

Implementation of Total Productive Maintenance (TPM)

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Abstract : In today's industrial scenario huge losses/wastage occur in the manufacturing shop floor. This waste is due to operators, maintenance personal, process, tooling problems and non-availability of components in time etc. Other forms of waste includes idle machines, idle manpower, break down machine, rejected parts etc are all examples of waste. The quality related waste are of significant importance as they matter the company in terms of time, material and the hard earned reputation of the company. There are also other invisible wastes like operating the machines below the rated speed, startup loss, breakdown of the machines and bottle necks in process. Zero oriented concepts such as zero tolerance for waste, defects, break down and zero accidents are becoming a pre-requisite in the manufacturing and assembly industry. In this situation, a revolutionary concept of TPM has been adopted in many industries across the world to address the above said problems. This chapter deals in length about this TPM..

Key words : rejected parts, tooling problems, zero tolerance, zero accidents.

INTRODUCTION

Total Productive Maintenance or TPM is a philosophy to enhance an organization's productivity and produce high quality goods by minimizing waste thereby reducing costs. The concept was started by the Japanese in the sixties when they realized that increased demand necessitated more specialized machines which in turn required dedicated maintenance groups. To improve equipment reliability, the TPM strategy was implemented in which the regular daily maintenance was carried out by the operators while the mandate given to the maintenance crew was to carryout specialized maintenance, upgrades and modification jobs to minimize failures thereby increasing machine availability, reducing costs and improving profitability of the organization. The concept looks simple but the practical aspect of implementation is very complex involving various stages each of which requires focused attention else the TPM implementation process is bound to result in failure. Due to this very reason, industries in India and world over have struggled and failed in TPM implementation. TPM is not a quick-fix methodology resulting in instant results; it requires commitment, dedication and perseverance on part of the management and employees over the long run (in terms of years) to deliver noticeable visible results.

What Is TPM?

“Maintenance program in which the field operators look after the routine maintenance and maintenance personnel develop modifications to improve reliability and availability of the equipments, maximize equipment efficiency and productivity of processes by eliminating losses and reducing costs thereby improving quality of the products and ensuring higher top and bottom lines for the organization.”

Necessity of TPM

TPM is necessary from both organizational and individual viewpoints. Let us start with a simple question: Why is an organization in business? – To make money. In these times of brutal competition, an organization can succeed, enjoy profits and stay ahead of the competition only by providing faultless service and defect-free high quality products which are easily understood by and useful to customers for a reasonable price.

TPM PILLARS

The basic practices of TPM are often called the pillars or elements of TPM. The entire edifice of TPM is built and stands, on eight pillars (Sangameshwaran & Jagannathan, 2002). TPM paves way for excellent planning, organizing, monitoring and controlling practices through its unique eight-pillar methodology. TPM initiatives, as suggested and promoted by Japan Institute of Plant Maintenance (JIPM), involve an eight pillar implementation plan that results in substantial increase in labor productivity through controlled maintenance, reduction in maintenance costs, and reduced production stoppages and downtimes. The core TPM initiatives classified into eight TPM pillars or activities for accomplishing the manufacturing performance improvements include autonomous maintenance; focused maintenance; planned maintenance; quality maintenance; education and training; office TPM; development management; and safety, health and environment (Ireland & Dale, 2001; Shamsuddin et al., 2005; Rodrigues & Hatakeyama, 2006). The detailed maintenance and organizational improvement initiatives and activities associated with the respective TPM pillars are as follows:

Pillar 1-5S: TPM starts with 5S. It is a systematic process of housekeeping to achieve a serene environment in the work place involving the employees with a commitment to sincerely implement and practice house keeping. Problems cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement. 5S is a foundation program before the implementation of TPM.

If this 5S is not taken up seriously, then it leads to 5D (delays, defects, dissatisfied customers, declining profits, and

demoralized employees). This 5S implementation has to be carried out in phased manner. First the current situation of the workplace has to be studied by conducting a 5S audit. This audit uses check sheets to evaluate the current situation. This check sheet consists of various parameters to be rated say on a 5-point basis for each 'S'. The ratings give the current situation. The each of the above-mentioned 5S is implemented and audit is conducted at regular intervals to monitor the progress and evaluate the success of implementation. After the completion of implementation of 5S random audits could be conducted using company check sheets to ensure that it is observed in true spirits by every one in the work place. Table 1 depicts the key activities to be holistically deployed for effective 5S implementation at the workplace.

