International Journal on Emerging Technologies **3**(1): 18-23(2012)

ISSN No. (Print) : 0975-8364
ISSN No. (Online) : 2249-3255

An Empirical Study Approach on TPM Implementation in Manufacturing Industry

Kapil Sharma*, Gaurav Gera**, Rajender Kumar, H.K. Chaudhary*** and S.K. Gupta******

**Department of Mechanical Engineering, S.S.I.E.T., Derabassi, (PB) India.*

***Department of Mechanical Engineering, YMCAUST, Faridabad, (HR) India.*

****Department of Mechanical Engineering, FET, MRIU, Faridabad, (HR) India.*

(Recieved 15 December. 2011 Accepted 15 January 2012)

ABSTRACT : Successful companies understand that the customer-defined quality can have the powerful impact their business. Due to this reason many competitive firms continually increase their quality standards. Competitive firms believe that the way to rebound is through improvements in quality, and each has outlined specific changes to their operations. Most of the automotive manufacturing industries are focusing on strict quality standards in their production process and implementing a quality program called Total Productive Maintenance. The aim of the paper is to study the implementation of the TPM program in a manufacturing industry. Through empirical study of implementing TPM in a manufacturing industry, the practical aspects within and beyond basic TPM theory, difficulties in the adoption of TPM and problems encountered during implementation are discussed. By using the empirical and comprehensive approach towards the methodology results in proper implementation of TPM. In this paper, measuring the successfulness of TPM implementation process with direct and indirect benefits for manufacturing industries are also discussed.

Keywords: Total productive Maintenance (T.P.M.), Overall Equipment Effectiveness (O.E.E.), Availability, Maintainability, and Quality rate.

1. INTRODUCTION

Quality, considered a key strategic factor in achieving business success, is more than ever required for competing successfully in today's global market place [2], and it has become the key slogan as organizations strive for a competitive advantage in markets characterized by liberalization, globalization and knowledgeable customers [3]. Following Millar's (1987) predication that there will be two kinds of company in the future–companies which have implemented total quality and companies which are out of business, companies worldwide, large and small, both in the manufacturing and service sectors, have adopted quality strategies, and made TPM a well accepted part of almost every manager's 'tool kit'.

In today competitive age, most of the manufacturing organizations require the significant competitive advantage; hence the need to change their organizational structures through upsizing or downsizing or by empowered new teams for the purpose to improve the performance and goodwill of the organization is increased day by day. The performance of any manufacturing organization is examined by using Preventive Maintenance [9]. The service life of the plant equipment can be improved by reconditioning the equipment before adverse condition lead to failure. In this concept the operator not empowered in maintaining minor activities rather he only operates the equipment. So that the Total Productive Maintenance concept and methodology introduced to manufacturing industries: played an important role in the development of contemporary management.

The father of TPM has pointed out that the origin of TPM traced back to 1951 when Preventive Maintenance was introduced in Japan, describes in his well-known book entitled TPM Development Program [6]. The Japanese has developed TPM to support their lean manufacturing system based on preventive maintenance, corrective maintenance and maintenance prevention concepts and methodologies that was originated and developed in the U.S.A. The process of O.E.E. finding is to increase equipment effectiveness so each piece of equipment can be operated to its full potential and maintained at that level. Nakajima describes in his book that TPM maximizes equipment effectiveness though two types of activity to insure that the equipment performs to design specifications, which is the true focus of TPM. 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 [4].

TPM is a strategic change management approach that has considerable impact on the internal efficiency of manufacturing organizations, both in west and Japan [3]. It increases the effectiveness of production environment, especially through increasing the effectiveness of equipments. In recent years, the theoretical framework for understanding the use of TPM and how it depends on managerial factors such as Just-in-Time (JIT), Total Quality Management (TQM) and Employee Involvement (EI) as well

as environmental and organizational factors such as country, industry and company characteristics is proposed [7]. TPM may involve training programme for the workers to do maintenance on machines while working. This methodology also promotes better team working in the workplace, as the operators will be helping the maintenance team with their tasks. It is the continuous improvement process. The goal is to reduce emergency and unscheduled maintenance. How TPM covers all the company activity shown in Fig. 1.

