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# TPM Implementation for the Performance Improvement and Running Cost Minimization

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## ABSTRACT

Total Productive Maintenance (TPM) is a maintenance program which involves newly defined concept for maintaining Plant, Equipment & available facilities. In this present paper concepts of TPM and its Implementation strategies, and Identified problems are categorized under the pillars of TPM as their remedy action. Solutions to these problems are suggested in accordance with TPM guidelines. In accordance with TPM such as lack of cleaning activities around different work stations, no planned maintenance whatsoever, and lack of safety measures for workers and room for improvement in Plant Layout are found. These problems create many related sub-problems and affect the overall productivity of the organization. So, there is a room for Implementation of TPM. The recommendations made on the basis of TPM guidelines will help the organization in increasing its productivity, better product quality, improved efficiency of equipment and machines, besides it also improves worker's job satisfaction by enhancing their technical skills, reduces work related accidents, & overall a healthy competitive atmosphere will prevail in organization.

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## Introduction

### Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a maintenance program which involves newly defined concept for maintaining Plant, Equipment & facilities. Seiichi Nakajima [1] defines TPM as "*Continuous improvement for all operational conditions, within a production system; by stimulating the daily awareness of all employees.*" The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction. The results of implementing TPM program in terms of increased plant efficiency and productivity are outstanding. Remarkable improvements have occurred recently in the maintenance management of physical assets and productive systems, so that less wastages of energy and resources occur. The requirement for optimal preventive maintenance using, for instance, just-in-time (JIT) and total quality-management (TQM) techniques has given rise to what has been called the total productive-maintenance approach.

TPM is not just a maintenance strategy, but a more comprehensive approach to productivity improvements. To think that TPM is only a maintenance strategy would be to miss the complexity of the concept, and underestimate the potential for improvements. Implementation of TPM is definitely not an easy task, which is considerably burdened by organizational, behavioral, and other barriers, and necessitates the difficult mission to change peoples' mindsets from a traditional maintenance approach. TPM focuses primarily on manufacturing although its benefits are applicable to virtually any process.

In this age of globalization and immense competition there is a need to synchronize manufacturing and maintenance activities so that the production is able to cope

with market demand. Receiving top management support for the installation of TPM can usually be achieved with the right information and an approach that meets their criteria for acceptance. The requirements may include specific timetables for a return on investment (ROI), specific performance improvements, or other economic justifications. The TPM process will require a reasonable investment of time, money, training, and patience. This investment will usually be returned through the favorable results achieved.

### Need of TPM in today's competitive environment

The manufacturing of the twenty first century is characterized by high degree of automation and minimum or no human interference. A complete automated process with robots has become a reality. Now, in this completely automated environment the quality depends upon the equipment as production equipment have become unmanageably sophisticated.

Though the operations have been automated, maintenance still to a greater degree depends on human input. Automated and technologically advanced equipment demand the higher skills and competencies of maintenance worker or supervisor. The effectiveness of this equipment requires an appropriate maintenance organization. TPM, which organizes all employees from top management to production line workers, is a companywide equipment maintenance system that can support highly sophisticated and technologically advanced equipment and production facilities.

The aim of TPM activities is to improve productivity, quality costs, and cost of products, delivery, and movement of products, safety of operations and morale of those involved. To achieve these goals operational elements (also referred as Pillars of TPM) of TPM is applied, they are The impact of total productive maintenance practices on manufacturing

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performance (Jitendra, 2014) done investigation on the relationship between Total Productive Maintenance (TPM) and manufacturing performance (MP) through Structural Equation Modeling (SEM) had been noted. It is found that, TPM has a positive and significant relationship with low cost (as measured by higher inventory turns), high levels of quality (as measured by higher levels of conformance to specifications), and strong delivery performance (as measured by higher percentage of on-time deliveries and by faster speeds of delivery). It is also found that the relationship between TPM and MP can be explained by both direct and indirect relationships. In particular, there is a significant and positive indirect relationship between TPM and MP through Just-In-Time (JIT) practices.

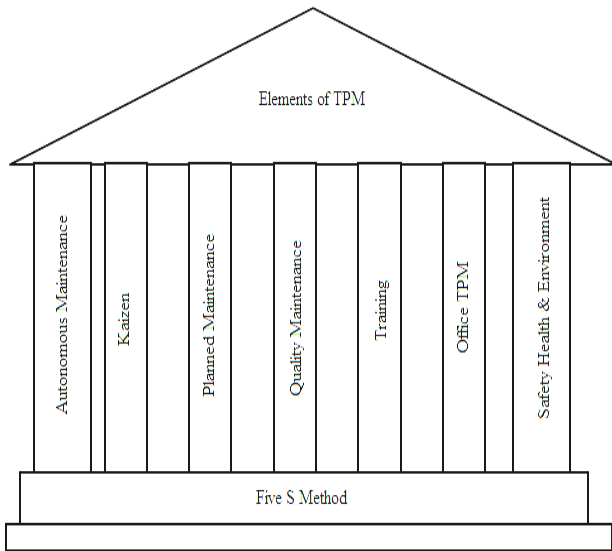


Figure 1. Operational Elements of TPM.

