Implementation of Total Productive Maintenance Methodology: A Review

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Abstract—Today’s global world competitive market every industry needs to minimize its operating cost and produce world class products. Maintenance Practice is considered as an important function to increase the Productivity by maximizing the overall equipment effectiveness. Total Productive maintenance (TPM) is an approach to understand equipments function, equipment failure and relationship with product quality. TPM is interference between man and machine. The purpose of this paper is to understand and investigate the contribution of TPM in Indian industry. TPM is a systematic procedure to achieve maximization of profit, increase equipment life, also improve employee morale. The study find out the basic requirement of TPM and proper planning for implementing TPM at the initial stage in the organization. This study discuss important key performance indicators (KPI) of TPM which are machine breakdown time, Mean time between failure (MTBF), Mean time to repair (MTTR). The main objective of TPM is to create active participation of all employees in maintenance and production system.

Keywords—Total Productive Maintenance, Overall Equipment Efficiency, Mean time between machine failure, Mean time to repair, Preventive maintenance.

I. INTRODUCTION

Total Productive Maintenance (TPM) is a unique Japanese philosophy combines with American preventive maintenance and total involvement of employees. TPM is an innovative system for equipment maintenance that optimizes effectiveness, eliminates breakdowns and promotes autonomous operator maintenance through day-to-day activities.

TPM aims to use equipment at its maximum effectiveness by eliminating waste and loss caused by failure of the equipment, set up and adjustment, speed losses, process defects and reduced yield.

TPM aims at improving the productivity by improving its personnel and their skills by changing the corporate culture. The operator carries out daily maintenance work such as clean up lubrication, tightening and external inspection so that the equipment does not break up.

Today’s industrial scenario huge losses occur in the manufacturing shop floor. These losses are due to operators maintenance personal process, tooling problems and non-availability of components in time etc. The quality related wastes are of significant importance, as they matter the company in terms of time, material and reputation of the company. These are also other invisible losses like breakdown of the machines, material shortages start up loss, bottlenecks in the process zero-oriented concepts such as zero defects, zero breakdown and zero accidents are becoming prerequisite in the manufacturing and assembly industries [1].

The changes in the current business environment are characterized by intense competition, there by increased pressures to reduce costs, and heightened volatility in customer requirements on the demand side [2].

The change in the market increased the level of global competitiveness between organizations and everyone wants to satisfy customers more than others do. The global marketplace has witnessed an increased pressure for reduced operating costs with improved performance in industrial sectors including healthcare [3, 4]. Hence, the aim of this paper is to present an implementation methodology for the TPM in chemical industries that can reduce maintenance cost and improve operational efficiency.

Avoid wastage in a quickly changing economic environment. Producing goods without reducing product quality. Reduce cost. Produce a low batch quantity at the earliest possible time. Goods send to the customers must be non-defective. Establishing a total system of Preventive Maintenance for the life of equipment [5]. TPM consist of eight pillars, which are autonomous maintenance, Kobestu kaizen, planned maintenance, Training & development, office TPM, Safety, environment, and finally initial flow control. [6]

II. LITERATURE REVIEW

A careful and systematic effort made to identify various factors influencing the Employees, Machines, Performance, Quality of product and available time for productivity through the literature survey.

For the world class maintenance how CMMS (computerized maintenance management system) help & CMMS need for industry with different factors for world-class maintenance system [7]

Ref. [8]: Author et al investigated that the critical study of OEE and tacit time analysis with eyed time and finding performance ratio of equipment. The performance ratio of such equipment as evaluated as 100% in traditional approach all the time because the cycle time is always same as the cycle time is always same as the ideal cycle time and high OEE value interaction approach will usually lead to overproduction during low demand of period.

Author et al, Study of implementation of TPM in small-scale industry it is essential tool for business competitive machines performance and improved OEE 13.83% and hence higher OEE indicate better control will have over equipment and processes [9]. Ref. [10]: Author et al investigate that the critical studies of auto industry of implementation of TPM reduce down time; improve monthly output 7.52% with performance efficiency and quality. Ref.[5]: Authors et al, imperial study of this paper OEE study, how 5S helps in TPM and find out Jishu hozen pillar implementation (Lubrication, CLIT and one point lesson).

Calculation of OEE with six big losses in short pining machine with increased OEE 20%[11]. Rigorous implementation of TPM need to top management commitment, resource management, performance measurement system, education and training, continuous improvement system and work culture involvement factors are most important.

