

Total Productive Maintenance: Need & Framework

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Abstract— Currently wide research is on to find out various methods and processes that will improve quality and productivity of a firm. Total Productive Maintenance (TPM) is one such means. It is a Japanese philosophy that focuses upon achieving zero breakdowns and zero defects by maintaining the equipments throughout its use. TPM integrates all areas of an organization. TPM is all about teamwork, it is a strategy that can help to achieve a world class level of overall equipment effectiveness (OEE) which is otherwise become difficult to achieve solely by equipments. OEE takes into consideration the availability rate of the machinery and equipment, the efficiency rate at which it operates and the quality rate of the products produced. TPM pillars that serve as guidance to effective TPM implementation program leads to improve in overall manufacturing performance of any organization. An attempt here is to highlight the key issues pertaining to need, benefits, framework, overall equipment effectiveness and implementation of TPM program.

Keywords— Quality Improvement, Total Productive Maintenance (TPM), Productivity, Overall Equipment Effectiveness (OEE), Pillars of TPM, Zero breakdowns, Implementation Framework.

I. INTRODUCTION

The term “Total Productive Maintenance (TPM)” was first coined by Nipponese, a company which used to provide electrical parts to Toyota in late 1960’s. In the year 1971, Nipponese became the first plant to be given the honorary award from the Japan Institute of Plant Maintenance (JIPM) for best maintenance practices. This award marked the new beginning in maintenance improvement methodology. Mr. Seiichi Nakajima because of his valuable contribution to more than hundreds of plants across Japan became the father of TPM. Nakajima has explained TPM as a distinct approach to conventional maintenance practices. He argued about optimizing equipment effectiveness by eliminating breakdowns. He stressed the use of autonomous maintenance as a strategic tool in maintenance wherein the operator performs day-to-day activities pertaining to his area of work by himself [1, 2]. TPM has revolutionized the maintenance as it does not involve the orthodox maintenance policy but inculcate a cultural shift in the organization. It may be termed as a more philosophical approach towards maintenance [3]. In 1989 JIPM recognized TPM as key to maximize company-wide productivity and defined TPM as a corporate culture that not only prevents losses, but effectively involve everyone from top management to workers to actively participate in small groups [4].

TPM explains a method of transformation. It is basically a set of organized activities which are capable of improving management of plant monies when carefully performed individually and with the help of teams. The culture of a plant has not evolved solely from TPM, but it might also prove to be a reflection of other processes for improvement that are currently proceeding, such as TQM, Six Sigma, Lean, Kaizen, Root Cause Analysis etc., A precarious aspect of TPM is that there should be rapid and continuous improvements. To implement TPM successfully, a company needs an environment of trust and belief, wherein both workforce and the top management proactively participate in resolving an issue. This in turn should be beneficial to both the company and the workers. TPM acts as a link between functions in the organization. These functions include improving company's maintenance practices by reducing manufacturing cost, improving product quality, reducing wastes, reduction in manufacturing cost, increment in equipment availability and by that enhancing company’s state of maintenance [5].

II. NEED OF TPM

The principal feature of TPM is the quest for economic growth, forestall of maintenance expenses, boost maintainability of equipments, implement preventive maintenance, and overall participation by all employees. TPM can be briefly described as a continuous improvement process which is structured equipment-centric. It plays an important role in optimizing the effectiveness in production which is done by identifying and eliminating major loopholes throughout the production system by virtue of an effective and pro-active team-based involvement by all employees across all hierarchical levels of operations [6].

The aspects which necessitate implementing TPM in any organizations are [6]-

- To grow into a world class organization by satisfying customers globally, thereby reaching sustained growth.
- To remain competitive in a dynamic environment.
- To attain boost in manufacturing flexibility objectives.
- Raise the level of work ethics & mindset of the entire organization.
- To sustain rise in productivity and quality.
- Minimize cost reduction as far as maintenance related expenses are concerned.
- Reducing expenditure in sophisticated technologies by attaining a higher return on investment ROI.

- To be able to provide superior manufacturing quality as well as satisfying large products varieties and quantities in a dynamic manufacturing environment.
- The requirements of the organization pertaining to products reliability and variety.
- To counter internal factors such as less productivity, higher customer complaints, increasing defect rates, inconsistency in delivery time, steep rise in wages and salaries, inadequacy of knowledge and skill set of workers.
- To optimize overall product life cycle costs for realizing competitiveness in the global market.
- Regulating time-to-time inventory levels and production lead-times for achieving optimal equipment up-time.
- Ensuring more effective use of human resources, supporting personal growth and garnering of human resource competencies through adequate training and multi-skilling.
- To minimize issues faced by organizations in the form of external factors such as a steep hike in raw material cost, energy cost and global competition.

