

Challenges in implementing Total Productive Maintenance in Indian Manufacturing Industries - A Review

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Abstract - In today's Indian manufacturing industries, practicing of Total Productive Maintenance (TPM) has been widely accepted and implemented, yet it is still possible to find industries facing maintenance challenges. The main objective of this review paper is to identify the hurdles of TPM implementation and its benefits after the effective implementation of TPM in the Indian manufacturing industries. Total productive maintenance is practical approach that targets maximizing the effective use of facilities that are available within an organization. Total productive maintenance builds a well-defined system of productive maintenance, encompassing the entire life cycle of equipment, covering all department in industry, involving participation of all associates from high level to bottom level and promotes small group autonomous activities. During the progressive growth period the companies are exhibiting the core technical progress in plant automation and centralization, which necessitates remarkable amount of human work to maintain the automation systems. The strategy of maintaining the equipments at their highest performing level is most important for the profound results in manufacturing. As the competitive edge in the world market continues to increase the pace of its progress, our review paper work intends to help companies to look for TPM implementation strategies and look for the possible barriers which other organizations faced during TPM implementation phase, to save on costs, develop employees to face future challenges and bring about a new working culture at their work place.

Key Words: World Class Manufacturing, Total Productive Maintenance, Overall Equipment Effectiveness, 5's, KAIZEN, KANBAN, JIT.

1. INTRODUCTION

TPM stands for Total Productive Maintenance, which is first developed in Japan, it is team driven preventive and productive maintenance and involves all levels, from high executive to the floor associates. TPM has exhibited to be successful in helping boost the productivity and overall plant equipment effectiveness [1]. TPM is all about total plant maintenance. TPM is a systematic approach of maintenance of equipments which focuses on perfect production by lowering the rejection, proper maintenance and making availability of equipment and leading toward zero defects.

Along with this it emphasizes on safer working environment with zero accidents too. It can be considered as suitable way to increase the performance of equipments. It emphasizes inclusive and preventive maintenance in improving the operational efficiency of equipment [2]. TPM initiatives in production help us in strengthening the manufacturing and other business functions, and getting sustained profits. The strategic results of TPM implementations in any industry are, noticeable reduction in occurrence of unexpected equipment's breakdowns that hinders production leading to losses, which can cross billion of amount annually. Overall plant equipment effectiveness (OEE) methodology incorporates inputs from all equipment manufacturing state guidelines into a measurement system that helps manufacturing and operations teams improve equipment performance and, therefore, reduce equipment cost of ownership [4].

1.1 Need and Goals of TPM

TPM implementation has achieved the following objectives. The most important ones are listed here. Avoid waste in a rapidly changing economic era. Producing the goods without compromising the product quality. Reduced cost. Producing minimum quantity batch goods at the least possible time. Goods delivered in hands customers should be free from defective. Involve equipment operators in the simple, day-to-day basics of equipment cleanliness and checks to improve employee ownership in maintaining and identifying equipment related problems quickly [3].

TPM goals are, Zero Defects Product -Zero sudden Failures of equipments and Zero Accidents.

1.2 Pillars of TPM

The below mentioned eight Pillars & their details as shown in figure 1

1. Focused improvement (Kobetsu Kaizen) - Continuously even small steps of improvement.
2. Planned Maintenance - It focuses on Increasing Availability of Equipments & reducing Breakdown of Machines.

3. Initial Control - To establish the system to start the production of newer product & new equipment in a short run up time.

4. Education & Training - Formation of Autonomous associates who have skill & technique for autonomous maintenance.

5. Autonomous Maintenance (Jishu-Hozen) - It means "Maintaining one's equipment by oneself".

6. Quality in Maintenance (Hinshitsu-Hozen) - Quality Maintenance is establishing the machine condition that will not allow the occurrence of defects & control of such conditions is required to sustain Zero Defect in products.

7. Office TPM - To make an efficient working office that removes the losses.

8. Safety, Hygiene & Environment - The main role of SHE (Safety, Hygiene & Environment) is to establish the Safe & healthy work place where accidents do not occur [1].