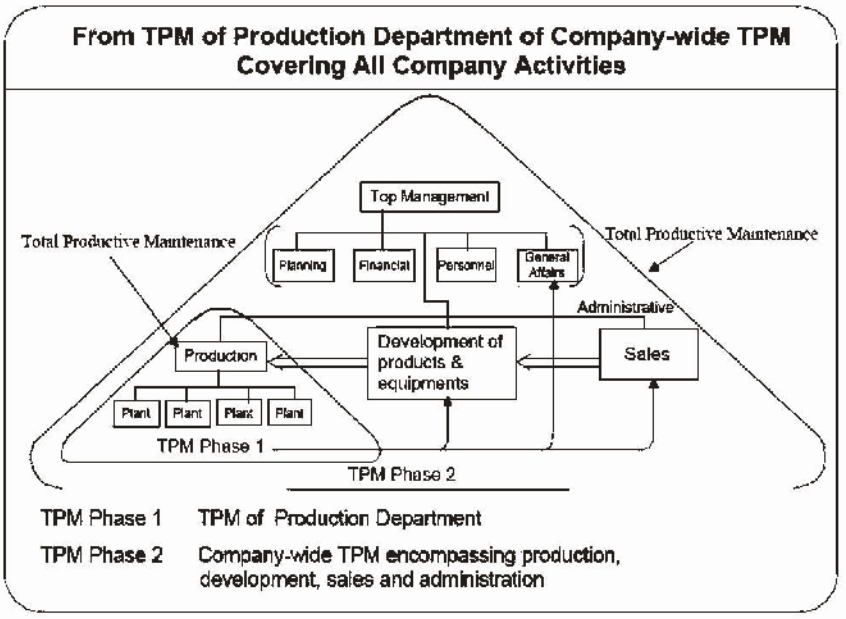

Fig. 1 TPM in Industry.

II. TOTAL PRODUCTIVE MAINTENANCE

Concept and methodology TPM has the targets to achieve - Zero Product Defects, Zero Equipment Unplanned Failures and Zero Accidents. It sets out to achieve these goals by Gap Analysis of previous historical records of Product Defects, Equipment Failures and Accidents etc. Then through a clear understanding of this Gap Analysis (Fishbone Cause-Effect Analysis, Why-Why Cause-Effect Analysis, and P-M Analysis) plan a physical investigation to discover new latent fuguai (slight deterioration) during the first step in TPM Autonomous Maintenance called "Initial Cleaning". The five key elements for characterizing the TPM concept are as follows:

1. TPM strives for maximum equipment effectiveness.
2. TPM establishes a total system of preventive maintenance for the entire life of the equipment.
3. TPM includes participation by all sectors of the organization that plan, use, and maintain equipment.
4. TPM participation is from top management to the frontline staff.
5. Execution of TPM is based on Small Group Activity.

Many companies struggle to implement TPM due insufficient knowledge and skills especially in understanding the linkages between the 8 Pillar-Activities in TPM. A typical TPM implementation requires company-wide participation and full results can only be seen after 3 years and sometimes 5 years. The main reason for this long duration is due to the basic involvement and training required for Autonomous Maintenance participation where operators participate in the restoring the equipment to its original capability and condition and then improving the equipment. TPM basically works on major 8 pillars (JH, KK, PM, QM, E&T, OT, 5s and SHE), each being set to achieve a "zero" target. These 8 pillars are shown in Figure 2. The 8 Pillars of TPM methodology shown in Figure 3 are explained with their key activities in Table 1 below.