III. 8 PILLARS OF TOTAL PRODUCTIVE MAINTENANCE

The key areas of TPM are addressed by eight different activities, popularly termed as eight pillars of TPM [7]. As suggested by JIPM, eight-pillar methodology of TPM, results in rise in labour productivity via contraction in maintenance costs and production stoppages and thereby having cut back on downtimes [6]. The eight TPM pillars include Autonomous Maintenance, Focused Maintenance, Planned Maintenance, Quality Maintenance, Education and Training, Office TPM, Development Management, and Safety, Health and Environment [8, 9, 10]. The JIPM eight pillar TPM implementation plan is depicted in Fig. 1 [6].

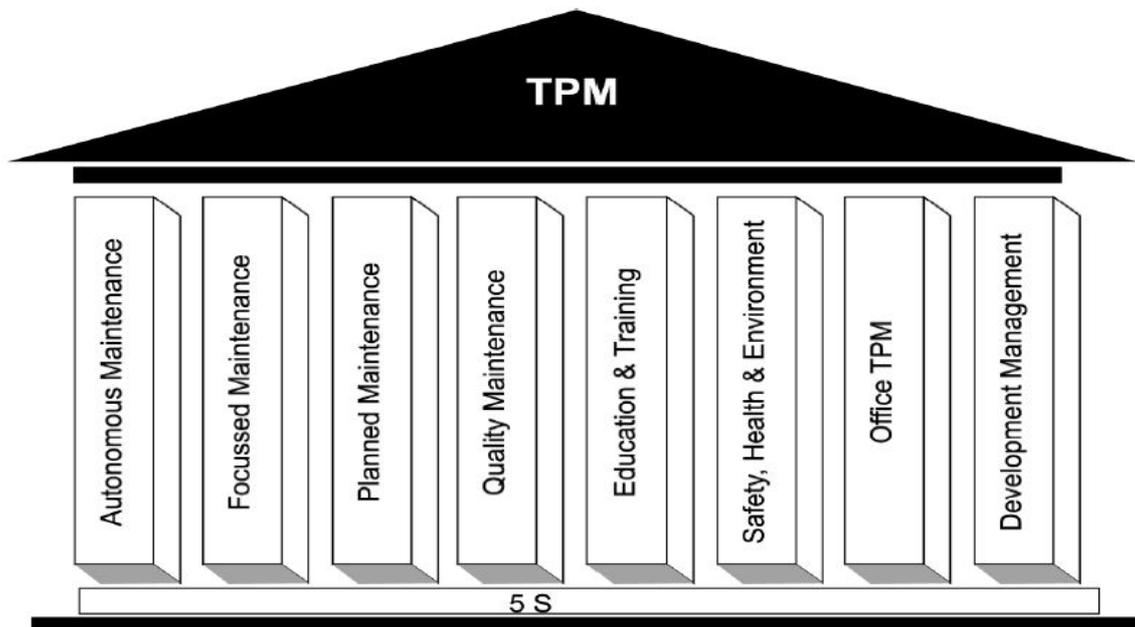


Fig. 1 Eight pillars approach for TPM implementation (suggested by JIPM)

A. 5 S

TPM commence with 5S. 5S is an orderly process to organize, set in order, clean & standardize a workplace and to keep it that way. It deals with organizing a workplace which helps to recognize the problems which otherwise go unnoticed. Problems should be made visible first in order to eliminate them. The meaning of 5S is Seiri means Sort out, Seiton means Organize, Seiso means Shine, Seiketsu means Standardization and Shitsuke means Self discipline.

B. Autonomous Maintenance

This pillar aims at developing operator ownership. The operator performs day-to-day tasks to be able to develop skills and in turn mastery of the equipment, thereby freeing up the skilled maintenance people. This way they can spend more time for technical repairs and other value added activities. In this activity operators are responsible for safeguarding of their equipment to avoid operating abnormalities.

C. Focused Maintenance (KAIZEN)

The principal behind focused improvement is the KAIZEN. It is believed that small improvements of large numbers have more effect than large improvements of small numbers in any organization. KAIZEN is a Japanese word, where "Kai" stands for change, and "Zen" stands for good or better. Kaizen principle is all about seeking small improvements. KAIZEN is executed on a continuous basis, which comprises of people across every level of the hierarchy of an organization. It requires almost negligible investment. This pillar aims to reduce losses in the workplace that are bottlenecks to plant efficiencies. Using a systematic procedure losses are eliminated in a phased manner. These activities can be implemented in both production as well as administrative areas.