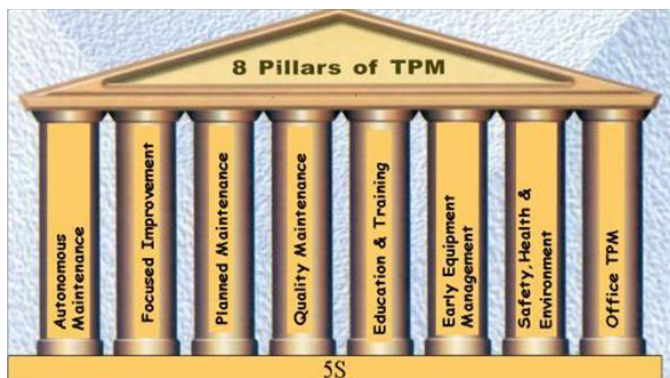


Fig -1: Pillars of TPM

1.3 5'S Foundation of TPM

TPM starts with 5S. Table -1: Nomenclature

Japanese nomenclature	English 5s	Features
seiri	sort	Segregate unnecessary items from the workplace and discard them
seiton	Set in order	Arrange all necessary things in good order and in sequence so that, can be easily picked up for use
seisio	Shine	Clean the work place to make it free from dust
seiketsu	standardize	Maintain high standard of housekeeping practice and work place

shitsuke	sustain	Train and motivate people to follow good housekeeping disciplines autonomously
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It is a well-defined process of housekeeping to create a convenient environment at the work place involving the associates with a commitment to sincerely implement and practice housekeeping regularly. If this 5S is practiced honestly, then it may lead to 5D. They are Delays, Defects, Demoralized associates, Declined profits and Dissatisfied customers [1].

1.4 Just-In-Time (JIT)

It is a tool of lean manufacturing that stands on the pillars of successful planning and the proper implementation of activities necessary to produce an end product. The main objective is to provide each and every process with one part at a time, exactly when need arises for that part, which is the principle of JIT. Reduced lot sizes, reduced buffer sizes, and reduced order lead times are highlighted as the important components of JIT. The traditionally adopted 'push' (based on forecast demand) system was substituted with a 'pull' (based on actual demand) system for getting a smooth and synchronized system, so that products were to be produced at the desired time and with the desired quantity [25].

1.5 Kaizen

A word Kaizen in Japanese is used for continuous improvement. Identifying, focusing and removing the wastes in machinery, operator or production methods refer to kaizen in manufacturing companies. The JIT approach can be further moulded in an approach that is called continuous improvement or kaizen approach. Where kai stands for change and zen stands for better. So, kaizen means 'to change continuously for the betterment of each individual and every system within the organization. The kaizen system approach has been utilized to remove problems step by step by the collection of data, the analysis of root causes, the discovery and selection of one best solution from various available solutions, implementation and proper documentation. The various benefits experienced by them after adopting kaizen were the complete elimination of wastes such as lack of quality, rejection, rework of products and a remarkable amount of expenses were saved [25].

1.6 Kanban

Kanban refers to parts-movement system in which material moves between workstations in a plant production line based on cards. A supplier should only deliver parts to the production line as and when they are required, so that there is no storage of parts in the plant production area, which is the basic need for Kanban system. A state map was prepared and analysed in order to note down the cycle time

of various activities involved in the plant production of the component. It is clearly noticed that a push system was usually adopted in manufacturing lines, which was a big issue for the assembly line process. A kanban system was generated to replace the push system with a pull system. Remarkable amount of work which is in process inventories, lower value-added time were major drawbacks which had been noticed during initial analysis stage. The kanban system played a pivot role in making a better product flow [25].

1.7 Kanban Benefits of TPM

Direct benefits of TPM encompasses, productivity and increased overall plant efficiency -Reduced manufacturing cost -Reduced accidents-Rectifies customer complaints-Satisfies customer’s needs to a great extent-Follows pollution control measures-Improves product quality-Increases consistency[5]. Indirect benefits of TPM includes, increases the confidence level among the associates-Workers feel ownership towards the machine-Workplace is always neat, clean and attractive-Attitude of the associates is changed towards company-Knowledge and experiences are shared among all the associates-All the associates work together to achieve organizational goals and horizontal deployment of a new concept in all departments of the organization [5].

2. METHODOLOGY

This review paper systematic literature review has been followed.

