufacturing environment, the Japanese developed and introduced the concept of Total Productive Maintenance (TPM), in 1971. TPM is a maintenance system defined by Nakajima [3] in Japan, which covers the entire life of equipment in every division including planning, manufacturing, and maintenance. It describes a synergistic relationship among all organizational functions, but particularly between production and maintenance, for continuous improvement of product quality, operational efficiency, capacity assurance and safety. TPM is a program that "addresses equipment maintenance through a comprehensive productive-maintenance delivery system covering the entire life of the equipment and involving all employees from production and maintenance personnel to top management". [3]. TPM is "a way of working together to improve equipment effectiveness" [4]. According to the Nakajima [3], the word 'total' in TPM has three meanings:

1. Total effectiveness indicates TPM's pursuit of economic efficiency and profitability.
2. Total maintenance system includes Maintenance Prevention (MP) and Maintainability Improvement (MI), as well as PM. Basically; this refers to ''maintenance-free'' design through the incorporation of reliability, maintainability, and supportability characteristics into the equipment design.
3. Total participation of all employees includes Autonomous Maintenance (AM) by operators through small group activities. Essentially, maintenance is accomplished through a 'team' effort, with the operator being held responsible for the ultimate care of his/her equipment.

II. PILLARS OF TPM

The pillars [6] on which the TPM implementation methodology is based are shown in fig.

The Japan Institute of Plant Maintenance propose the introduction of TPM pillar is based on the implementation of a series 8 pillars of TPM in a systematic way to optimize plant and equipment efficiency by crating perfect interaction between man and equipment. The Figure 1 represents a common structure of TPM.

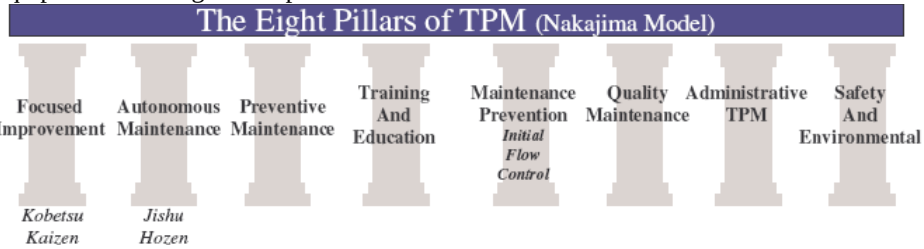

Fig. 1 Pillars of TPM

PILLAR 1 – KOBETSU KAIZEN

This pillar focuses on that "A very large number of small improvements are more effective in an organizational environment than a few improvements of large value." [7].

Focused improvement includes all activities that maximize the overall effectiveness of equipment, processes, and plants through uncompromising elimination of losses and improvement of performance" [8]

PILLAR 2 - AUTONOMOUS MAINTENANCE OR JISHU HOZEN

This is the basic premise of TPM "Autonomous maintenance is the process by which equipment operators accept and share responsibility (with maintenance) for the performance and health of their equipment" [9].

PILLAR 3 – PREVENTIVE MAINTENANCE

The objective of Planned Maintenance is to "establish and maintain optimal equipment and process conditions" [10].

PILLAR 4 - MAINTENANCE PREVENTION PILLAR (MP)

Maintenance Prevention refers to "design activities carried out during the planning and construction of new equipment, that impart to the equipment high degrees of reliability, maintainability, economy, operability, safety, and flexibility, while considering maintenance information and new technologies, and to thereby reduce maintenance expenses and deterioration losses." [11].

PILLAR 5 – EDUCATION AND TRAINING

Education and Training [1] is the important pillar of TPM. Training of operators is needed to give them the knowledge of what daily maintenance is needed as well as what are the optimal operating conditions as well.

PILLAR 6 - QUALITY MAINTENANCE PILLAR

"Quality maintenance, in a nutshell, is establishment of conditions that will preclude the occurrence of defects and control of such conditions to reduce defects to zero."

PILLAR 7 - ADMINISTRATIVE TPM PILLAR

Administrative TPM applies TPM activities to continuously improve the efficiency and effectiveness of logistic and administrative functions.

PILLAR 8 - SAFETY AND ENVIRONMENTAL PILLAR

Although shown as the last pillar of TPM (Figure 1), the TPM Safety and Environmental pillar is equally, if not more, important than the seven others.

