

TOTAL PRODUCTIVE MAINTENANCE: A UNIQUE COMBINATION OF PRODUCTION AND MAINTENANCE

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ABSTRACT

Total Productive Maintenance (TPM) is one of the latest maintenance systems adapted first time in Japan. The TPM method tries to eliminate the main factors of production losses e.g. the faults, the setting changes, the defective pieces etc. TPM is used by the organizations to modify the preventive maintenance programme on the basis of the operation results obtained on the field. The TPM allows structuring the organization to adapt maintenance forms to train the employees of both the streams i.e. production and maintenance.

The objective of TPM is to achieve maximum efficiency, involve the entire workforce from bottom to top, avoid wastages and to achieve zero accident, zero defect and zero breakdown. TPM should help in achieving high Overall Production Effectiveness (OPE), high Overall Equipment Effectiveness (OEE), reduced manufacturing cost and maximum customer satisfaction.

TPM can be implemented successfully in an organization if it is done meticulously and follows the 12 steps as explained in the following text. The right ingredients for the successful TPM implementation may be detailed as below:

Top management cooperation, Training programme, Encouraging statements, Existence of preventive maintenance programme, Complete information about equipment performance, Good communication skill of the TPM coordinator, Full time employees assigned to TPM tasks, Follow up
The implementation of TPM is not as easy as it seems to be. It has got certain barriers which must be surmounted at the earliest opportunity. TPM implementation is a costly affair if the existing systems in the organization are poor and not up to the mark. Organizations having good cultural environment and good practicing systems, the cost of TPM implementation will not be high. There are numerous benefits if TPM is implemented successfully and as per established guide lines.

In today's industrial scenario, TPM is one of the most important factors that stands between success and failure. It is a proven, successful programme that can harvest rich benefits for the organization.

Keywords: Arrangement; Assignment; Breakdown; Benefit; Cost; Condition; Customer; Command; Consultant; Culture; Delay; Downtime; Employee; Environment; Effectiveness; Equipment; Failure; High; Hazard; Implementation; Improvement; Idle; Loss; Maintenance; Management; Morale; Negotiation; Organization; Productivity; Plant; Product; Quality; Result; Services; System; Satisfaction; Structure; Total; Technology; Union; Yield; Zero.

INTRODUCTION

In modern day's manufacturing and service industries, improved quality of products and services largely depend upon the features and conditions of the organization's equipment and facility. The economic environment is becoming increasingly harsh day by day. In order to survive every industry has to strive for improved productivity in all spheres of activities. Hence, it is

logical to utilize the resources like machinery, men and material as optimally as possible. On the other hand massive capital assets creation is taking place for meeting the ever increasing demand of various industrial products. These capital assets in turn require substantial service support to achieve vitality and long life cycle. As automation in equipment take production task away from

humans; the condition of equipment, enhanced output, quality, cost, delivery, health, safety and employee morale become vulnerable. The concept of Total Productive Maintenance (TPM) which aims at maximizing the equipment activeness originated from Japan. It made progressive strides in countries like USA, Europe and other South Asian countries after its successful implementation in Japan. TPM is beginning to make the transition from a repair department to that of high level business function.

The importance of maintenance has been emphasized especially in the manufacturing environment. The failure of equipment or machines to produce product on time as required can reflect the inefficiency in operations, thus, failure to deliver the products to the customers. The objective of the TPM is to create an active participation of all employees in maintenance and production functions, including the operators who operate the machines and equipment.

Total Productive Maintenance (TPM) has attracted the attention of industries all over the world. The perceptible impact of TPM lies in attaining the far-reaching productivity and quality standards. Attempts have been made to examine TPM for the feasibility in Indian industries.

HISTORY

TPM is a innovative Japanese concept. The origin of TPM can be tracked back to 1951 when preventive maintenance was introduced in Japan, however, the concept of preventive maintenance was taken from USA itself. M/s Nippondenso was the first company to introduce plant wide preventive maintenance in 1960. Preventive maintenance is the concept wherein operators produced goods using machines and the maintenance group was dedicated with work of maintaining those machines. However, with the automation of M/s Nippondenso, maintenance became a problem as more maintenance personnel were required. So the management decided that the routine maintenance of equipment would be carried out by the operators, known as 'Autonomous Maintenance'. Maintenance group took up only essential and complicated maintenance works.

