

# Total Productive Maintenance- A Systematic Review

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**Abstract**— TPM is an effective tool and a practical technique, which is aimed at maximizing the effectiveness of the facility by minimizing the downtime of machine, production losses and the material, production losses that occurs during the continuous production process. This also increase the working efficiency and productivity of the employee and a positive inclination is registered in the overall environment of a company. This paper presents the literature review of total productive maintenance which is a positive approach for solving the manufacturing problem, also gives the objective of TPM, a detail about a six big losses, 8 pillar of TPM also give the tool used for improvement, implementation stages, methodology for calculating the overall equipment efficiency and also give the direct and indirect benefits of TPM. The aim of this paper is to study the TPM concept and its implementation program which gives a successful improvement in overall equipment efficiency.

**Keywords:** Six Big Losses, TPM Pillar, Implementation Stages, OEE

## I. INTRODUCTION

Now days, Maintenance is a critical factor to improve productivity and quality in manufacturing industries. TPM is a techniques and an effective tool which aimed at increasing the productivity and quality by reducing the waste, proper maintenance and availability of equipment and aiming toward zero defect. TPM is a lean tool which establishes a system of productive maintenance, covering the entire life cycle of equipment, covers all departments, involves participation of all the employees from the top to bottom i.e., from management to the shop floor. The concepts of the TPM were first introduced by Seiichi Nakajima who is the father of TPM who gives a fundamental concept and also explains the steps for implementing TPM in Industry. The first implemented of TPM strategy in M/S Nippon Denso co. Ltd of Japan in the year 1971. The concepts of TPM was originally developed from maintenance and from United States between 1940 to 1950 at that time the company used to do only productive maintenance. TPM is method of a tool which wholly depend on the OEE which was proposed by Nakajima and it's a multiplication of A, P and Q which is used for finding out the current situation of company, where they are and what are the weakness and how to improve. Therefore, TPM can be considered as treatment to improve the performance of machines. TPM is a maintenance program for maintaining plant and equipment.

## II. LITERATURE REVIEW

Ranteshwar Singh et al. [1] In this paper the author implemented a TPM strategy in the machine shop having a CNC turning of different capacity and eliminate the losses, improve the utilization of CNC Machine. OEE is used to

measure success of TPM implementation. Jihnasha P Acharya et al.[2] in this paper the author present the literature review of TPM and is used to solve the manufacturing problem, this paper also explain the overview of TPM pillar. Nitish Mundhada et al.[3] In this the researcher uses a lean which aim is to diagnosing the production process , removing/reducing process waste , cleaning the production environment , improving plant layout and organization workstation by using a 5s. Sarang Katkamwar et al.[4] In this the author study and overview of TPM implementation in Indian spinning Industries and uses a JH-check sheet, PM-Check Sheet, OPL in order to improve the OEE and proper implementation of TPM. Ajit pal singh ,

Melesse Wakajiran et al.[5] this the author focus on significant contribution of TPM implementation process and also focus on the TPM pillar for success and also it carried out a case study in power plant industry to find out the OEE before and after TPM and is compared with world standards. Prof. pradeep Kumar et al.[6] In this a researcher uses a TPM technique which aimed at maximizing the effectiveness of facility and also carried out a successful implementation of work literature reviews was done and carried a study at printing press machine and packaging based on real time data and analysis was done to obtain achievable results and calculate OEE and solve problem to increases OEE. G . Ananth, DR. B.K Vinayagam et al.[7] In this researcher aim is to maximize the availability and Overall Equipment effectiveness of the steam power and thermal efficiency of a plant by implementing of TPM. Mr. ranjeet M. Jadhav et al.[8] In this the researcher study the implementation of TPM program in an Indian history using JH Check sheet , PM Check sheet , OPL for proper implementation of the TPM and after implementing both direct and indirect benefits are shown. Osama Taisir R. Almeanazel et al.[9] In this a team is formed to find out the benefits of formation of a team from different dept. To eliminate any boundaries between a dept. and make maintenance process more effectively and also adopt the autonomous maintenance and also suggest to implement TPM to improve their maintenance procedure and productivity after calculation of the OEE. I.P.S Ahuja et al.[10] The purpose of this paper is to review the literature on TPM implementation practices adopted by the manufacturing organization. It also focus seeks to success factors for eliminating barrier in successful TPM implementation.