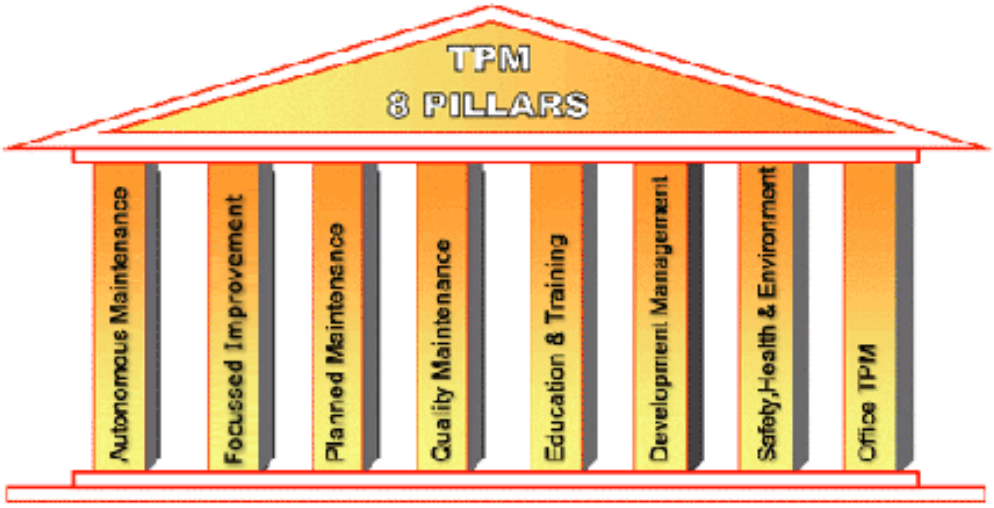

Fig. 2. Pillars of TPM Methodology.

Table 1 : TPM pillars with key activities.

Pillars	Key Activities
Autonomous Maintenance (Jishu Hozen)	It means "Maintaining one's equipment by oneself". There are 7 activities of Jishu Hozen.
Focussed Improvement (Kobetsu Kaizen)	Continuously even small steps of improvement.
Planned Maintenance	It focusses on Increasing Availability of Equipments & reducing Breakdown of Machines.
Quality Maintenance (Hinshitsu Hozen)	Quality Maintenance is establishment of machine conditions that will not allow the occurrence of defects & control of such conditions is requored to sustain Zero Defect.
Education & Training	Formation of Autonomous workers who have skill & technique for autonomous maintenance.
Initial Control	To establish the system to launch the production of new product & new equipment in a minimum run up time.
Safety, Hygiene & Environment	The main role of SHE (Safety, Hygiene & Environment) is to create Safe & healthy work place where accidents do not occur, uncover & improve hazardous areas & do activities that preserve environment.
Office TPM	To make an efficient working office that eliminates losses.

A. Prerequisite for TPM Implementation

The core part of the TPM is the motivation, participation, and development of shop floor personnel, pleasant workshop and sincerity of management towards overall improvement of organization. Generally 5's is the starting point of improvement activities. 5's is shown in Table 2 with their key role explanation.

Table 2 : Key roles of 5's in TPM.

5'S	Meaning	Explanation
Seiri	Sort out	Sort out unnecessary items from necessary and discard them.
Seiso	Cleaniness	Work place should be spic and span.
Seition	Neatness/orderliness	A place for everything and everything its place.
Seiketsu	Standardization/Safety	Maintain high standard of house keeping and workplace organization at all times. Healthy and hygienic conditions should be explored.
Shitsuke	Self Discipline	Get into the habit of doing right thing at work place and abiding norms and conditions of the organization.

TPM identifies the 7 losses (types of waste or muda), namely set-up and initial adjustment time, equipment breakdown time, idling and minor losses, speed (cycle time) losses, start-up quality losses, and in process quality losses, and then works systematically to eliminate them by making improvements (kaizen). On the base of the detail study of the factors involve in the reduction of the equipment effectiveness are divided into three main types are shown in Fig. 4.