D. Planned Maintenance

This pillar is associated with raising the output by carefully minimizing defects and failures along with bettering the quality of maintenance personnel, thereby raising machine availability and in turn plant availability.

Planned Maintenance follows the concept of zero failures similar to Focused Improvement. Zero failures mean zero defects, zero reworks and zero accidents. Various maintenance methodologies such as Breakdown Maintenance, Maintenance Prevention and Corrective Maintenance can be used.

E. Quality Maintenance

The focus of this pillar is to bring customer delight via highest quality through error free manufacturing. Much like Focused Improvement, the aim here is to eliminate non-conformances in a systematic manner. It helps in recognizing which parts of the equipment disturb the quality of product and helps the operator to eradicate present quality concerns before they turn out to be a potential quality concerns.

F. Education and Training

Employees having high morale and knowledge do wonders for a company. This is the bottom line of this pillar. Aimed at developing employees into multi-skilled dynamic work forces wherein everyone who is enthusiastic about his work and does all the given functions effectively and more independently. This is imparted by engaging the operators in various ways of education in order to upgrade their skills.

G. Safety, Health and Environment Control

This pillar focuses on developing a safer workplace and surroundings without getting damaged by the process or procedures. It is an important pillar which plays a crucial role in the development of all remaining pillars on a regular basis. An independent committee is set up for this pillar which comprises of representatives of various officers and operators. Safety is given an unconditional importance in the plant. Manager of safety ensures the safety measures. In order to create awareness amongst employees, various competitions like safety slogans, Quiz, Drama, Poster making, etc. related to safety can be organized at regular intervals.

H. Office TPM

Office TPM aims at improving productivity and efficiency of the administrative functions by identifying and eliminating losses. It includes activities such as analyzing the procedures and processes for increased office automation. It targets several major losses in administrative work such as cost and processing loss in the areas of accounts, procurements, and sales and marketing that leads to high inventories.

I. Development Management

This pillar is aimed towards making use of previous learning's in developing the maintenance practices for new systems. It consists of minimizing the problems occurred in the existing system so as to avoid repeating the same for the new ones.

IV. OVERALL EQUIPMENT EFFECTIVENESS

Overall equipment effectiveness (OEE) is a key to TPM practice. OEE methodology embodies metrics from all equipments in manufacturing states to measure and improve existing performance of equipment and, thereby, reducing cost of ownership (COO) of equipments [11]. TPM initiatives address major losses and wastes relevant to the production system by establishing systematic and continuous evaluation of production facilities [12, 13, 14]. TPM uses OEE as a quantitative measure for gauging the production systems' performance. OEE is the basis to measure the successful implementation of the TPM program [15]. The ultimate goal that TPM aims to achieve is higher OEE. Overall equipment effectiveness is measured by gathering information with regards to availability of the equipment, performance efficiency of the process and rate of quality products [16, 17]. Fig. 2 depicts the calculations of OEE based on six major production losses [6].