Pillar 2- Autonomous maintenance (AM): This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating. By use of this pillar, the aim is to maintain the machine in new condition. The activities involved are very simple nature. This includes cleaning, lubricating, visual inspection, tightening of loosened bolts etc. AM policy are-uninterrupted operation of equipments, flexible operators to operate and maintain Total Productive Maintenance: A Case Study in Manufacturing Industry Global Journal of Researches in Engineering Volume XII Issue VI Version I 26 (G) other equipments, and eliminating the defects at source through active employee participation. Steps in AM are preparation of employees, initial cleanup of machines, take counter measures, fix tentative AM (JISHU HOZEN) standards, general inspection, autonomous inspection, and standardization.

Pillar 3-Kaizen: "Kai" means change, and "Zen" means good (for the better). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are more effective in an organizational environment than a few improvements of large value". This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well. Kaizen policy are practice concepts of zero losses in every sphere of activity, relentless pursuit to achieve cost reduction targets in all resources, relentless pursuit to improve over all plant equipment effectiveness, extensive use of PM analysis as a tool for eliminating losses, and focus of easy handling of operators. Kaizen target are achieve and sustain zero losses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost reduction. Tools used in kaizen are Why-Why analysis, Poka-Yoke (Poka-Yoke is Japanese term, which in English means 'mistake proofing' or 'error prevention'), summary of losses, kaizen register, and kaizen summary sheet. Six losses in the work place: The objective of TPM is maximization of equipment effectiveness. TPM aims at maximization of machine utilization and not merely

machine availability maximization. As one of the pillars of TPM activities, kaizen pursues efficient equipment, operator and material and energy utilization that is extremes of productivity and aims at achieving substantial effects. Kaizen activities try to thoroughly eliminate losses. Six major losses that were identified are-equipment failure, set-up and adjustments, small stops, speed losses during production, and losses during warm-up (Nakajima, 1988).

Pillar 4-Planned maintenance (PM): It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into four "families" or groups, viz., preventive maintenance, breakdown maintenance, corrective maintenance, and maintenance prevention. With PM we evolve our efforts from a reactive to a proactive method and use trained maintenance staff to help train the operators to better maintain their equipment. In PM policy are achieve and sustain availability of machines, optimum maintenance cost, reduces spares inventory, and improve reliability and maintainability of machines. PM targets are zero equipment failure and break down, improve reliability and maintainability by 50 percent, reduce maintenance cost by 20 percent, and ensure availability of spares all the time. Six steps in planned maintenance are equipment evaluation and recoding present status; restore deterioration and improve weakness; building up information management system; prepare time based information system; select equipment, parts and members and map out plan; prepare predictive maintenance system by introducing equipment diagnostic techniques; and evaluation of planned maintenance.

Pillar 5-Quality maintenance (QM): It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like focused improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, and then move to potential quality concerns. Transition is from reactive to proactive (quality control to quality assurance). QM activities 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 condition is checked and measure in time series to verify that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand. In QM policy are defect free conditions and control of equipments, quality maintenance activities to support quality assurance, focus of prevention of defects at source, focus on Poka-Yoke (fool proof system), in-line detection and segregation of defects, and effective implementation of operator quality assurance. QM targets are achieve and sustain customer complaints at zero, reduce in-process defects by 50 percent, and reduce cost of quality by 50 percent.

Pillar 6-Training: It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill. It is not sufficient know Total Productive Maintenance: A Case Study in Manufacturing Industry Global Journal of Researches in Engineering

Volume XII Issue VI Version I 27 (G) only “Know-How” by they should also learn “KnowWhy”. By experience they gain, “Know-How” to overcome a problem what to be done. This they do train them on knowing “Know-why”. The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills is phase 1-do not know, phase 2-know the theory but cannot do, phase 3-can do but cannot teach, and phase 4-can do and also teach. Training policy’s are focus on improvement of knowledge, skills and techniques, creating a training environment for self-learning based on felt needs, training curriculum including tools/assessment etc. conducive to employee revitalization, and training to remove employee fatigue and make, work enjoyable. Training target are achieve and sustain downtime due to want men at zero on critical machines, achieve and sustain zero losses due to lack of knowledge/skills/techniques, and aim for 100 percent participation in suggestion scheme. Steps in educating and training activities are setting policies and priorities and checking present status of education and training, establish of training system for operation and maintenance skill up gradation, training the employees for upgrading the operation and maintenance skills, preparation of training calendar, kick-off of the system for training, and evaluation of activities and study of future approach.