2.1 Goals of TPM
1. Obtain Minimum 90% OEE (Overall Equipment Effectiveness)
2. Run the machines even during lunch. (Lunch is for machines)
3. Operate in a manner, so that there are no customer complaints
4. Reduce the manufacturing cost by 30%
5. Achieve 100% success in delivering the goods as required by the customer.
6. Maintain an accident free environment.

III. FRAME WORK OF TPM

As per Japanese concept workplace, need to clean and all the things arranged as per requirement and unnecessary things are removing from the work place hence first step towards TPM implementation is '5S'.

5S
5S is a barometer of management.
Various companies reveal frequent use of the term, PM/QC, and the posting of various management graphs on the management board at the workplace.

However, examinations of machines, materials and workers in the field reveal that the driving mechanism of machines is covered with dust, oil is leaking, and workers are working without a hat and shoes, as if nothing matters. In plants, quantity and quality should be manufactured by equipment, however in conditions such as the ones described above, TPM or TQC cannot be considered to be performed successfully.

What is 5S?
1. Order (Seiri):-
   This means sorting and organizing the items as critical, important, frequently used items, useless, or items that are not need as of now. Critical items should be kept for use nearby and items that are not be used in near future, should be stored in some place. For this step, the worth of the item should be decided based on utility not cost. Because of this step, the search time reduced.

2. Arrangement (Seiton):-
   The concept here is that "Each item has a place and only one place". The items should be placed back after usage at the same place. To identify items easily, nameplates and colored tags has to be used. Vertical racks used for this purpose, and heavy items occupy the bottom position in the racks.

3. Cleaning (Seiso):-
   This involves cleaning the work place free of burrs, grease, oil, waste, scrap etc. No loosely hanging wires or oil leakage from machines.

4. Standardizing (Seiketsu):-
   Employees have to discuss together and decide on standards for keeping the work place / Machines / pathways neat and clean. These standards implemented for whole organization and are tested / inspected randomly.

5. Discipline (Shitsuke):-
   Considering 5S as a way of life and bring about self-discipline among the employees of the organization. This includes wearing badges, following work procedures, punctuality, dedication to the organization etc. [5]
IV. EIGHT PILLARS OF TPM

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 creating perfect interaction between man and equipment. The Figure 1 represents a common structure of TPM.

![Figure 1. Pillars of TPM](image)

1. Jishu Hozen / Autonomous /Operators pillar

Autonomous Maintenance aims to create a scenario where all operators look after own equipment, carrying out routine checks, oiling and greasing, replacing parts, doing repairs, spotting problems at an early stage, checking precision and so on. The most important skill required of an operator is the ability to identify abnormalities and notice immediately when something is not quite right with the quality or the equipment. This skill requires three abilities:

- The ability to set conditions.
- The ability to sustain.
- The ability to take corrective action and affect repairs.

The problems that stop equipment from working, or make it work less effectively, can be eliminated - in other words, zero-defect, zero-breakdown status can be attained - by changing the way everyone who works with the equipment. When the equipment works better, the people work better, and when the people work better, the whole factory works better. Autonomous Maintenance should be introduced gradually under the guidance of management, with each step implemented thoroughly. It should involve the whole workforce and empower each individual to fulfill his or her potential.

Seven step of implementation of Jishu Hozen pillar.

Step 0: Safety
Step 1: Initial Cleaning
Step 2: Eliminate sources of contamination and inaccessible.
Step 3: Creation and Maintenance of cleaning and lubrication Standard.
Step 4: General inspections.
Step 5: Autonomous inspections.
Step 6: Standardization.
Step 7: fully implemented autonomous maintenance pillar

Step zero to four implement initial understanding base and after that making a schedule for general inspection and then fully implement the autonomous pillar & analyzed MTBR.

2. Kobetsu Kaizen

Various “kaizen” activities to accomplish maximum efficiencies of individual facilities, equipment and manufacturing processes, as well as entire plants, by thoroughly elimination losses and improving performance. Kaizen Realize the zero loss situation in such as an equipment failure and product defect & that affect ultimate production efficiency situation.