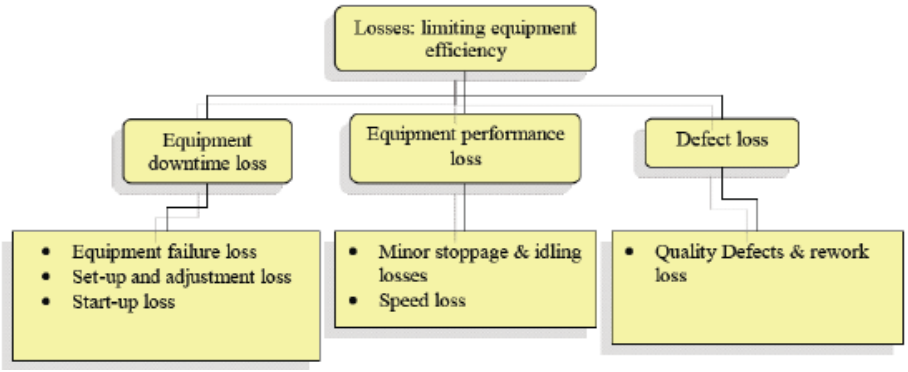

Fig. 4. Major losses limiting equipment efficiency.

B. Major Activities of TPM

If so, of course, necessary to match development of TPM with the conditions that exist in each company, such as manufacturing goods, plant configuration, organization, local history, and culture at the plant site (Arora, 2004). In general, TPM consists of six major activities explained below:

(*a*) Elimination of big losses like low productivity, availability of machine, quality of products etc. based on project teams organized by the production maintenance, and plant engineering departments.

(*b*) Planned Maintenance carried out by the maintenance departments.

(*c*) Autonomous maintenance carried out by the production departments.

(*d*) Preventive engineering carried out mainly by the plant-engineering department.

(*e*) Easy to manufacture product design carried out by the product design departments.

(*f*) Education to support all the above-mentioned activities.

C. Steps to Start TPM

The six main steps for implementing TPM are as follows:

(a) Management should learn the philosophy.

(b) Management must promote the philosophy.

(c) Training for all the employees.

(d) Identify the areas where improvement is needed.

(e) Make an implementation plan.

(f) Form an autonomous group.

D. TPM Success Measurement

A set of performance metrics, which is considered to fit well in a lean manufacturing/TPM environment, is Overall Equipment Effectiveness (OEE). For advanced TPM world-class practitioners, the OEE cannot be converted to costs using Target Costing Management (TCM) OEE measurements are used as a guide to the potential improvement that can be made to equipment. And by identifying which of the 6 losses is the greater, then the techniques applicable to that type of loss. Consistent application of the applicable improvement techniques to the sources of major losses will positively impact the performance of that equipment. Using a criticality analysis across the factory should identify which equipments should be improved first, also to gain the quickest overall factory performance.

Overall equipment effectiveness (O.E.E): The overall equipment effectiveness is the main goal of the TPM system. It is the benchmark of the any TPM process and is used to measure the equipment effectiveness. The formula for equipment effectiveness measures the availability, the rate of performance, and the quality rate. The formula of the overall equipment effectiveness is as follows:

O.E.E = Availability * Performance rate * Quality rate

Availability: The availability is calculated as the required availability minus the downtime and then divided by the required availability. This can be written in the form of formula as:

$$\text{Availability} = \frac{(\text{Availability} - \text{Downtime})*100}{\text{Required availability}}$$

Performance rate: The performance rate can be defined as the ideal or design cycle time to produce the item multiplied by the output of the equipment and then divided by the operating time. This will give the performance rate of the equipment. The formula to calculate the performance rate can be expressed as:

$$P.R. = \frac{(\text{Design Cycle time} * O/p * 100)}{\text{Operating time}}$$

Quality rate: The quality rate can be expressed as the production input into the process or equipment minus the volume or number of quality defects then divided by the production input. The quality rate can be expressed in a formula as

$$\text{Quality rate} = \frac{(\text{Input} - \text{quality defects}) * 100}{\text{Production Input}}$$

E. Impact of TPM Implementation

After measuring the success of TPM implementation by measuring the O.E.E. of the plant and comparing the values between before and after TPM, It is observed that:

1. Management improvement participation (leadership)
2. Organizational infrastructure.
3. Craft and culture of collaboration and co-operation.
4. Linking TPM to business strategy & also to quality.
5. Project prioritization and selection employee training& understanding of TPM methodology.
6. Linking TPM to customers & employees & to create empowerment and authority at all levels.
7. Spreading of TPM in production, R & D, design, marketing, and all departments of industries including health, office and safety departments.