Thus, M/c Nippondenso which already followed preventive maintenance also added 'Autonomous

Maintenance' done by production operators. The maintenance crew went for the equipment modification for improving reliability and efficiency. The modifications were made or incorporated in the new equipment. This led to maintenance prevention. Thus, preventive maintenance along with maintenance prevention gave birth to Productive Maintenance. The aim of productive maintenance was to maximize equipment effectiveness to achieve maximum life of production equipment at optimum cost.

DEFINITION

Total Productive Maintenance (TPM) is a management system for optimizing the productivity of manufacturing equipment through systematic equipment maintenance involving employees at all levels. The aim is to increase production while at the same time increase the employee's morale and job satisfaction. Here the operators inspect, clean, lubricate, adjust and even perform simple repair/calibrations on their respective equipment. Under TPM, everyone is involved in keeping the equipment in good working condition to minimize production losses from equipment repairs, setups etc.

OBJECTIVES OF TPM

1. Aims at the creation of collective culture to attain maximum efficiency throughout the production process.
2. Use the system so as to prevent losses and to reach 'zero accident', 'zero defect', and 'zero breakdown' in the manufacturing system.
3. Involve entire work force from bottom to top.
4. Obtain maximum productivity by integrating the activities of teams with the production system.
5. Avoid wastages in a fast changing economic environment.
6. Goods delivered to the customers must be free from defect.

TPM TARGETS

1. Obtain Minimum 80% OPE (Overall Production Effectiveness).
2. Obtain Minimum 90% OEE (Overall Equipment Effectiveness).
3. Run the machines during shift change overs and lunch period.

4. Products should not have any complaints.
5. Reduce the manufacturing cost by 30%.
6. Achieve 100% success in delivering the goods as per customer need.
7. Ensure an accident free working environment.
8. Increase the Employee's suggestion by three times.
9. Develop multi-skilled and flexible workers.

WASTE ELIMINATION IN TPM

Application of TPM eliminates the following six wastes:

1. Breakdowns which can result in long expensive repairs.
2. Set-ups and change overs that take much longer time than needed.
3. Idling and minor stoppages which are difficult to quantify and add to big losses.
4. Reduced equipment speed which results in gradual deterioration of equipment cycle time.
5. Defects and rework which affect work quality and leave customers unhappy.
6. Start-up losses which can take much time to reach steady state after a change.

TPM IMPLEMENTATION

1. An Overview

TPM focuses on productivity which depends upon three major factors i.e., Availability, performance and yield. Availability losses arise from breakdowns and change-overs i.e. the situation in which the production line is not running while it should be. Performance losses arise from speed losses and small stops or idling. Yield losses consist of losses due to rejects and poor start-up behavior in the line producing the products. These losses lead to low value of the overall equipment effectiveness (OEE), which provides an indication of how effective the production process is. TPM helps to raise the value of the OEE by supplying a structure to facilitate the assessment of these losses. Application of TPM leads to both short and long term improvements.

TPM emphasizes in having a –

- Linear organizational structure.
- Multi-skilled workforce.
- Rigorous appraisal of the method the thing is

done resulting into improvements, simplification and standardization.

TPM seeks to encourage the setting of ambitious but attainable goals for raising the value of OEE and to measure any deviations as compared to the original objective. Introduction of a TPM system is by no means an easy task because there are several barriers that hamper the implementation process. The driving forces to success have to be identified and well understood and a process of organizational change has to be managed successfully.

2. Organizational structure / Pillars for TPM implementation

The results of TPM implementation depends upon the organization structure or its 8 pillars. Improper organization structure can lead to the failure of TPM implementation. A typical organizational structure for TPM implementation is shown in Figure-1. For this purpose, a person should be made responsible for implementing TPM i.e. a plant manager should be appointed as TPM coordinator. The coordinator will look over the whole TPM implementation process. TPM requires effective leadership from the top. That is part of the meaning of 'total' in Total Productive Maintenance. Without effective leadership that links TPM effort to the business and holds the people accountable for performing highly specified work, the equipment performance and reliability will continue to decline and TPM initiatives will be short lived.