## III. OBJECTIVE OF TPM

- Maintain an accident free environment.
- Increasing the operator involvement.
- Maximizing the Reliability of machine.

- Improving the Quality and Reduce cost.
- Focus on Maintainability engineering.
- Improving problem solving by team
- Upgrading each operator.
- Motivating the operator
- Increasing the OEE.

#### IV. SIX BIG LOSSES

The aim and the objective of the TPM are to minimize or eliminate the six big losses which mostly affect the efficiency of the plant, it is necessary to make improvement in maintenance strategy. Following are the six big losses which occurs during the production process which are as follows,

- (1) Breakdown losses.
  - (2) Setup and adjustment losses.
  - (3) Minor stoppages losses.
  - (4) Speed losses.
  - (5) Quality defect and rework losses.
  - (6) Yield losses.
- Breakdown losses: - This loss is comes under the downtime losses. This type of losses is occurs due to the failure of parts , which causes stop of production and these can be measured by how long it takes to repair or replaced the part or problem.
  - Setup and adjustment losses: This is also comes under the downtime losses .this type of losses occurs during to change in production process such as change of section , change operating condition , start of different shift , change of product and many more.
  - Minor losses: This loss come under the sped losses i.e. speed losses means the output is smaller than the rated output or targeted output. Minor stoppage occurs due to jamming, machine idling.
  - Speed losses: These losses are due to reduction in speed of the equipment that means the machine is not running at its original operating speed.
  - Quality defect and Rework losses: These losses are due to the defective product produced during the production process and the product are not in the standard Specification give by the company for stated products and therefore rework has to be done to remove the defects and make it again into the standard specification of the company.
  - Yield losses: These losses are due to wasted raw material.From the above losses, the first two losses affect the availability of a piece of equipment, the third and forth affect the equipment performance, fifth and sixth affect the quality rate.

#### V. TPM PILLAR

##### A. Pillar 1 – 5S:

This is the first step in TPM .5S is a lean method and it's a system of process improvement through reduction in waste cleaning workplace. It's a systematic process of housekeeping to achieve a good environment or a clean and clear in the workplace. If this 5s is not taken up seriously, then it leads to 5D i.e. Delays, Defect, Dissatisfied

customers, Declining profit and Demoralized employees. Following are the component of 5s

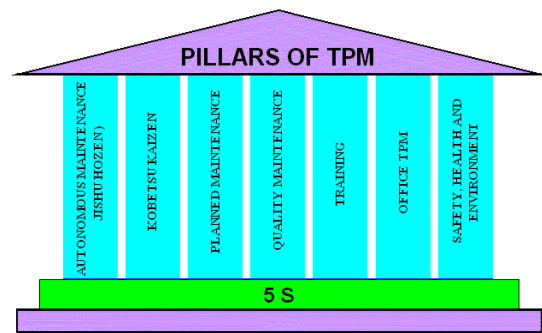


Fig. 1: Shows the TPM PILLAR

##### B. SEIRI-Sort-out

This means sort-out unnecessary items from the shop floor or workplace and removes them.

##### C. SEITON-Set in Order

This means that arrange items i.e. necessary items in a proper order to that they can be easily picked up for use when required.

##### D. SEISO-Shine

This means cleaning the workplace free of burrs, grease, oil, water, waste, Scrap etc. i.e. cleaning the work piece completely.

##### E. SEIKETSO-Standardizations

This means maintain high standard for keeping the workplace, Machine, pathways neat and clean.

##### F. SHITSOKE-Self-discipline

This means train and motivates people to follow good housekeeping discipline autonomously.

##### G. PILLAR 2 – Autonomous Maintenance

Autonomous Maintenance means maintain one's own equipment by one self. The concepts of this pillar are to take care of small maintenance task. In this the operator are responsible to upkeep their equipment on daily basis so as to prevent it from deteriorating. The activities involved in this are daily inspection, lubrication, minor repair, part replacement. The abnormalities are eliminated by using the technique such as abnormality sheet, CLITA, OPL, Inspection, Lubrication Sheets.