III. OVERALL EQUIPMENT EFFECTIVENESS (OEE)

Measurement is an important requirement of continuous improvement processes. It is necessary to establish appropriate metrics for measurement purposes. From a generic perspective, TPM can be defined in terms of overall equipment effectiveness (OEE), which in turn can be considered a combination of the operation maintenance, equipment management, and available resources. The goal of TPM is to maximize equipment effectiveness, and the OEE is used as a measure. According to Nakajima [3], OEE measurement is an effective way of analyzing the efficiency of a single machine or an integrated manufacturing system. It is a function of availability, performance rate, and quality rate. Actually, the three dimensions are measures of the equipment losses. In practice, OEE is calculated as the product of its three contributing factors:

OEE = Availability X Performance X Quality

For example, if all the three contributing factors are 90.0%, the OEE would be72.9 %.The method of calculating OEE is: In practice, the generally accepted worldwide goals for each factor are quire different from each other, as shown below:

TABLE I WORLD CLASS OEE

OEE Factor	World Class
Availability	90.0 %
Performance	95.0 %
Quality	99.9 %
OEE	85.0 %

Worldwide studies indicate that the average OEE rate in manufacturing plants is 60%. World class OEE is considered to be 85% or better [3]. Clearly, there is a room for improvement of OEE in many manufacturing plants!

IV. STEPS FOR TPM IMPLEMENTATION IN AN AUTOMOBILE INDUSTRY

Following are the important steps for successful implementation of TPM on the basis of case study conducted by the author at a reputed Automobile Manufacturing Company.

1. Selection of Machines

The first step of TPM implementation is to selection of machines on which the study is carried out. To start with TPM, a few machines have been selected for implementation of TPM, which is known as TPM model machine. A code is assigned to each machine for ease of identification. Each machine is studied thoroughly to identify each part and to understand the working of every component.

2. Implementation of 5S on selected Machines

This is also called foundation pillar of TPM. **5S** is a simple but highly effective set of techniques that remove waste from work environment through better workplace organization, visual communication and general cleanliness. 5S are defined as Sort, Set in Order, Shine, Standardize and Sustain. Because each of the five pillars begins with S, this method was appropriately named 5S. These 5S are implemented on TPM model section.

3. Implementation of Jishu Hozan

Jishu Hozen also called autonomous maintenance is a team-based approach to maintenance activities. The goal of autonomous maintenance is to prepare operators to do some equipment care independently of the maintenance staff. Jishu Hozen implementation lays the foundation for other maintenance activities by establishing the basic conditions for a machine's operation. Various tentative standards for cleaning, inspection and lubrication are set for all machines. After setting up of standards for all machines, fuguaies are found in all machines. Fuguaies are the abnormalities in the machine, which is noted during the initial cleanup

4. Implementation of Kobetsu Kaizen

Kaizens are performed on all the machines/equipment to accomplish maximum efficiencies of individual facilities, equipment and manufacturing processes, as well as entire plants, by thoroughly elimination losses and improving performance. A proper kaizen sheet is to be filled for each kaizen, which contains all information like before and after photographs, ideas and benefits. So, if any further other modification is suggested then this sheet is very helpful for that.

5. Calculation in Improvements of OEE

According to Nakajima [3], OEE measurement is an effective way of analyzing the efficiency of a single machine. It is a function of availability, performance rate, and quality rate. In practice, OEE is calculated as the product of its three contributing factors:

OEE = Availability X Performance Rate X Quality

OEE is calculated for all the machines before and after implementation.

6. Result Analysis

The improvement in the OEE is carefully calculated and compared with best OEE index of world class manufacturing companies. This analysis is important to assess the output of the TPM implementation and developing future policies to continue TPM programme in other plants of the company.

V. CONCLUSIONS

In today's times TPM can be adapted to work not only in industrial plants, but in construction, building maintenance, transportation, and in a variety of other situations. While implementing TPM we found some barriers for effective implementation of TPM, such as Lack of Management Exposure, difficulty in understanding TPM methodology and philosophy by middle management, long time taken for implementation so people shows strong resistant to it. Employees must be educated and convinced that TPM is not just another "program of the month" and that management is totally committed to the program and the also in extended time frame necessary for full implementation. One of the important and widely used methods of performance in manufacturing is OEE especially for firms applying TPM. TPM activities in administrative and support departments do not involve production equipment. Rather, these departments increase their productivity by documenting administrative systems and reducing waste and loss. Total productive maintenance is one of the best tools for making our industries competitive and effective in the field of maintenance.TPM may be the only thing that stands between success and total failure for many companies.

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