#### About Selected Company

Selected company, located at Mandideep Industrial Area, is spread over 625 Sq. meters. The Main Operation done here is hot dip Galvanization & Machining operation on Bracket castings used for mounting Insulators. It has a capacity of 200 tonnes per Month. Total number of worker is 25.

Firstly necessary machining operations are done on Job (metal casting part), like Extra Material Removal, Facing, Boring, Tapping, & Threading. Machines used for these operations are Engine lathe, Drilling Machining & Grinding Machine. After the necessary Machining operation Jobs are manually transferred from Machining shop to Pickling room.

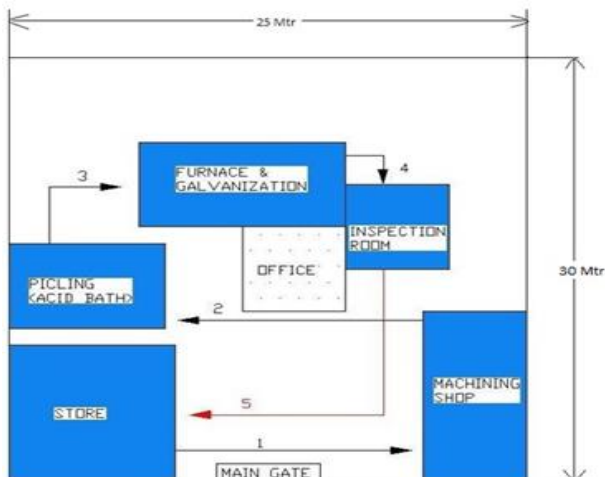


Figure 2. Block Diagram of Selected case company.

In Pickling room Jobs are washed by acids so as to remove dirt, grease and other foreign material over its surface.

Acids used are Hydrochloric acid, Sulphuric acid, and Hydrofluoric acid. After the Pickling room Jobs are transferred to Furnace room.

First up, Jobs are heated in primary furnace. After Heating in primary furnace, Jobs are dipped in Galvanization Pan. After half an hour the hot galvanized jobs are taken out of the Galvanization Pan and dipped in water for cooling. Lastly Jobs are inspected and then Transferred from Inspection room to Store room.

Table 1. Machine Tools at Selected case company.

Name	Total Number	Specification
Lathe Machine	7	25 HP, 6 ft
Drilling Machine	6	1 Inch
Grinding Machine	1	

Table 2. Materials Used in Selected case company.

Name	Cost (per Kg in Rs)	Daily Consumption
Hydrochloric Acid	3	250 Kg
Sulphuric Acid	8	10 Ltr
Hydrofluoric Acid	150	50 kg
Ammonium Chloride	50	50 kg
Zinc	150	200 kg
Hard Coke	14	600 kg for 1 time
Zinc Spirit	300	4 kg

#### Purpose of the Work

In India most of the automobile giants had already applied TPM at their workplaces. The concept of Kaizen & Five S is, now-a-days, very popular in Large Scale Industries but this technique is still finding its feet in Medium & Small Scale Industries. The present work is an effort to apply TPM concepts on a small manufacturing unit and to increase its productivity with minimum investment.

**Clarification & Physical Analysis of the Problems:** In this step clarification of the entire problem and its physical analysis is done. Considering how the physical conditions causing the observed problem. Review all apparent basic causes, as well as actions that have been taken in previous occurrences of the problem. After the careful observation and investigation of all the problems, reason of occurrence and their ill effects are summed up and given below.

**Problem 1. Daily Maintenance of Lathe Machines:** Daily maintenance activity should be a part of daily routine unfortunately this is not in the Selected case company. Maintenance activities are scheduled periodically. Lack of Daily Maintenance has considerable effect over the productivity of the machine. If Lubrication of Gears, Bed ways, Compound & Cross slides, Carriages and Lead Screw is not done properly, wear and tear of Machine increases which affects the Efficiency of the machine.