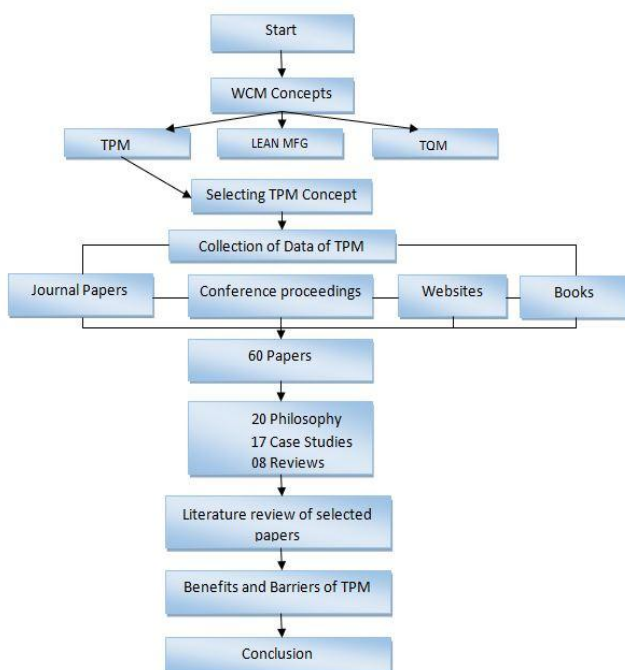


Fig -2: Methodology

The source for literature is from leading journal papers from various publications and conference proceedings. At the start some books and websites and classroom lecturing were helpful in understanding total productive maintenance approach. This review paper would help in inclusive understanding of the total productive maintenance practices in manufacturing organizations and the challenges which organizations will encounter during introducing and implementation of the total productive maintenance within the organization.

At the beginning 60 papers have been collected and later on a systematic segregation of the paper is done. Different categories of papers as Case study related papers, review papers, TPM philosophy papers is done. 17 papers listed under case study and 08 papers listed under review papers 20 papers under philosophy. Papers selected for the review have been studied and author’s findings and issues are summarized. Methodology is depicted in figure 2.

3. LITERATURE REVIEW

Selected papers have been put into three sections as TPM philosophy, reviews and case studies.

3.1 Literature of TPM review papers

Total productive maintenance stood as one of the best tools for making our industries competitive and effective, in the field of maintenance. TPM may be the one major thing that clearly distinguish success and failure for companies as far as maintenance is concerned.

M Ranjeet, Jadhav M, Mr. Morosin Alessandro, Prof.S.H. Sawant, [1] concluded that the main beneficial objective is to understand TPM principle and to bring the awareness among the younger technocrats and enterprises about TPM philosophy adoption. S. Vigneshwaram, M. Maran, G.Manikandan [2] stated about tangible and intangible benefits attained after TPM implementation. It is clearly observed that the direct benefits such as availability, performance, efficiency and rate of quality increase largely upon TPM implementation which benefitted in the improvement of OEE. Notably TPM implementation enhances the morale of employees and their level of self-confidence. Clean and impressive work environment is maintained after the TPM implementation.

Suchisnata Pradhani, Prof. Ajit Senapati [6] in their study found that TPM is not a quick-fix solution. It requires change in both the company’s and workers attitude, and their values, which takes time to bring about. Hence, it necessitates long-term planning. Organization wide quick benefits should not be stressed during the initial stage of implementation. TPM is not a radically new concept, it is simply the next step in the development of good maintenance practices. TPM is one concept need to focus to sustain just-in-time operations. TPM facilitates positively the organizations in improving the

coordination between maintenance department and other production activities, resulting in removing defects, improving manufacturing process reliability, improving overall equipment effectiveness, and reducing costs, thereby improving sustainability efforts of an organisation to meet global competition for business excellence.

I.P.S Ahuja and J.S Khamba [4] clearly revealed that the successful implementation of TPM practice can facilitate the manufacturing firms thirst for achieving enhanced manufacturing performance leading to competitive advantage.

Amit Kumar Gupta, Dr. R. K. Garg [24] in their study concluded that TPM reveals its importance between growth and failure for few companies, it has been proven to be a tool that really works. Abhishek Jain, Rajbhir Bhatti, Harwinder Singh [5] concluded that practice of TPM is necessitated thirst in Indian manufacturing industries, notably in SMEs. Most of the large-scale industries have implemented TPM but their exist limitation in SMEs. Hence, it's the need to implement TPM to get benefitted in quality, production rate, equipment availability and to lower the cost of equipment maintenance and breakdown.

Panchali Singh [3] in his study concluded that efficient TPM implementation initiative highlights maintenance related issues. The pillars of TPM helps in effective TPM implementation and helps to improve overall OEE. TPM succeeds only when all employees at all levels remain committed towards bringing the much-needed cultural change within an 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 under consideration.

Melesse W.Wakjira and et al [26] have studied and analyzed issues in the implementing TPM, and the benefits gained from OEE as an outcome of TPM practice. As an outcome of this overall productivity of industry also increased. OEE value is encouraging and with the passage of time results will be quite good and may reach a world class OEE value of higher percentage. Focused TPM practice improved quality issues, reduced the cost and equipment deterioration and failures. Assured autonomous maintenance activities were followed by all associates with honest participation. The investment made in training and education helped to boost workers morale and the commitment towards organization's long-term goals.

