

Implement Total Productive Maintenance (TPM) concept in manufacturing Industry

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Abstract: This project applies the efforts to reduce machines Breakdowns at a manufacturing unit Of Switchgear, Located in Vadodara. The machines are idle because of the sudden break downs which reduces the productivity of the machines. These machines are assets of the company if they are idle it is a big loss in terms of running cost and depreciation.

It is essential to implement Total Productive Maintenance (TPM) in the company to reduce the break downs and maintain the machines in Basic condition (best and perfect condition of the machine which ensures smooth operations of machine without any unplanned stoppages generation of defects). Identifying this aspect the management has initiated the process of implementing TPM and this work reports the steps taken for the same.

The company had followed Nakajima's seven steps of autonomous maintenance, although different TPM pillars had been adopted, with the common ones being improvements, education and training, safety, and quality maintenance. Overall equipment effectiveness (OEE) is used to quantify the Implementation rate of TPM concept and the losses associated with Equipment are identified.

Keywords: Total productive maintenance, 5S, Kaizen, Overall Equipment effectiveness.

1. INTRODUCTION

TPM is the new direction in production. At the Era, where Robots produces Robots and 24 hours production is possible. In discussing Quality control people often say that Quality is depends on process. Now, With Increasing maximum utilization of machine approach, it might be more appropriate to say that Quality mainly depends on Equipment. Productivity, safety, inventory, Cost, Health, And Production output as well as Quality –all depends on Equipment. TPM includes all the Factors of Quality of an organization.

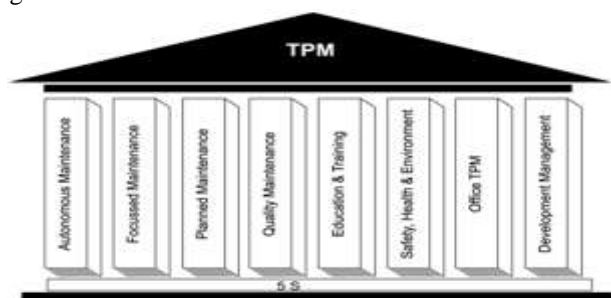


Fig-1: TPM House

In the early stage of TPM the company must bear the additional expense of restoring Equipment to its Basic Condition and Educating Personnel about the equipment. The actual cost depends on the quality of equipment and quality of Maintenance. As productivity Increases, However, these costs are quickly replaced by profits. For

this reason TPM is often referred as “Profitable PM (Planned Maintenance).”

2. LITERATURE REVIEW

Togar M., et Al In today’s time based competition, high equipment productivity in a manufacturing line is necessary in ensuring a competitive company. Focused Productive Maintenance emphasizes the importance of achieving profitability through equipment effectiveness. This paper demonstrates the logic of Buffer Management and Focused Productive Maintenance to shape competitive advantage in utilizing resources.

Ramayah , et al carried our research on TPM in one of the leading suppliers of various automotive components such as weather strip, pillar drip molding and plastic molding parts. They viewed that maintenance cost increased about 20 to 30 per cent. Moreover, emergency repairs were three times more expensive so they decided to implement TPM in that automotive industry. TPM was implemented with main focus on autonomous maintenance and planned maintenance. The basic maintenance activities were performed by operators which were highlighted under autonomous maintenance and planned maintenance were carried by technicians and engineers. The rejection rates from year 2003 to 2006 was respectively 22, 17,14.4 and 11 and total breakdown in the company were 4.22 per cent on

average for year 2003 to 2006. It showed that only for the year 2003 it exceeded the target value.

Kathleen et al. quantified the impact of total productive maintenance practices on manufacturing performance. She investigate the relationship between Total Productive Maintenance (TPM) and manufacturing performance (MP) through Structural Equation Modelling (SEM). She 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). She 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.