Pillar 7-Office TPM: Office TPM should be started after activating four other pillars of TPM (AM, Kaizen, PM, and QM). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation. Office TPM addresses twelve major losses, they 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; time spent on retrieval of information; non availability of correct on line stock status; customer complaints due to logistics; and expenses on emergency dispatches/purchases. Office TPM and its benefits are involvement of all people in support functions for focusing on better plant performance, better utilized work area, reduce repetitive work, reduced administrative costs, reduced inventory carrying cost, reduction in number of files, productivity of people in support functions, reduction in breakdown of office equipment, reduction of customer complaints due to logistics, reduction in expenses due to emergency dispatches/purchases, reduced manpower, and clean and pleasant work environment.

Pillar 8-Safety, health and environment: In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis. Safety, health and environment target are zero accident, zero health damage, and zero fires. A committee is constituted for this pillar, which comprises representative of officers as well as workers. The committee is headed by senior vice president (technical). Utmost importance to safety is given in the plant. Manager (safety) looks after functions related to safety. To create awareness among employees various competitions like safety slogans, quiz, drama, posters, etc. related to safety can be organized at regular intervals.

BARRIERS IN TPM IMPLEMENTATION

Having understood the basics of TPM, we will now discuss the barriers in TPM implementation. As mentioned earlier, TPM implementation though easy on paper, is difficult to achieve and this is mainly due to reluctance by the organization to understand and implement the concepts of TPM and failure to realize the benefits obtained by implementation of TPM. Let us look at the various factors:

1. Lack of top management commitment: TPM programs can be effective if and only if the top management is totally committed and involved. The top management drives TPM. It is the responsibility of the top management to distill the benefits of TPM down the organizational levels. Management commitment for TPM implementation comes in the form of operator’s time and a short term investment of dollars that brings equipment into condition (Robert Jostes and Marilyn Helms, 1994). Without top management support, the TPM program will suffer a premature death.

2. Organization resistance to change: This is a direct off-shoot from the lack of top management commitment. An organization changes if and only if its top management is willing to change. To adopt a complex ideology, the organization needs to be fearless and should be able to adapt and change as per the environment. In this world of cut-throat competition and globalization, to stay ahead, innovation is the key. A majority of the organizations once set in a particular path, believes it to be too risky to alter its course and hence finds it difficult to implement TPM.

3. Unwillingness to commit resources: TPM implementation requires investment by the top management in terms of resources (man, materials, money and time). In majority of the cases, management considers TPM as an unnecessary expenditure and drain on its resources, thereby resisting calls for implementation of the same and finding out ways and means not to allocate budget for its implementation. They fail to see the larger picture and the effect of TPM in improving profits. As mentioned earlier in this paper, TPM implementation takes time and the top management should be willing to show patience in achieving the desired results.

4. Work culture: —Keep the distance is practiced in many organizations. Boundaries between management and non-management staff impede flow of communication and foster indifference among employees. All employees should be involved in the decision making process. The same is true among the various departments of the organization. For example – maintenance does not fully trust operations to carry out autonomous maintenance. Jack Welch, former Chairman and CEO of General Electric espoused the philosophy of —boundaryless! where-in all barriers were removed among engineering, manufacturing, marketing and the other functions which would open the organization up to the best ideas and practices and finding a better way every day.

5. Resistance by employees: A common comment in Indian organizations is “This is not my job”. When the work culture promotes distinction and boundaries, employees view themselves as belonging to the departments in which they work and not to the organization that employ them. A narrow sense of vision hinders growth of an organization. It is the task of the management to align employees to the organization’s vision and goals.

6. Long term commitment of management and employees:

Human resource assets are to be treated with care and management should go the extra distance to make them feel at home. Remuneration and employee benefits and facilities should be at par with global levels. Employees should feel wanted in the organization and be motivated to overcome all obstacles in TPM implementation.

7. Manpower costs: Organizations opt for minimum manpower to cut costs. Manpower recruitment has to be done in line with the requirements the processes demand. Unfortunately, as TPM implementation is not considered a core requirement, it is not considered when manpower allocation is carried out.