Many of today's business leaders have risen through the ranks when maintenance was only responsible for 'fixing things' – not for preventing problems. Many business leaders often look at the maintenance department as cost incurring process, this usually results in higher costs due to decreased equipment effectiveness. TPM is not like a standard short range project which normally has a starting and an end. Rather, TPM is a long range 'living programme' which can take few years to implement and enjoy the recurring benefits when the whole organization has become strategy focused instead of evaluating one new program after another.

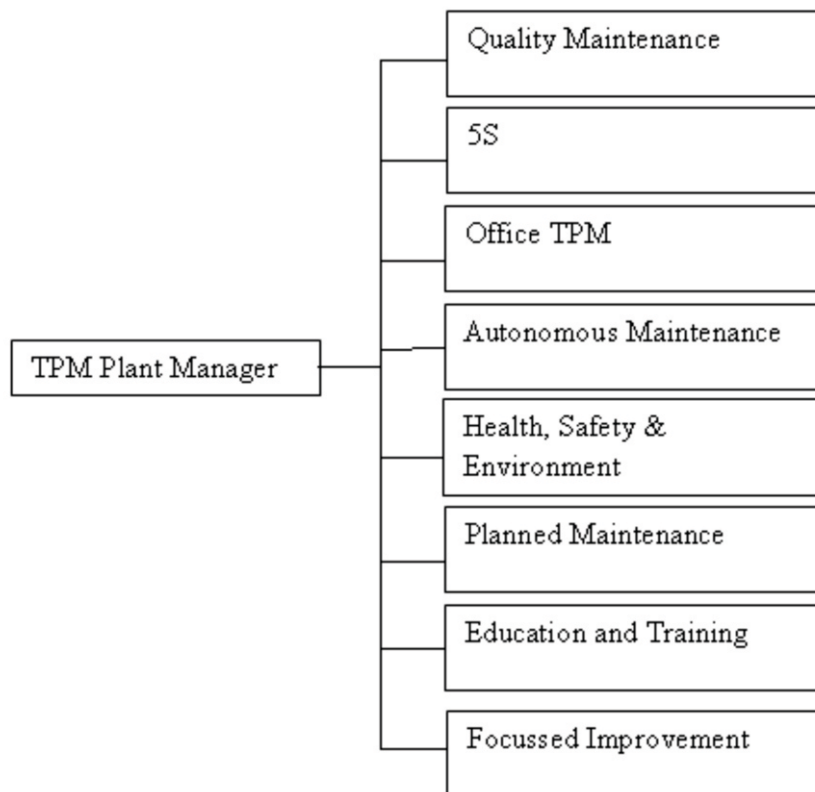


Figure – 1: Organization structure / Pillars for TPM implementation.

3. Steps for implementing TPM

The 12 step process is designed to implement TPM which broadly include: Accomplish TPM acceptance; Create TPM support from management, unions and employees; Create enthusiasm and positive expectations for TPM; Develop a realistic custom implementation plan and Accomplish world class results in a defined time frame.

Step – 1: Announcement of top management decisions of implementing TPM

Top management needs to create an environment that will support the introduction of TPM. Without the support of management, resistance and doubts may kill the initiative. Detailed TPM articles including TPM objectives should be clearly stated in company's newsletter and magazines.

Step – 2: TPM education programme and collection of information

This programme will inform and educate everyone in the organization about TPM activities, benefits and its objectives.

For managers: offer seminars /workshops according to level.

For general employees: provide slide presentation.

This step of implementing TPM also consists of collection of information about TPM and to understand how it works. TPM coordinator must understand what TPM is, how it works, its proper implementation sequence, the amount of effort that will be required, how it can be beneficial for the plant, how long it will take to implement etc.

Step – 3: Establish an organizational structure

Organizational structure will promote and sustain TPM activities once they begin. Team based activities are essential to a TPM effort. It needs to include members from every level of the organization from management to the shop floor. The structure will promote communication and will guarantee that everyone is working toward the same goals.

Step – 4: Formulate basic TPM policies and goals

Analyze the existing conditions and set the goals that are result oriented, specific, measurable, attainable and realistic. Then predict the results. The established TPM policies and goals should be very much clear to everyone involved in TPM implementation.