The results of the analyses indicate that TPM, as measured for this paper, has a strong positive impact on multiple dimensions of MP. While TPM directly impacts MP, there is also a strong indirect relationship between TPM and MP through JIT. Her results are important for two reasons. (1) Maintenance programs have long been used as a means to control manufacturing costs. Our results show that TPM does more than control costs, it can improve dimensions of cost, quality, and delivery. TPM can be a strong contributor to the strength of the organization and has the ability to improve MP. (2) World Class manufacturing programs, such as JIT, TQM, and TPM, should not be evaluated in isolation. They are closely related and in combination can help foster better MP. Future research should further consider the relationships between these practices and their combined impact on performance.

3. CASE STUDY

3.1 Overall Equipment Effectiveness: Before starting implementing TPM, to identify Existing situation Ocalculation is used to give a clear view

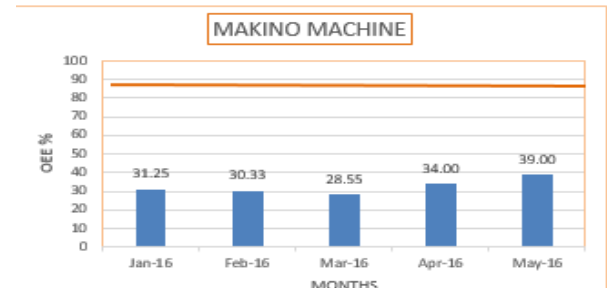
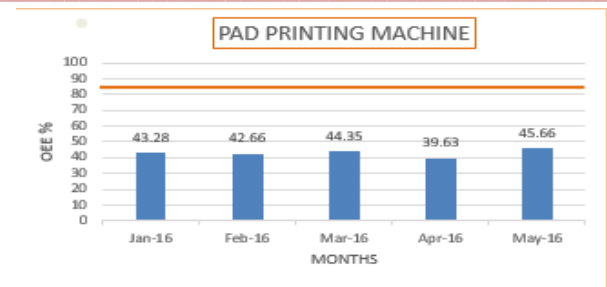


Fig-2: Existed OEE %

3.2 Base: 5 S

In the base of these 8 pillars 5s in the TPM model. So if it is required to implement TPM it is must to implement 5s first.

5S Step	Description
Sort	Remove all items from the workplace that are not needed for current production (or clerical) operations. Excess material (waste) 14 at the work place can lead to errors and defects.
Set in Order	Arrange needed items so that they are easy to locate and use. Label them so that they are easy to find and put away.
Shine	Clean floors, equipment, and work stations. The Shine step of 5S also includes identifying and preventing the sources of contamination or dirt. Shine is integrated with daily maintenance tasks to maintain condition as pristine as possible.
Standardize	Create methods and practices to maintain Sort, Set in Order, and Shine on an ongoing and continuously improving manner.

Sustain	Make 5S an integral part of standard operating procedure.
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Table-1: 5 S Description

NO	DESCRIPTION	BEFORE	AFTER	
1st S SORT	Remove unnecessary items from the work area			
	Overhaul worktable, rearranging the work table area			
	Storage of tools and material on portable worktable Make a Place for Check/Changeover area			
2nd S SET IN ORDER	improper placements of Plumbing Accessories		proper placements & identification of Plumbing Accessories	
	Improper placements of Tool Boxes in identified area & grease pump found on tool box area		grease pump removed from tool box area and make proper placement of Tool trolleys with tool boxes	
	Improper Placing of Tools		proper palcing arrangement of Tools	
	Improper Placement of TPM Tags & Register		proper placement arrangement for Put TPM tags and Register	
3rd S SHINE	uncleaned coolant gun pipe		cleaned coolant gun pipe	
	Uncleaned ATC area of machine		claned ATC area of machine	
	uncleaned ATC holder		Cleaned ATC holder	






4th S STANDARDIZE	No operator was writing hourly Report	-	operator is writing Hourly report of Daily Production	
	No Standard Operating Procedure available.	-	Standard Operating Procedure Available in English as well as Local Language.	
	No Currently working Information Display	-	Display of Current Working	
5th S SUSTAIN	No 5S dashboard available to have a clear pic of sustainancne	-	5S Dashboard available for ease of 5S sustainancne	
	No TPM dashboard available to have a clear pic of sustainancne	-	No TPM dashboard available to have a clear pic of sustainancne	