8. Non-Involvement of non-management staff: All organizations in India have unionized staff of appreciable strength. The actual job of running the machines is done by the operators who belong to the workers union. To get TPM started, management must find time to sit with the union, take them into confidence and convince them about the benefits of TPM. The operators and lower level workers are key constituents of TPM programs. Without their involvement, TPM implementation will definitely fail.

9. Lack of a suitable reward mechanism: TPM implementation is unlike the normal routine activities carried out by the employees of an organization. It is a specialized job demanding specific skill sets. Employees whole heartedly invest their time and knowledge for a successful implementation and for this reason they should be publicly appreciated by the management for their efforts. A suitable reward mechanism should be instated to encourage a sense of inclusiveness to the employees.

10. Lack of knowledge of TPM: Many organizations are not able to successfully implement TPM due to insufficient knowledge on TPM. Before announcing and implementing TPM programs, it is imperative that organizations send senior personnel to industries where TPM has been successfully implemented to learn the nuts and bolts of TPM implementation. The failure of organizations to successfully institutionalize effective TPM implementation program is due to lack of support system to facilitate learning and transform learning into effective diffusion of the practices of TPM (Ahuja and Khamba, 2008). The organization's success in fully achieving the benefits of TPM through effective implementation of maintenance strategies is reliant upon the competencies of the workforce (M. Panneerselvam, 2012).

11. Need for training: To impart knowledge on TPM, extensive training schedule needs to be developed by the organization. An organization should identify the specific knowledge, skills and management abilities that it wants its employees to have and then design suitable training to achieve to develop the skills (Suzuki T., 1994).

12. Non-implementation of pilot study: Organization wide implementation should be done only after implementing a pilot study on a specific area of requirement. This is a must to bring out the difficulties and finding solutions to the problems uncovered in the pilot study. A pilot study is very important from the view point of uncovering productivity related issues. TPM implementation should always be structured and planned with a well design pilot study.

13. Improper constitution of teams: Teams are integral to TPM implementation strategy. The —Team| concept on which TPM is based on should involve all departments

including engineering, operations and maintenance (B. S. Blanchard et al., 1995). If the teams are not constituted properly, problems in the equipments cannot be detected and rectification and modification actions cannot be initiated. A team consisting of only management staff or only non-management staff or personnel from one department does not add any value. The teams should consist of personnel from the cross-section of the organization spanning all the levels and departments.

14. Attitude towards manufacturing / production process: This is directly related to work culture in an organization where-in frequent breakdowns are tolerated and not analyzed, processes are inefficient, product quality is not checked and customer feedback not monitored. Operators have to become involved in routine maintenance and improvement activities that halt accelerated deterioration, control contamination and help prevent equipment problems (Suzuki T., 1994).

15. Repair driven maintenance: This is an offshoot of attitude towards manufacturing process. In a large number of organizations, instead of carrying out maintenance jobs to avoid failure and repair, focus is on carrying out immediate repair and bringing the machine back on line as fast as possible. The focus should really be on reliability centered maintenance which implies that the function must concentrate on assuring maximum reliability in production equipment and not on quick repair time (R. Moore, 1997).

16. Inability to plan design change or replacement maintenance: In many organizations, sufficient time for maintenance of equipments is not given, pushing the maintenance crew to carry out the minimum maintenance required to restart the equipment and keep it running to meet the daily requirements. If equipment requires design change or planned replacement, it should be taken out of service for as much time as required for the maintenance activity so that it does not fail in future. The ultimate goal of the maintenance department is maintenance prevention.

17. Maintenance management process: To implement TPM, management and employees should embrace technology. Maintenance management process should be computerized to have ready access to the schedules and failure analysis reports, which should be uploaded on to the organization's Local Area Network. Organizations should develop preventive, predictive and corrective maintenance programs to achieve the goal of maintenance prevention.

18. Issues in design modification: There is a general feeling that the design given by the Original Equipment Manufacturer (OEM) is considered sacrosanct. This need not always be the case. The design would be suited for a particular process but when the process is changed to enhance efficiency and productivity, the original design need to be modified to suit the new requirement.

19. Non-availability of Standard Operating Procedures: SOP is a set of clearly written down instructions that document any activity followed by an organization. They document the way activities are to be performed to facilitate consistent conformance to technical and quality system requirements and assist an organization to maintain quality control and quality assurance processes (United States Environmental Protection Agency, 2007). Clearly written down procedures ensure that the equipments are run properly and the probability of failure is minimal.