Step – 5: Master plan for TPM deployment and its presentation

After establishing TPM policies and goals, a detailed proposed master plan for implementation of TPM is prepared and proposal is presented to management. This activity can be carried out by a consultant or plant engineer or both. Consultant involvement typically begins with a plant visit to observe production operations, learn about the equipment (type, function, condition, problems and losses etc.), study maintenance systems (structure, size and tasks etc.), gauge orderliness and cleanliness in the plant, talk to employees to determine their motivation and attitude. The consultant then can develop and conduct the TPM presentation to management including questions and answers and cover the following:

- TPM introduction (What is TPM?).
- What TPM can do for the plant, its expected costs and benefits?
- Sequence for its implementation.
- Customized implementation strategy.
- How management and the union can support the TPM?
- How to get organized for implementing TPM?

The presentation can be made by the plant engineer also covering the same points with examples and impressions from seminars, conferences and plant visits. The presentation should end with a recommendation to implement TPM. Normally, management will make a positive decision at this point. This decision must include a commitment of strong support to TPM, carry out the necessary training and feasibility study, appoint a TPM coordinator and create the TPM steering committee. This plan will identify what resources will be needed and when for training, equipment restoration, improvements, maintenance management systems and new technologies.

Step – 6: Feasibility study and its presentation

Every successful TPM implementation has been preceded by a good feasibility study. The results of the feasibility study will establish a base line against which TPM results and progress can be measured and also helps in setting the realistic goals based on the data obtained. A feasibility study typically includes 2 to 6 teams (5 to 9 members each). It will include overall equipment effectiveness (OEE) observations and calculations for 100% of important equipment. The

study will evaluate the condition of these equipments and required current and future maintenance activities. Skills of plant personnel, cleanliness or orderliness of the plant and plant culture (attitude, motivation, and management style) will be studied also. Feasibility study results are then presented where both management and union should be present. The presentation should propose the implementation strategy and justify a pilot implementation. It should conclude with a recommendation that TPM is to be implemented. At this point, management will make a second and final commitment to implement TPM and this meeting/presentation can be regarded as the TPM kickoff.

Step – 7: Pilot implementation

A TPM pilot implementation should cover between 20 and 25% of plant equipment, not just a few selected machines. There should be a minimum of six TPM teams to ensure survivability of the implementation. Areas appropriate for pilot implementation are where major improvement is needed (too many breakdowns, delays, idle time, low capacity, poor productivity etc.) and where quick success is likely. A good feasibility study is required for all pilot areas. All employees in the pilot areas must receive TPM training. Clear goals and deadlines must be established and team meetings must be held on schedule.

Step – 8: Plant – wide implementation

TPM coordinators of most companies wait too long before expanding the TPM implementation over the whole plant.

There is no need to wait for final results of the pilot implementation. A good and well thought out staggered expansion plan is important as is a detailed implementation plan for each additional area. Expansion initiatives should begin every 3 months (6 months maximum) using the same priorities and decision criteria as for pilots' areas.

Step – 9: Introduction audit

To ensure good progress and a proper successful implementation audits have proven to be very valuable. It checks if the TPM fundamentals are done correctly (organizational structure, teamwork, tasks, preventive maintenance developments etc.) and whether the program is on schedule. The audit is carried out by internal or external auditors after 6 – 12 months of launching of TPM.

Step – 10: Progress audit

It is usually the last step before the certification. The audit will point out existing deficiencies and opportunities to bring TPM to a successful conclusion. The theoretical part of the audit will be done in the office over a lot of data followed by a practical part out in the plant around the equipment. The progress audit is done after 18 -24 months of launching to determine how:

- Preventive maintenance is carried out by the TPM teams.
- Equipment improvement activities have been executed according to schedules.
- Increase in OEE has been reached.
- The improved equipment condition has been accomplished and documented.
- The planned levels of skill have been accomplished.

Step -11: Certification

The certification process is gaining more and more importance because certificate is used to show to the customer that equipment and product quality have been improved and standard procedures are in practice to maintain the equipment to the highest levels. The International TPM Institute certification process is based on a strict set of certification requirements.

Step – 12: TPM award

The final and most rewarding step of a TPM implementation is achieving the TPM award. The award testifies that the plant is world class i.e. highly productive, produces only top quality product, maintains its equipment in top shape and has a culture based on teamwork.