Table-2: 5 S Implementation Report

3.3 Pillar: 1 Autonomous Maintenance

AM SEVEN STEP IMPLEMENTATION METHODOLOGY: TPM holds the involvement of everyone as one of its key principles and thus makes the operators who use the machines more responsible for the upkeep of the machines as well as the running of

them. Obviously to get to this point the operators require training and many machines need improvement and modification to make them easy to clean and maintain, we therefore need a methodical implementation program to introduce them to TPM and autonomous maintenance. This program is most commonly broken down into seven steps

Autonomous maintenance seven step Implementation report	
Step	Work done
1. Cleaning and Inspection	Remove all dirt and grime from the machine
	Uncovered and highlighted all problems within the machine.
	All fluids drained and covers removed so that every part of the machine can be inspected and cleaned.
	Used Red/green Tags to highlight any problems,
	Cleaned machine by Operator as well as Maintenance persons.
2. Remove Causes of Contamination and improve Access	After cleaning, Identified root cause of contamination
	Identified inaccessible areas
3. Cleaning and Lubrication standards	Prepared Cleaning, Lubricating, Re-tightening, Inspection (CLRI) check sheet.
	Mapped cleaning frequency for Big machines

4. Train for general Inspections	Conduct in depth training with the operators to explain the function and purpose of each component of the machine as well as training in problem solving skills such as the Cause & effect and 5 whys .
	We then have the operators re-inspected the machines with their new-found knowledge and highlighted new problems discovered in much the same way that we did in step one.
	Created One Point lesions
5. Conduct Autonomous Inspections	With what they have learned in stage 4 the operators modified the standards and instructions that they put in place for the first three stages of autonomous maintenance to streamline and improve their maintenance tasks.
	The tasks at this stage are also compared and rationalized with the maintenance departments own maintenance schedules allowing tasks to be allocated correctly and prevent duplication of effort.
6. Implement Visual Maintenance Management	Provides Green/Red marks on Pressure gauges, oil level indicators
	sticked JH stickers that what to clean by which Tool
	Fix Machine area Dashboard which Displays all the details regarding that machine
	highlight the direction of flow of fluids through pipework
	valves have to be turned to open and close
7. Continuous Improvement (KAIZEN)	highlighted “safe” and “normal” operating values on gauges and sight glasses in green and undesirable readings in red
	Repeated and improved on all that we have found and done in the previous stages to continually improve and reinforce what done with autonomous maintenance.
	Team leaders, managers and maintenance technicians audited the work done by the operators on a regular basis and both congratulated the operators on a job well done and to give them the benefits of their knowledge.

Table-3: AM seven Step Implementation Methodology

3.4 Pillar: 2 Planned Maintenance (PM)

Planned maintenance pillar focused mainly on the actions related to maintainability and reliability of equipments. In this Process, equipment and design weaknesses are corrected and ideal state of equipment parts are maintained. This results in improvements in quality of products and Leads in finally reduces Breakdowns to zero.

The following step-by-step methodology has been followed to achieve prevention of Equipment Failures/Breakdown.

Step -1. Support and Guidance of Jishu-Hozen Activity: During Step-1 of autonomous maintenance activity (cleaning & Inspection), Maintenance personnel participated with operation division in putting green tag & red tag. During this activity, maintenance person educated Operators as to structure, mechanism, functions, and how to find defects of machine. Also Developed One Point Lesion (OPL).

Step-2. Evaluation of equipment failure/Breakdown status and understand situation: Collected data on all the failures/breakdowns of which are the equipments were decided to taken for PM ,which caused production loss and analysed. After that understood the nature of loss and equipment importance, settled target for equipment failure/breakdowns.

Step-3. Reverse Deterioration and correct weaknesses: There were two sides of roles were vitally performed to make success over reverse deterioration and correct weaknesses .i.e. 1st is participation of Operation Division which was available through Jishu-Hozen implementation. : i. doing cleaning, inspection, lubrication, and retightening to bring back equipment in basic condition, ii. Keep operating condition through correct operation handling. iii, restoration of forced deterioration, iv, operation skill including inspection techniques.