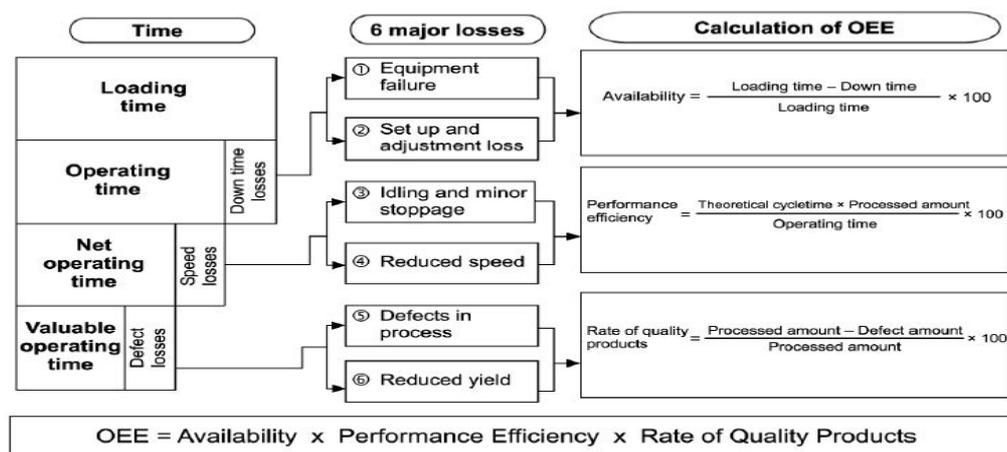


Fig. 2 Calculation of OEE based on six major production losses

V. FRAMEWORK OF TPM

TPM which focuses on maximizing equipment effectiveness through the equipment life span, struggles to sustain the optimum condition of the equipment in order to avoid unexpected breakdowns, speed losses and defects in quality that occur due to process activities. TPM has three ultimate goals; zero defects, zero accident, and zero breakdowns [18, 19, 20]. Nakajima [18] has suggested that equipment should run at its rated capacity for maximum time. A benchmark for individual parameters like quality, productivity, delivery, cost, morale and safety will lead to zero defects, zero breakdowns, zero machine stoppages, zero pollution and zero accidents, which ultimately serves as TPM objective. TPM has been visualized as an overall manufacturing strategy for improving productivity of the equipment. The components of this strategy include cross-functional teams to remove machine uptime barriers, rigorous programs of preventive maintenance, improved maintenance operations management efficiency, training for equipment maintenance to the lowest level and information systems for supporting the development of imported equipments with higher reliability and lower cost [6]. Fig. 3 mentions the TPM implementation framework [6].

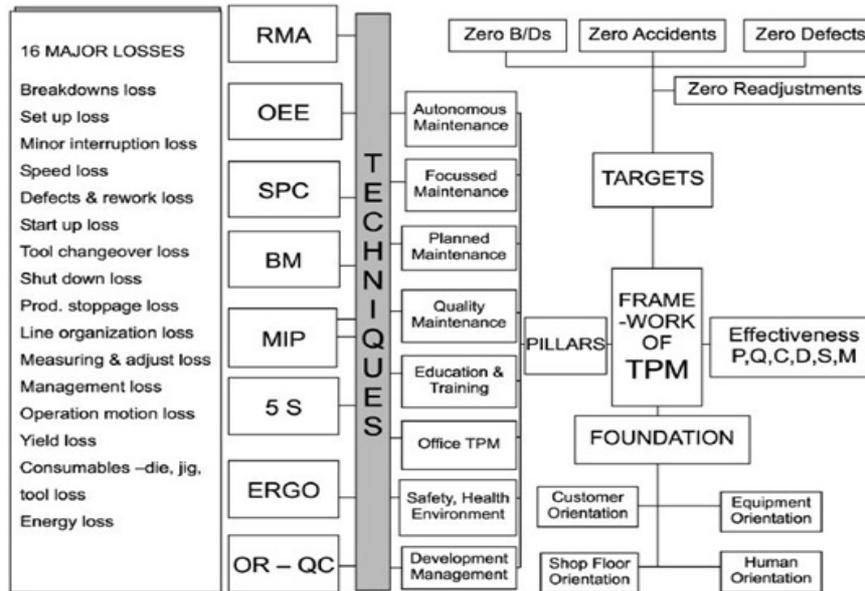


Fig. 3 TPM implementation framework

VI. BENEFITS OF TPM IMPLEMENTATION

TPM comprises of almost all the organizational elements, which team-up so that equipments become more effective in sustaining higher organization goals. TPM may be implemented in those organizations who wish to become world leader. TPM seeks to achieve higher productivity, better quality, less failures, cost reduction, dependable deliveries, inspiring working surroundings, improvements in confidence and safety of the employees [20]. The bottleneck behind the implementation of TPM is that it has the capability to increase throughputs of an organization both monetary and non-monetary. Another influential paradigm is that TPM requires no or very little capital investments in human resources, which in turn create wonders for the work force, shaping them to become more proactive in their decision making [21]. TPM holds the basis of a scientific field which deals with the health of machines [22].

Previously unknown and hidden manufacturing losses can also be identified with the help of OEE. Scores of OEE can be traced which can help to improve manufacturing processes. The functions that are delivered by OEE are rich in nature and are truly important to find the appropriate time needed for production and also to identify the causes of lost in productivity. The importance can be understood by the very fact that even as minute as 1% improvement in OEE index can prove vital and improve profits and productivity drastically [21].

VII. CONCLUSION

In this paper an effort has been made to exhibit a critical review about TPM philosophy. Efficient TPM implementation initiative highlights maintenance related problems, with a view to enhance performance of equipments. An essential prerequisite to implement TPM productively requires the motivation of employees within an organization to get ready to welcome the change for betterment. The rate of progress towards final goal will be based on the eagerness to accept change by one and all. TPM pillars that serve as guidance to effective TPM implementation program leads to improve in overall equipment effectiveness (OEE). TPM will only succeed where people from all levels remain committed towards bringing the much needed cultural shift in the organization. TPM also focuses on to provide the much needed training and regular analysis of the success or failure of the consequent initiatives of improvements.

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