It is certain that implementing TPM using the above 12 steps leads to 'zero breakdowns', 'zero defects' and zero accidents. Ming Hong (2004) suggests that to be successful, not only support is required from top management but also from the heads of each department. The other key factor is that each employee must feel that they also have been benefitted from this activity. This will improve their performance. This improved performance will reflect in their higher remuneration. This will motivate the employee which in turn will lead to better progress. The design of the activities should be kept as simple as possible.

4. The right ingredients for a successful TPM implementation

Following are the few important factors which must be taken into account for successful TPM implementation:

Top management cooperation

It is the main factor that makes the effort of TPM implementation a great success.

Training programme

TPM discipline, while technical, is more cultural. Everyone in the organization must receive sufficient information on TPM. Therefore, training programmes /seminars should be arranged weekly/monthly for all levels of organization.

Encouraging statements

Vision and Mission statements should include the concepts like – 'Employees are the single most valuable asset in the company', 'Employees are company associates', 'Employees are responsible for success' etc. Management must be ready to move all the way from the old image of 'Power from Authority' to 'Respect and Admiration from true leadership'.

Existence of preventive maintenance programme

It is necessary to have a good preventive maintenance programme in place to have clear identification of each piece of equipment and have good history.

Complete information about equipment performance

To begin a project, research for all possible information about the actual, expected and designed performance of project is done. It is strongly recommended to establish a very good communication with the 'owners' i.e. the operator of the machine, the area supervisor and area manager.

Good communication skill of the TPM coordinator

TPM coordinator is the key person in the success of the TPM implementation. The mission of TPM coordinator is not only to train the team but also to educate everyone else in the plant. Coordinator has to become an expert in TPM culture and explain it to anyone in organization.

Full time employees assigned to TPM tasks

The TPM philosophy require continual dedication and training. One/two full time persons are required to attend a minimum of one seminar each year on TPM.

Follow up

Once a project is delivered back to the 'owners', it is understood that TPM has just begun for that particular machine or system. The actual success will depend on the permanent communication that the coordinator establishes with the employees. This follow up builds up the confidence of employees towards the project.

5. Difficulties faced in TPM implementation

Implementing TPM is not an easy task as it seems to be. A great infrastructure and commitment of all personnel from top level management to bottom level is required. A lot of problems have to be faced while implementing it. Some of them are as follows:

- Sufficient resources like people, money, time, assistance etc. are not provided.
- TPM involves cultural change in the organization for its smooth implementation.
- Incomplete understanding of the methodology and philosophy by middle management.
- Many people treat it just another 'program of the month' without paying any focus and also doubt about its effectiveness.
- Employees show strong resistance to any change.
- Many people considered TPM activities as additional work or threat.

6. Cost of TPM implementation

The cost of implementing TPM depends upon the following factors:

- *Maintenance program in place*
- Some plants have excellent maintenance programs in place and have kept the equipment in very good shape, so the cost of implementing TPM in these plants will be lower than for those who have a bad programme or none in place.
- *Age of equipment*
- Old equipment, sometimes, will face the high cost of spare parts if wear/tear is high.
- *Pace to be taken*
- If a fast paced implementation is required, the cost per year will be higher.

BENEFITS OF TPM

The main benefits of TPM are as follows:

- Increase in productivity and OEE (Overall Equipment Efficiency), say 1.5 to 2 times.
- Timely rectification of customer complaints.

- Reduction in manufacturing cost up to a great extent, say 30%.
- Satisfaction of customer's needs by almost 100% i.e. delivering the right quantity at the right time, in the required quantity.
- Reduction in accidents.
- Good pollution control measures.
- Higher confidence level among the employees.
- Work place is clean, neat and attractive.
- Favorable changes in the attitude of the employees.
- Good working team for achieving goals.
- Horizontal deployment of a new concept in all areas of the organization.
- Sharing of knowledge and experience.
- Higher loyalty level, the employees get a feel of owning the machines.

CONCLUSION

Today with competition in industry at an all time high, TPM is one of the most important factor that stands between success and failure. It has been proven to be the programme that works. It can be adapted to work not only in industrial plants but also in construction, building maintenance, transportation and variety of other situations. Employees must be educated and convinced that TPM is a way to success and excellence and the management is totally committed to the program and its full implementation. If everyone involved in a TPM program does his/her part, an unusually high rate of return, compared to resources invested, may be expected.

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