And 2nd is roles of maintenance Division are i. technically support the JH activity. ii. Assured restoration of deterioration by inspect using optimal condition check sheet. iii. Found defects, deteriorations and weak points of design. Using cause & Effect Diagram and why-why analysis countermeasures were implemented for the removal of defects and restored condition of parts.

Step-4 Built an information management system: Started with, Prepared equipment ledger. feeded Equipment data like model, specifications, capacity, manufacturer's recommendations, equipment history right from installation to till date i.e. the breakdown maintenance report, failure analysis report, preventive maintenance report.

- Used equipment data & history data arrived at yearly and monthly preventive maintenance plan.
- The Equipment spares were to be kept in stocked under three categorized as Vital, Essential and Desirable.

Step-5 Built a periodic maintenance system: This is related to time based maintenance of an equipment. From the equipment data base, preventive maintenance data base, machine manufacturer's recommendation, past experience, life span of parts and operator's information, arrived at planned maintenance calendar.

- Prepared time based work system flow to carry out the activities. The efficiency of Time based maintenance (TBM) has been felt in reliability of equipment and cost.
- Revisited optimal condition check sheet and corrected wherever necessary based on experience.

Step-6 Build a Predictive maintenance system: Introduced equipment diagnosis technology. Trained maintenance personnel in handling diagnostic instruments.

Step -7 Evaluate the Planned Maintenance System: By following 1-5 steps the maintenance Division had achieved improvement in reliability and maintainability of equipment.

- Compared the current results on breakdown rate, Mean time to repair, Mean time between failures, preventive maintenance rate, with target. After comparison, revisited the total system and strengthen the weak points. And consolidated the planned maintenance.
- In order to carrying these maintenance activities, Master plan has been prepared.

3.5 Pillar: 3 Kobetsu-Kaizen (KK)

Kaizen mean Continuous improvement. Kaizen involves small improvements and is carried out continuously by involving all the levels of personnel of an organization.

The pillar Kaizen aimed to reduce losses from workplace which affect our efficiency and quality of work. By using detailed and procedure, we eliminated losses in a systematic method using various kaizen tools.

• Poka-yoke: Mistake Proofing technic.

This tool board is made in house as a poka yoke device as show in figure below. This is a warning type mistake proofing device which warns the operator/helpervisually if they are picking up wrong dimensional tool and putting wrong toolat right place.



Fig-3: shadow board for Tools

• Pressure plate breakdown in 40 ton power press problem: To identify the reason of breakage of pressure plate, fishbone diagram has been prepared. According to

frequency & impact matrix, no. provided to each causes and corrected them.

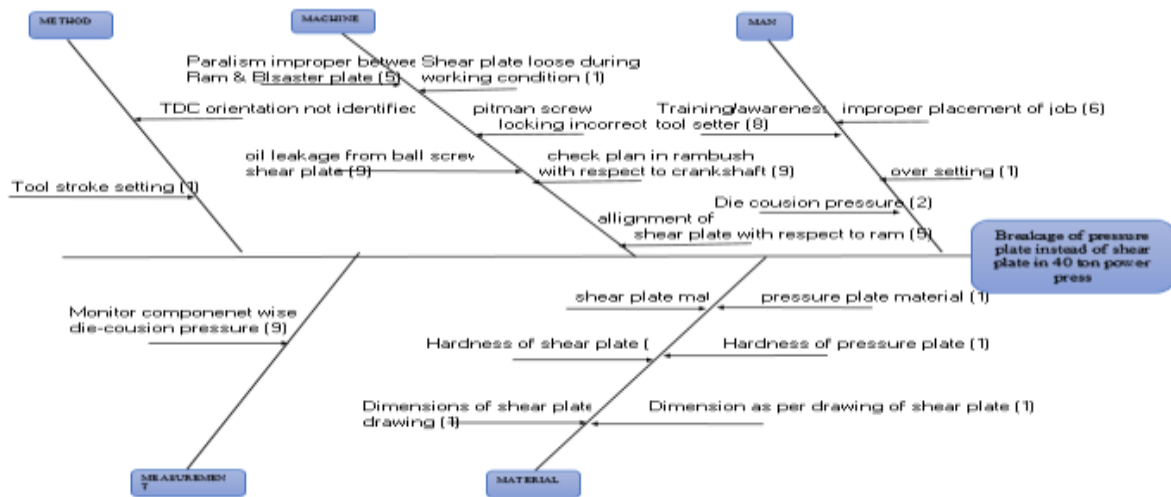


Fig-4: Fish-Bone Diagram

Layout improvement: Management has decided to buy new cnc machine to increase production. As the company was planning for new machine, so there was a necessity to