**Problem 2. Short Circuiting of Motor Winding of Lathe Machine:** On an average a motor winding get burned or short circuited every three month at selected case company. Reasons for short circuiting of motor winding

- Machining of Superior Grade gray cast iron produces very fine chips which get settled between the motor winding, results in short circuiting.
- Due to Moisture content in Atmospheric air. Moisture came into play only in rainy seasons that is from latter part of June to earlier part of September. Moisture get accumulate between the windings and shorts the circuit.
- Due to fluctuation of voltage

**Problem 3. Vibrations & Noise in Lathe Machines:**

Vibration in a machine can affect machining operation in machines lying by side, as they have common foundation. Vibration results in poor surface finish & increased power requirement. In addition to this it also produces noise, which affects the comfort levels of workers, which in turn affect their efficiency to work considerably.

**Problem 4. Manual Handling of Jobs between Different Work Stations:** In Selected case company, material handling between different work stations are done by workers manually which consumes unnecessary time & labour. Average weight of a job is around 25 kg, which is handled one at a time, manually. This cause unnecessary fatigue to worker and consumes too much extra time.

**Improvisations & Suggestions**

Problem wise suggestions and improvisations for different problem are given below:

**Daily Maintenance Activities:** Implementation of 5S methodology will eliminate this problem. After every shift, a cleaning round has to be done by machine operator itself, so that the conditions would not become too much messy.

**Daily Maintenance Activities:**

- Tightening of Nut Bolts of Applied attachment like Milling Machine Attachment, taper Turning Attachment etc.
- Oil the lathe ways at the start of each day's first use of the lathe.
- Before the start of each day's work oil level in Headstock & Carriage Apron should be checked
- Check the level of the Cutting Fluid reservoir and add as needed.

**Daily Maintenance Chart**

**Table 3. Daily Maintenance Chart to be filled by Operators.**

Day	Oil level in Headstock & Carriage Apron	Oiling of Lathe Ways	Cutting Fluid Level	Tightening of Nut & Bolts
1	Ok	Oiled/ Ok	Ok	Tightened/ Ok
2	Ok	Oiled/ Ok	Ok	Ok
3	Added/ Ok	Oiled/ Ok	Added/ Ok	Tightened/ Ok
4	Ok	Oiled/ Ok	Ok	Ok
5	Ok	Oiled/ Ok	Ok	Tightened/ Ok
6	Added/ Ok	Oiled/ Ok	Added/ Ok	Ok

**Following are the Efforts done for the Implementation of 5S:**

- Setting of tools according to priority. This will help in avoiding unnecessary movement of worker.
- Proper Brushing & Cleaning of Lathe Machine after every shift. This will avoid requirement of any mass cleaning activity. Besides it will also ensure proper operation of machine.
- From time to time painting of machine has to be done. This will make aesthetics of machine more soothing, and will give worker a sense of visual relief.



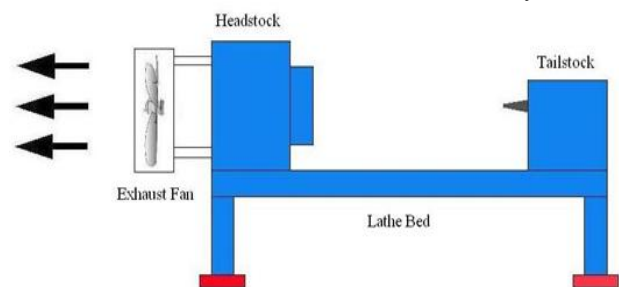
**Earlier**



**After**

**Figure 3. Cleaning of Lathe Machine after every session. Prevention of Short Circuiting of Motor Winding of Lathe Machine:**

- Short circuiting of motor winding due to chips of Superior Grade gray cast iron can be checked by use of cutting fluid. Application of cutting fluid will not allow the fine chips to fly around, and hence its embarking into the Machine parts is avoided.
- Short circuiting of motor winding due to Moisture content can be checked by mounting Exhaust fan on the machine. Before starting the machine exhaust fan must be started for a while so that moisture around the machine will dry out.



**Figure 4. Mounting of Exhaust fan on Lathe Headstock. Cost calculation for exhaust fan installation**

Cost of a Exhaust Fan	Rs. 800/-
Number of Lathe	3
Total Cost of Exhaust Fan	Rs. 800/-
per m/c	
Installation Cost will be about	Rs .320/-
Total Cost Incurred	Rs.800+ Rs 320= Rs.1120/-

Averagely Short Circuiting of Motor Winding of Lathe in rainy season i.e. from July to September, occurs 2 to 3 times

Cost incurred in Repairing of 01 Lathe Motor Winding Rs.350/-

Total Expense per season if repaired 2 times Rs.350 X 2 (for 1 m/c) =Rs.700/-

Total Expense per season if repaired 3 times Rs.350 X 3 (for 1 m/c) =Rs.1050/-

Therefore the repairing cost per m/c varies from Rs.700 to maximum to 1050/- per season.