##### H. PILLAR 3- Planned Maintenance

This pillar aimed toward to have a trouble free machine and equipments for improving the reliability and maintainability and also for total customer satisfaction for the products. Planned Maintenance are mainly divided into four categories:

- (1) Preventive maintenance
- (2) Breakdown maintenance
- (3) Corrective maintenance
- (4) Maintenance prevention

In this we use a trained maintenance start to help train the operator to better maintain their equipment.

##### Benefits

- (1) Optimum maintenance cost.
- (2) Reduce spares inventory.
- (3) Improve Reliability and maintainability.

##### I. PILLAR 3- Kaizan

In this KAI means "change" and ZEN means "good". Generally kaizen is for small improvement and it involves

all people from the organization. The principle behind kaizen is that a very large number of small improvements is more effective in an organization than a few improvements of large value. The aim of this pillar is to reduce losses in the workplace that affect our efficiencies. The objective of kaizen is to achieve and sustain zero losses with respect to minor stops, measurement and adjustment, defect and unavoidable downtime. The tools used in kaizen are why-why analysis, poka-yoke i.e. mistake proofing.

#### J. PILLAR 4 – Quality Maintenance

This pillar aimed toward achieving the customer requirement through highest Quality through defect free manufacturing. Through focused improvement, defect the process after identifying the parameters of machine which mainly affect the products. Transition is from Quality control to Quality Assurance.

#### K. PILLAR 5- Training and education

This pillar aimed toward developing a multiskill employee whose morale is high and who has eager to come to work and perform all required function effectively. In this an operator is educated as per required. So that he/she will be able to solve the problem. The goal is to create a factory full of expert. Training policy are focus on improvement of knowledge, skills and technique. The different phase of skill is,

- (1) Do not know.
- (2) Know the theory, but cannot do.
- (3) Can do but cannot teach.
- (4) Can do and also teach.

#### L. PILLAR 6- Office TPM

This pillar should be started after its successful activating of four pillar of tpm which are JH, KK, QM, PM office tpm must be followed to improve productivity and efficiency of the administrative functions. Due analyzing process and procedures towards increasing in the office automation office TPM has some major losses such as processing loss, cost loss, idle loss, setup loss, office equipment breakdown.

#### M. PILLAR 7- Safety, Health and Environment

This pillar focuses towards to create a safe workplace and a surrounding area so that our process does not damaged that area. This pillar plays an important role in each of the other pillar on a regular basis- Manager or any other higher authority looking after function related to safety. In this it is necessary to create awareness among employees aimed also safety slogans, Quiz, poster, Drama must be organized on regular basis.

### VI. TPM IMPLEMENTATION STAGES

#### A. Preparatory Stage

- Announcement of TPM by management in the organization.
- Launching a formal education.
- Establishing TPM and departmental committees.
- Establishing the TPM working system.
- A master plan for institutionalizing.

#### B. Introduction Stage

In this stage a small get together is arranged which includes our supplier as they should know that we want quality supply from them and also people from related companies who can be our customers are also invited. In this some may learn from us and some can help us and customer will get

the message from us that we care for quality output, cost and keeping to delivery schedule.

#### C. TPM Implementation

In this stage eight activities are carried out which are eight pillars in the development of TPM activity of these four activities are for establishing the system for production the system of new product and equipment, one for improving the efficiency of administrative and are for control of safety.

#### D. Institutionalizing Stage

By now the TPM Implementation activities would have reached to the maturity stage and now it's time to apply for preventive maintenance.

### VII. OVERALL EQUIPMENT EFFICIENCY

OEE is a tool to measure the productive and a best way to monitor and improve the efficiency of a manufacturing process in the organization. OEE is the ratio of the actual output of the equipment to the maximum output of the equipment under the best performance condition. This term OEE is originated from the total productive maintenance developed by S. Nakajima at the Japan institute of plant maintenance. The aim of the TPM is to achieve the ideal performance and also to achieve the ideal performance and also to achieve no. scrap, no breakdown, no accident, no waste during the process. OEE is divided into three main factors, which are availability, performance, and Quality rate.