prepare a new layout to fix location of new machine. Bellows figures shows the layout improvement wish less material handling factor consideration.

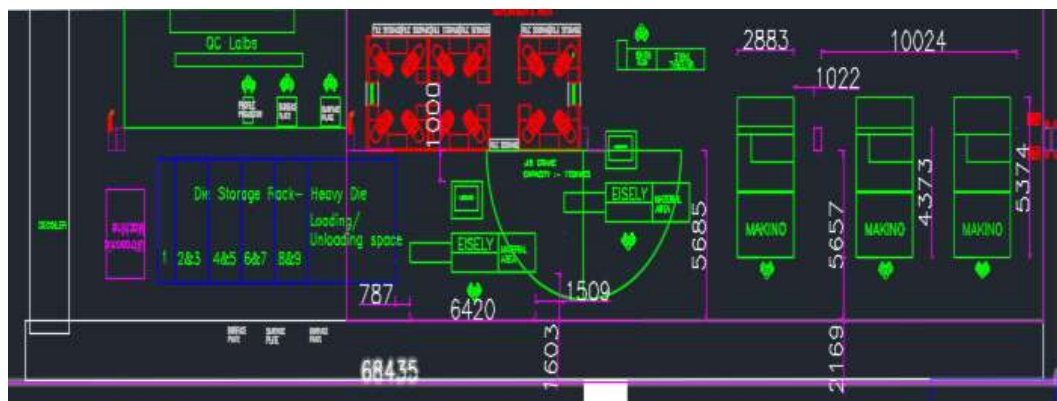


Fig-5: Lay-out improvement

3.6 Pillar: 4 Quality Maintenance (QM)

It is aimed to deliver highest quality product to the Customer. Customer satisfaction is this pillar’s goal.

Focusing on eliminating Non-conformance from a manufacturing system. We understood what parts of an equipment affects the quality of product.

To Operator	To Shift incharge
Provided training about,	Provided training about,
Standard operating procedure	Quality control tools,
identifying abnormality	small improvement projects
detail explaining importance of quality	Educating them for better understanding and usage of measuring instruments.
visual inspection	
usage of gauges	
usage of different measuring Instruments	
common ealry detection symptoms	

Table-4: Quality Maintenance

Continuous improvement is possible with continuity with knowledge gaining of cross functional members. To reduce

the defects, training is provided, which details are as follows.

3.7 Pillar: 5Office TPM

The initial preparation stage for the pillar ensures that the goals and objectives for each department are aligned to the organization's vision and Mission. There are then five key activities that the Office TPM pillar undertakes

Within an appropriate timeframe. The Office TPM team implemented office versions of Focused Improvement, Autonomous Maintenance and the Training and Education pillars to establish sustainable, performing processes. They deploy a flexible staffing policy to allow departments to manage peak workloads, without overstaffing, and a prioritized improvement program, by loss analysis, against the goals and objectives set in the preparatory activity phase. Office TPM addresses nine major losses which are processing loss, cost loss including in areas such as procurement, accounts, marketing, sales leading to high inventories, communication loss, idle loss, set-up loss, accuracy loss, office equipment breakdown, communication channel breakdown, telephone and fax lines and time spent on retrieval of information.

- Now operators fill up daily job cards, which contains time booking of machine, cat. No., no. of total produced quantity, no. of total rejected quantity, no. of total ok quantity.
- New Computer system with SAP attachment provided at maintenance department to collect data in direct soft copy instead of notebooks.
- Weekly report has been possible to make with perfect data.
- Getting easily accurate data of breakdown.