2.1 Activities of Kobetsu kaizen

Recognition of 16 major losses, improve Overall equipment efficiency, material, die, jig, tool and energy requirement per product unit calculation and settling the target for the above. Analysis of phenomenon and review of associated factors, Execution of PM analysis.
2.2 Various methods for kobetsu kaizen

PM Analysis (Analysis method approaching phenomena from a physical viewpoint) ,Know-how analysis (why-why analysis) ,Fault tree analysis (FTA) Failure mode and effects analysis (FMEA), Industrial engineering ,Value analysis (VA),Just in Time (JIT),QC Tools.

3. Planned Maintenance

When we want to implement equipment maintenance in line with the business objectives, factory-wide maintenance orientation must be proactively changed from breakdown maintenance to preventive and predictive maintenance. Factories need this because they aim to minimize cost and maximize production.

The purpose of Planned Maintenance is to ensure the equipment conditions at their best with the minimum maintenance cost, enabling equipment to function at an optimal level whenever operation is required.

In order to achieve this purpose, both the production department and the maintenance department must carry out their roles of equipment maintenance properly. In addition, other activities such as Kobetsu Kaizen (Individual Improvement, Focused Improvement) and MP (maintenance prevention) activities must be coordinated to realize the ultimate aim of minimum cost production.

4. Quality Maintenance

The purpose of Quality Maintenance is to produce defect free products to maintain the product quality through eliminating non-conformance to satisfy the demand of the customer. The Japanese Institute Of Plant maintenances define Quality Maintenance as activities that are to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The conditions are checked and measured in time series to verify that measured values are within standard values to prevent defects. The transition of measured values watched to predict possibilities of defects occurring and to take counter measures before hand.

5. Training and Education

All shop-floor training should be based on a clear understanding of the human resource development systems and policies laid out by the company’s personnel and training departments. Prospective trainees are selected, and their training needs assessed. This assessment may be based on past work performance evaluations, daily observation, or the individual’s own stated wish for training. Once these training needs have been established, a training plan is drafted.

The training policy, objectives, curriculum, teaching method and other details worked out, and the training and development plan is finalized.

Training may implemented by day-to-day teaching and coaching, informal chats, and assistance with self-study. Off-the-job-training is another effective method worth considering.

6. Safety, Health and Environment

The basic principle of safety, health and environment is to minimize the number of accidents, health problems and damage to the environment. This pillar plays a great role in the other pillars that addresses workplace organization and discipline, regular inspections and servicing, and standardization of work procedures.

7. Office TPM

Companies must map out a clear strategy to respond to this change and dramatically shorten their product time-to-market. At the same time, they must distinguish themselves from their competitors in both quality and cost. These are the most important challenges facing managers today.

Eighty percent of a product’s quality and cost is already determined at the development, design, and production stages. Development, design, and all other staff departments must cooperate determinedly to ensure that the production department does not produce useless or wasteful products. Meanwhile, companies must set up manufacturing plants in a way that enables the production department to fill orders on time, at the quality and cost that the development and engineering departments prescribe. This is not the responsibility of the production department alone – it requires a TPM program that embraces the entire company, including the administrative and support departments.

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. They can help raise production-systems effectiveness by improving every type of organized activity that supports production. Their contributions to the smooth running of the business should be measurable.

V. OVERALL EQUIPMENT EFFICIENCY (OEE)

OEE calculated in terms of basic six big losses, which is essential function of Availability, Performance rate, and quality rate of machine, production line or Factory whichever is the focus of OEE application.
OEE (%) = Availability (%) * Performance rate (%) * Quality rate (%)

Where

Availability (%) = \frac{Actual\ operating\ time (\text{min})}{Planned\ operating\ time (\text{min})} \times 100 \quad (2)

Performance rate (%) = \frac{Net\ operating\ rate \times Operating\ speed}{100} \quad (3)

Quality rate = \frac{Total\ no.\ produced - No.\ Scrapped}{Total\ no.\ produced} \times 100 \quad (3)

The most important objective of OEE is not to get an optimum measure, but it indicates in which area improvement is needed [6].

VI. CONCLUSION

The main aims of study of this paper understand TPM methodology and tools of TPM. Implementation of TPM is not overnight. It is day-to-day activity with involvement of all employees. It needs top management commitment. The performance measurement for production process is very important for sustaining firms. Managers make decisions from this correct evolution. Therefore, appropriate measurement is necessary. The accuracy of global performance evolution is essential to improve and succeed in business goal. One of the important and widely used metrics of performance in manufacturing is OEE especially for firms applying TPM [3]. 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 some companies [11].

REFERENCES