F. Direct Benefits of TPM

The direct benefits for implementing TPM in manufacturing industries are:

1. Increase in productivity and OEE (Overall Equipment Efficiency)
2. Reduction in customer complaints.
3. Reduction in the manufacturing cost by 30%.
4. Satisfying the customer's needs by 100 % (Delivering the right quantity at the right time, in the required quality) & reduced accidents.

G. Indirect Benefits of TPM

The indirect benefits for implementing TPM in manufacturing industries are:

1. Higher confidence level among the employees.
2. A clean, neat and attractive work place.
3. Favorable change in the attitude of the operators.

III. CONCLUSION AND RECOMMENDATIONS

Since this is the age of globalization, therefore it is necessary for the manufacturing industries to move towards modern trend development in all sectors of industries including maintenance department. So-that it is observed; TPM is one of the best tools for making manufacturing industries competitive and effective, in the field of maintenance. It may be the only thing that stands between success and total failure for some companies as far as maintenance is concerned. While implementing TPM some barriers were observed for effective implementation of TPM, such as lack of management exposure, difficulty in understanding TPM methodology and philosophy by middle management, long time taken for implementation etc. that is why the people shows strong resistant to it.

With the help of this paper, it is tried to advocate the concept of TPM for Indian scenario. The main objective is to understand TPM concept and to generate awareness among the budding technocrats and budding enterprises about TPM philosophy adoption in Indian context. There are some recommendations for the manufacturing industries, which will be helpful for the industries to develop a good and reliable production system & they are as follows:

- The company should use the O.E.E. as the tool to assess the current situation and to find out the starting point for the improvement process.
- The company should have to modify the current preventive maintenance plan for the all machines which will be able to decrease the failures and short stoppages and keeping the machines in the best conditions for production.
- Most of the time in manufacturing industries is wasted due to unavailability of the spare parts in store i.e. the time is consumed in the waiting of the spare parts. So the company should keep the frequently problem creative parts in the store so that they can be used in the case of need.
- The operators are the key persons in the production system. So to get the maximum out put with high quality products, it is necessary that they have the good skills as according to their job. So our suggestion is that the company should arrange some training for them time to time to keep them updated and motivated.
- The company should take advantage from the maintenance system to establish a more reliable and stable production system. With the help of good maintenance systems the production of the goods and their delivery to customers will be on time, which will increase the satisfaction level of the customer and also increase the production quantity.

The paper reveals the important issues in Total Productive Maintenance ranging from maintenance techniques, framework of TPM, overall equipment effectiveness (OEE), TPM implementation practices, barriers and success factors in TPM implementation, etc. The contributions of strategic TPM programmes towards improving manufacturing competencies of the organizations have also been highlighted here.

REFERENCES

[1] Arora, K.C., "Production and Operation Management", University Science Press, New Delhi, p.p. 597-620(2004).

[2] Dean, J. & Evans, J., "Total quality management, organization and strategy", St. Paul, MN: West Publishing (1994).

[3] Jackson, M., "An analysis of flexible and reconfigurable production systems: an approach to a holistic method for the development of flexibility and reconfigurability", Production Systems, Dept. of Mechanical Engineering, Linköpings universitet (2000).

[4] Kennedy, R., "Examining the Process of RCM & TPM", The Plant Resource Center, Australia, pp. 9-13(2005).

[5] Millar, R.M.G., "Implementing total quality", Bedfor, IFS Publications (1987).

[6] Nakajima S., "Introduction to TPM (Total Productive Maintenace), Productivity Press, Cambridge, MA. pp. 1-121(1988).

[7] Schroeder, R. G., Cua, K.O., and Kathleen, E.M., "Total productive maintenance: a contextual view", *Journal of Operations Management*, Vol. **17**(2): 123-144(1999).

[8] Sureshchandar, G.S., Chandrasekharan, R., & Anantharaman, R.N., "A conceptual model for total quality management in service organizations", *Total Quality Management*, Vol. **12**(3): 343–363(2001).

[9] Wireman T., "Developing performance indicators for managing maintenance", New York, Ist Ed (1998).