3.8 Pillar: 6Safety, Health and Environment

The objective of this pillar is to maintain Safe work place and surrounding are don't get damaged from our process or Procedures. Safety is always vital care taking area in any organization.

- Performing mock drills for fire, electric shock, bone fractures.
- Personally provided PPE, explain importance and its benefits.
- Provided sufficient no. of fire extinguishers.
- Provided first aid boxes to certain intervals.
- Provided a Near miss Station, where victim will fill up the form to help to make prevention from happening it next time.
- As well as gave seminar on No Tobacco, pan masala and smoking.

3.9Data Analysis

overall equipment effectiveness (OEE) is used to quantify the implementation of TPM. OEE is calculated as: Availability (A) × Performance efficiency (PE) × Quality rate (Q). Prepared OEE sheet for each machine on TPM to identify the implementation rate of TPM. Operating time to loading time. Performance Efficiency includes losses due idling and minor stoppages and speed loss and is calculated as ratio of net operating time to operating time. Quality rate factors the defects in process and reduced yield and is defined as ratio of valuable operating time to net operating time.

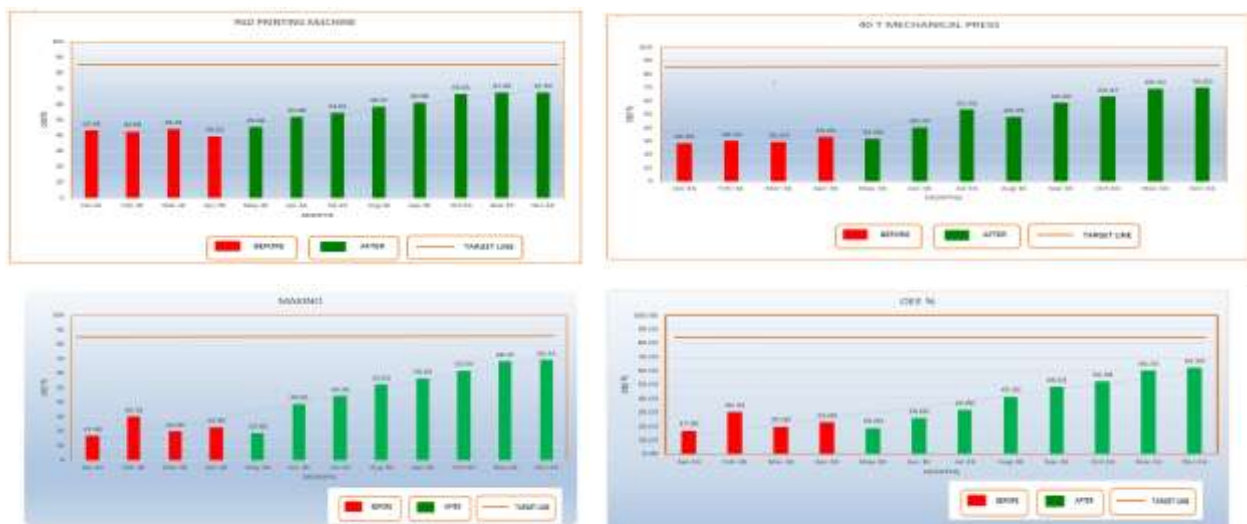


Fig-6: Before –After Scenario after Implementing TPM

4. CONCLUSION

Following conclusion is derived from implementation of TPM in the machine shop of switchgear manufacturing company:

- 1) TPM can be implemented by Total Participation. Success of TPM depends on various pillars like 5-S, Jishu Hozen, Planned Maintenance, Quality maintenance, Kaizen, Office TPM and Safety, Health & Environment.

- 2) OEE increase from 45.66% to 67.49 % in pad printing machine, 32% to 69.33% in press machine, 39% to 68.47% in VMC and 29% to 60.33% in SPM.
- 3) The key factors for this implementation are workers involvement and top management support. Still world class
- 4) TPM implementation is possible with continual support at all the levels along with the supply of necessary resources.
- 5) Machine Breakdowns reduced.

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