If we use Exhaust Fan in rainy season then Short Circuiting of Motor Winding can be reduced to 1 to 2 times, Therefore we save cost of repairing of one Motor Winding per Lathe per Season

Which is Rs.350/- as explained above?

Total payback duration of cost of exhaust fan can be recovered in the same season:

$$= \text{Total incurred Cost} / \text{Cost Recovered per season} \\ = \text{Rs.1050} / \text{Rs.700}$$

= Approx 3 months (in same season)

Also the machine breakdown time will also be reduced instead of maximum 3 breakdowns it is reduced to maximum 2 times in a season. The reduction in breakdown time can be utilized further for production.

- Short circuiting of motor winding due to voltage fluctuation can be checked by use of voltage regulators. Voltage Regulators will ensure proper supply of voltage to the machine motor.

**Handling of Jobs by Trolley Between different Work Stations:** This problem can be easily overcome by providing trolleys for this job. Using trolleys much of the extra labor and time can be saved, same can be used in some other work. Using trolley 4 jobs can be transferred at a time without much effort.

Cost of a trolley is around 1500Rs and it doesn't require much of the maintenance.

#### Cost calculation for trolley

**Table 4. Distance Calculation.**

S.No.	TOTAL DISTANCE OF MATERIAL HANDLING		
	Starting Point	End Point	Total Distance
1	Stores Department	Machine Shop	12 meters
2	Machine Shop	Pickling Room	13 meters
3	Pickling Room	Furnace	6 meters
4	Furnace	Inspection Room	2 meters
5	Inspection Room	Stores	20 meters
	<b>TOTAL DISTANCE</b>		<b>53 meters</b>

No. of Products Produced PER DAY (averagely) 100  
 Total distance moved by material per product 53meters  
 Total distance moved by labour carrying the material per product 53meters  
 Total Distance Moved by labour carrying the material per day 5300 meters  
 If We Use Trolley We can Transfer about Three to Four Jobs at a Time  
 Thus, Total Distance Moved is reduced by three times (say) i.e.  $5300/3 = 1767$  meters  
 Therefore by use of Trolley, the Manpower Movement is reduced by 3533 meters  
 Approximately 66% Manpower Movement is saved, and the same can be utilized for other work.  
 Cost of a 01 Trolley is about Rs.2000/-  
 Wage per day per employee is Rs.150/- per day  
 Manpower Movement is reduced by approximately 66% (shown above)  
 Therefore approx. 5 hours labour cost will be saved  
 Approximately 60% of labour charge i.e. Rs 90/- saved per day  
 Labour Charge saving per month will be Rs 90 X 26 (26 working days in a month) is equal to Rs 2340/- which is less than cost of trolley.  
 Total duration of the payback of cost incurred in making a trolley will be in less than a month.

#### Discussion

1. After the implementation of 5S methodology, time taken for particular work reduced considerably. Daily maintenance of Lathe Machines improves its Efficiency and ensures smooth operation. Breakdown of Machines also reduced
2. Earlier short circuiting of motor winding occurs once in every 3 month. By the use cutting fluid in machining of superior grade gray cast iron & voltage regulators it occurs once in every 4 to 5 month. By the use of exhaust fan in rainy seasons short circuiting of motor winding is reduced from 2

to 3 times to 1 time. This will decrease the idle time of a machine, and timely production of finished products.

3. By the use of dampers no. of defective products will be reduced considerably and power requirement will also reduce. Thus time and cost invested over finishing operation is also reduced.

Use of Trolley for Material Handling between Different Work Stations, will save unnecessary fatigue to workers and time

#### Conclusion

The basic measures of TPM are quite familiar to most people; it is the utilization of these measurements that can be confusing. The concept of TPM as it relates to standard engineering measures and practices. TPM brings information and functions together in a comprehensive way to better identify actual performance levels, and better quantify improvement opportunities in manufacturing.

Following are the conclusion drawn from this research:

- TPM has an impact on the availability, reliability, quality, and performance of equipment and machinery.
- Training is required to make autonomous maintenance effective.
- For the implementation of TPM, Support and commitment from top management is essential & necessary. Establishing a top management steering group would assist in providing the necessary planning, commitment, direction and continuance of TPM activities. Creation and establishment of clear measures of performance including achievable milestones and objectives, using project management techniques, Incentives and rewards need to be given in order to encourage continuance of TPM activities.
- The goals of production and maintenance departments need to be linked so that they work together in order to achieve the organization's goals.
- Most of the production operators and production team managers still view TPM as a maintenance issue, rather than as a production issue. This is a result of TPM issues being pushed to the maintenance department rather than the pooling of resources from both departments in order to achieve success.
- Implementation of TPM is a long-term process and requires 3 to 5 years. Until then efforts should be continued with enthusiasm.

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