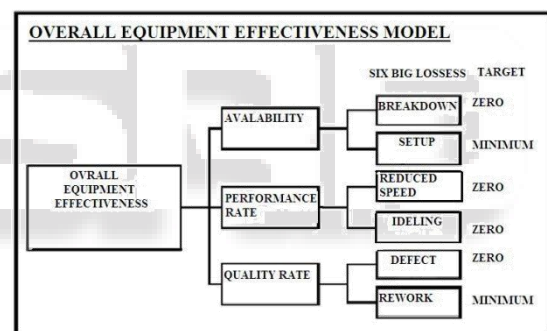


Fig. 2: Show the OEE Model

#### A. Availability

It can be defined as the time of production to operate the equipment minus the other planned downtime.

$$\text{Availability} = \frac{(\text{Required availability} - \text{Downtime})}{(\text{Required availability})} * 100.$$

#### B. Performance

It can be defined as the design cycle time to produce the item multiply by the output of the equipment and then divided by the operating time.

$$\text{Performance} = \frac{(\text{design cycle time} * \text{output})}{(\text{operating time})} * 100$$

#### C. Quality

It is the ratio of production output to the production input.

$$\text{Quality} = \frac{\text{output}}{\text{input}}.$$

#### D. OEE

It is the product of Availability, Performance, and Quality.

$$\text{Overall Equipment Efficiency} = \text{Availability} \times \text{Performance} \times \text{Quality}.$$

### VIII. DIRECT BENEFITS OF TPM

- OEE is improved.
- Customer complaint reduced.
- Reduction in the manufacturing cost by 30%.
- Satisfying the customer need by 100%.
- Reduced accidents.

### IX. IN DIRECT BENEFITS OF TPM

- Confidence of Employees increase.
- A clean, neat and attractive Workplace.
- Favorable change in the attitude of the operators.

### X. CONCLUSIONS

- (1) From the above discussion it is clear that success of tpm depends on various pillars such as 5S, KK, PM, QM, Office TPM and safety, Health.
- (2) TPM focus on maximizing the overall equipment Efficiency with the involvement of each and everyone in the organization by implementing the TPM strategy we can eliminate most of the waste and increase the efficiency of the plant.

### REFERENCES

- [1] Ranteshwar Singh, Ashish M Gohil, Sanjay Desai- "Total Productive Maintenance Implementation in a machine shop: A Case Study", ELSEVIER (2013).
- [2] Jignasha P Acharya, Maharshi J Bhatt- "A Brief Literature Review on Total Productive Maintenance", IJAERD, vol.1, issue 5, may 2014.
- [3] Nistesh Mundhada, Aditya Wankhede, Bhavesh Bohra- "Detail Investigation, Analysis and Implementation for improving Quality/productivity in Rolling mill", IJEIT, Vol.2, Issue9, March 2013.
- [4] Sarang G. Katkamwar - "Study of Total Productive Maintenance & Its Implementing Approach in Spinning Industries" (IJETT) - Volume4Issue5- May 2013.
- [5] Melesse Workneh Wakjira, Ajit Pal Singh- "Total Productive Maintenance: A Case Study in Manufacturing Industry" , Global Journal of researches in engineering Industrial engineering , Volume 12 , Issue 1 Version 1.0 February 2012, ISSN: 2249-4596 Print ISSN:0975-5861.
- [6] Prof. Pradeep Kumar- "A Methodology for implementing Total productive maintenance in manufacturing Industries- A case Study", IJERD, Vol. 5, Issue2.
- [7] G Ananth, DR. B K Vinayagam- "Implementation and fall of TPM in Micro Manufacturing Industries Using SWOT Analysis-A review", IJEIT, Vol.1, Issue 4, April 2012.
- [8] Mr. Ranjeet M. Jadhav, Mr. Morosin Alessandro, Prof. S.H. Sawant- "Total Productive Maintenance Theoretical Aspect: A journey Towards Manufacturing Excellence", IOSR-JMCE, ISSN: 2278-1684, pp: 51-59.
- [9] Osama Taisir R. Almeanazel - "Total Productive Maintenance Review and Overall Equipment

Effectiveness Measurement", JJMIE, Volume 4, Number 4, September 2010 ISSN 1995-6665 Pages 517 - 522.

- [10] IPS Ahuja- "Total Productive Maintenance literature review and direction" Emerald (2008).
- [11] Dennis McCarthy, "LEAN TPM", Book of Elsevier Publication.
- [12] Steven Borris, "Total Productive Maintenance", Book of MCGrawll-Hill Publication.