Sarang G. Katkamwar and et al [27] have carried out study in medium scale industry producing cotton spinning. The TPM implementation practice has been suggested to improve equipment availability, efficient performance and the rate of quality, which brought tremendous improvement in OEE. Their study utilized method of See through, JH-Check sheet, PM-Check sheet, single Point Lessons, empirical method and inclusive which resulted in proper implementation of TPM.

Post implementation of TPM showed both tangible and intangible benefits for equipment as well as for employees. TPM ensures equipment availability, increased performance, rate of quality, hence OEE is achieved.

Abhijit Gosav [28] and others have developed mathematically sound models, based on renewal theory for TPM. There is a need to point out that models were developed for optimizing mean and variance combination, which could be adopted easily for combining mean and the standard deviation, which have the same units. The renewal theory model was motivated by an industrial need for a model that quantifies risk in tractable units. The recorded results showed reduction in unexpected machine breakdowns that improved production rate and hence reduced annual cost of maintenance.

3.2 TPM philosophy and implementation

This section emphasizes on the facts such as principles, factors for success, implementation methods, and approaches of total productive maintenance.

C.C.Shen [13] pointed successful key factors of TPM in enterprises. He points out TPM is getting implemented gradually over the years stage wise as preparatory; commencement; implementation and realization stage. The successful key factors as commitment of managers, overall employee involvement, technical related training to operators, management plans, motivation of employees, launch of 5's are necessary for implementation of TPM. As a result he intends most of the factors focused on commitment and involvement of management and overall employee involvement.

F.De. Felice and A.Petrillo [11] in their study revealed that practices of TPM, TQM, Lean, fetches organization world class recognition and highlights the issue of competitive advantage in the global market to provide the product or services at lowest possible cost with an acceptable lead time. This practice encompasses all plant process from safety to environment and from maintenance to logistics, quality. The objective lies at achieving zero waste. World class best manufacturing practices brings employees a culture to identify emerging problems and get involved and brings cultural change also.

Kamran S, Seyed Ahmad Y [10] found that to sustain in truly competitive world of business, it is necessary to deliver the product of highest quality in least possible time for an acceptable cost, so to achieve this machine maintenance strategy has to be implemented positively. They developed model through system thinking approach which showed TPM is a reliable strategy. This reduces issues related to machine breakdown maintenance and enhances machine reliability, product and process quality as well.

H. Yamashina [8] points out that first step-in world-class manufacturing focuses on TPM implementation successfully and create active organization by bringing the total employee involvement culture and training the employees which helps to identify the potential problems and find the solution themselves. It needs continuous improvement culture. Author also finds problems during TPM implementation, as resistance from employees, lack of commitment of top-level management, risk of losing the trained persons. So, organizations have to tackle the issues to start journey to WCM.

Rajesh Prasad M. and et al [9] developed a new framework of world class maintenance where they considered the strategies related to total quality control, just in time, total productive maintenance; concurrent engineering making it clear that maintenance brings world-class status.

Rajesh P. Mishra and et al [12] discuss that implementation of maintenance system is necessary to have a competitive advantage over its competitors. TPM approach is best way to get better results. They established the correlation among the elements of maintenance as a framework through interpretive structure modelling which has stages of planning, organizing, controlling through identifying the relationship among the specific item so that organizations based on their uniqueness can adopt it in their own way to define and find the solution to the problems.

Kathleen E and et al [7] in their work investigate relationship existing between TPM and performance in manufacturing through structural equation modelling, where TPM has positive and significant relationship with low cost, high quality, strong delivery performance, where it helps to control manufacturing cost. World class manufacturing approach, just in time, total quality control, TPM should not be evaluated in isolation, as all have correlation and have positive effect on manufacturing performance.

Hugo Pinto and et al [14] stated that gaining the competitive edge among its competitors is one of the strategies to survive. This way, Total Productive Maintenance Model provides the development such as autonomous maintenance. The method exhibits the different tools, in order to seek operator's commitment to maintain optimal conditions for production and equipment performance. The TPM practice promoted the interaction of operators with the equipment, providing continual attention in identifying and anticipating problems resulting in the reduction of failures, breakdowns and quality defects. The practice of a culture promoting a sense of psychological ownership ensures the involvement of workers and brings increased levels of productivity.

3.3 Case study literature survey

Taufik Djatna, Imam Muharram Alitu [15] pointed that slow managerial decision making is the big challenge in TPM

implementation in the manufacturing industry. In their focused study on wooden door manufacturing industry TPM implementation resulted in increased Overall Equipment Effectiveness. Data mining techniques were utilised to solve real time problem especially in machine maintenance in a targeted molding machine. The OEE calculation of molding machine shows a machine availability loss due to low effectiveness caused by high setup and adjustment loss.