20. Tools and instruments: Organizations should invest in latest state-of-the-art tools and measuring instruments for

faster identification and rectification of problems arising in manufacturing processes. This will help in considerably reducing failures and breakdowns of equipments and machines.

TPM IMLEMENTATION

The following is the brief description of each of the TPM implementation activities:

(i) Master plan: The TPM team, along with manufacturing and maintenance management, and union representatives determines the scope/focus of the TPM program. The selected equipments and their implementation sequence are determined at this point. Baseline performance data is collected and the program's goals are established.

(ii) Autonomous maintenance: The TPM team is trained in the methods and tools of TPM and visual controls. The equipment operators assume responsibility for cleaning and inspecting their equipment and performing basic maintenance tasks. The maintenance staff trains the operators on how to perform the routine maintenance, and all are involved in developing safety procedures. The equipment operators start collecting data to determine equipment performance.

(iii) Planned maintenance: The maintenance staff collects and analyzes data to determine usage/need based maintenance requirements. A system for tracking equipment performance metrics and maintenance activities is created (if one is not currently available). Also, the maintenance schedules are integrated into the production schedule to avoid schedule conflicts.

(iv) Maintenance reduction: The data that has collected and the lessons learned from TPM implementation are shared with equipment suppliers. This 'design for maintenance' knowledge is incorporated into the next generation of equipment designs. The maintenance staff also develops plans and schedules for performing periodic equipment analysis (burner pump, fuel filter, rotary cup atomizer, furnace tube and valve, etc.). This data from analysis is also fed into the maintenance database to develop accurate estimates of equipment performance and repair requirements. These estimates are used to develop spare parts inventory policies and proactive replacement schedules.

(v) Holding the gains: The new TPM practices are incorporated into the organization's standard operating procedures. These new methods and data collection activities should be integrated with the other elements of the production system to avoid redundant or conflicting requirements. The new equipment management methods should also be continuously improved to simplify the tasks and minimize the effort required to sustain the TPM program.

TPM IMLEMENTATION STAGES

a) Stage A-Preparatory stage

Step 1-Announcement by management to all about TPM introduction in the organization: Proper understanding, commitment and active involvement of the top management in needed for this step. Senior management should have awareness programmes, after which announcement is made. Decision the implement TPM is published in the in house magazine, displayed on the notice boards and a letter informing the same is send to suppliers and customers.

Step 2-Initial education and propaganda for TPM: Training is to be done based on the need. Some need intensive training

and some just awareness training based on the knowledge of employees in maintenance.

Step 3-Setting up TPM and departmental committees: TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs.

Step 4-Establishing the TPM working system and target: Each area/work station is benchmarked and target is fixed up for achievement.

Step 5-A master plan for institutionalizing: Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.

b) Stage B-Introduction stage A small get-together, which includes our suppliers and customer's participation, is conducted. Suppliers as they should know that we want quality supply from them. People from related companies and affiliated companies who can be our customers, sisters concerns etc. are also invited. Some may learn from us and some can help us and customers will get the message from us that we care for quality output, cost and keeping to delivery schedules.

c) Stage C-TPM implementation In this stage eight activities are carried which are called eight pillars in the development of TPM activity. Of these four activities are for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.

d) Stage D-Institutionalizing stage By now the TPM implementation activities would have reached maturity stage. Now is the time to apply for preventive maintenance award.

CONCLUSION

Today in the era of globalization, to compete with other worldwide industries like Japan, Korea, China etc. therefore it is necessary to move our industries towards modern trend development in all sectors of industries including maintenance department. So it was found that total productive maintenance (TPM) is one of the best tools for making our industries competitive and effective, in the field of maintenance. While implementing TPM works on major 8 pillars which are (JH, KK, PM, QM, E&T, OT, 5s) It works on methodologies like CLITA, JSA (Job Safety Analysis), PM Analysis for achieving its goal of success. Through this paper is trying to advocate the concept of TPM for Indian approach. The results of implementing an effective program in terms of increased plant efficiency and productivity are outstanding. It is known that a TPM implementation is not a short-term fix program. It is a continuous journey based on changing the work-area, then the equipment so as to achieve a clean, neat, safe workplace through a "PULL" as opposed to a "PUSH" culture. Significant improvement can be evident within six months, however full implementation can take many years to allow for the full benefits of the new culture created by TPM. Apparently, successful TPM implementation can achieve better and lasting result as compared to other isolated program because there is an ultimate change in people (knowledge, skills, and behavior)

during the progress.

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