Amit Kumar Gupta, Dr. R K. Garg [16] studied effect of TPM implementation in an automobile industry. Their study reveals the concepts to increase the productivity in terms of OEE. Before TPM implementation availability was 80%, Efficiency 76.9%, Quality 95.5% and after TPM implementation availability raised to 85.1%, Efficiency to 83.1%, Quality to 99%.

Soraphon Kigsirisin, Sirawit Pussawiroa, Onurai Noohawm [17] in their case study of water treating plants found frequent breakdown of equipment and loss of water during production. By adopting 8 pillar techniques & TPM concepts both aforesaid problems were reduced which enhanced OEE. The operators skills also enhanced in all departments including maintenance

Dinesh Seth & Deepak Tripathi [18] have pointed, Total Quality Management and Total Productive Maintenance have attained considerable acceptance in Indian manufacturing industry to take on the challenge of transition from domestic economy to global competition. The implementing results provide evidences of effectiveness of TQM and TPM in improving performance of business in Indian manufacturing industry, both in terms of profitability and operational parameters. This is indicated both in the case when these are used individually as well as simultaneously as a combined approach.

Bupe. G. Mwanza, Charles Mbohwa [19] have established TPM model to bring change in the maintenance practice at a chemical producing company. The researchers set objectives to study the current maintenance system, to find the overall equipment effectiveness, key performance indicators and success factors of TPM. Required relevant data was gathered using set questionnaires, interviews, direct observations and available records of company. The results came multi folded by reviewing overall equipment effectiveness. Equipment downtime was a principle issue of plant under utilization with 52% of it due to shortage of spares, 32% due to shortage of raw materials, 8% because of power failures and 8% others. Among employees of company 70.5% were aware of TPM concepts and 14.7% not sure. 29.5% of the employees were unaware of TPM with 64.3% not sure that the TPM concept can help improve the current maintenance system. Based on these results, they found that knowledge and information sharing, operator involvement and training are the added advantages. Later they designed a TPM model which could bring effective implementation of TPM in growing dynamic business environment. Adoption of TPM

can reduce losses and reduce rework to or below the acceptable marks. The research therefore concluded that TPM can be used as a tool to improve OEE of the organization.

Rajesh choudhary and et al [20] in their study reveals the advantages of TPM implementation. An organizational behaviour in the Indian process industry is in the thirst to gain world-class competitiveness and sustainability. TPM is more focused in bridging the gap between production and maintenance functions through best working practices, team work, and continuous improvement. As whole TPM brings motivation, self-commitment and competency among the employees of the company.

Ranteshwar S, Ashish M G, D. B Shah, Sanjay Desai [21] in their investigation for a company producing automotive component focused on TPM concept implementation. OEE is used as a measure for outcome of TPM implementation in machine shop having CNC turning centers of different capacity. Author pointed out that quality and maintenance of manufacturing systems are closely related functions. Total Productive Maintenance and Total Quality Management along with other concepts to achieve World Class Manufacturing system. OEE has improved from 63% to 79% indicating the positive change in productivity and improvement in quality of product.

F.T.S. Chan, and et al [22] suggested that, Total productive maintenance is a methodology that focus to increase the availability of existing equipment hence reducing the need of additional capital investment. Investment in training the employees can further result in high equipment utilization, higher product quality and reduced labour costs. After the implementation of TPM model machine, both direct and indirect benefits were obtained for equipment as well as employees. The productivity of equipment increased to 83%. These indirect benefits resulted from cultural change in company, coordination between maintenance, production and quality departments.

Panagiotis Tsarouhas [23] suggested adopting the total productive maintenance in the food industry over the span of five years increases the profitability. TPM implementation enhanced the rate of production via reduced downtime of equipment, product quality and provides healthy and safe work place via increase in attendance of operators.

4. CONCLUSIONS

TPM is team-based approach needs active participation from all at each level within an organization which leads towards safe working environment leading to zero defect in products and zero accidents and unexpected equipment breakdowns and failures hence enhanced OEE. TPM implementation makes the industries competitive in the field of maintenance and plays crucial role in deciding the success and failure of the organization. TPM implementation increases morale and confidence of employee at all levels as clean-safe-attractive

workplace is maintained. TPM requires long term planning and at initial phase of implementation no one should be stressed. It focuses on regular training and commitment and analysis of both success and failure of the initiatives for the improvement under consideration. Organisations have to tackle the resistance of employees in implementing TPM and lack of commitment of top level management. TPM helps the Indian organizations to compete globally by enriching its quality of products-work culture-satisfied and well-trained human resource-reliable equipments which would render in producing defect free products and maintenance free plant.

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