

Review Paper on: Total Productive Maintenance

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Abstract

Importance of TPM which stands for Total Productive maintenance for Liberalization of global economy has resulted tough competition in global market and for the sustainability in market for any product or service, the optimization of resources and costs in all sorts is required. The global competition is based on the innovation of advanced products, processes etc. and technology support is the essential requirement for any advancement in product or process where concept of Total productive maintenance has very much relevance today where it focus on improvement in equipment availability, performance and quality with assuring health and safety of employees and protection of environment. TPM provides a method for the achievement of world class levels of overall equipment effectiveness through people and not through technology or systems alone. It includes the organizational structures, human interactions, analytical tools and success criteria associated with the implementation of Total Productive Manufacturing programs.

Keywords

Total productive maintenance, Productivity improvement, Continuous improvement, Preventive Maintenance and reliability.

I. Introduction

TPM focus on improvement in equipment availability, performance and quality with assuring health and safety of employees and protection of environment. TPM helps for eliminating equipment breakdown and improving quality performance of equipment, thus the achievement in TPM strongly supports in attaining the lean concepts which includes the elimination of waiting time, defects in process etc. TPM is a program that addresses equipment maintenance through a comprehensive productive-maintenance delivery system covering the entire life of the equipment and involving all employees from production and maintenance personnel to top management. It is intended to “bring both functions (production and maintenance) together by a combination of good working practices, team working, and continuous improvement. TPM is characterized by 5 key elements:

1. TPM aims to maximize equipment effectiveness.
2. TPM establishes a thorough system of Preventive Maintenance (PM) for the equipment’s entire life span.
3. TPM is cross-functional, implemented by various departments (engineering, operators, maintenance, managers).
4. TPM involves every single employee.
5. TPM is based on the promotion of Preventive Maintenance through the motivation of management and autonomous Small Group Activity (SGA).

II. TPM Pillar

- i. Total effectiveness indicates TPM’s pursuit of economic efficiency or profitability which includes productivity, cost, quality, delivery, safety, environment, health and morale.
- ii. Total maintenance system includes maintenance prevention and maintainability improvement as well as preventive maintenance.
- iii. Total participation of all employees includes autonomous maintenance by operators through small group activities: the small group activities promote planned maintenance through “motivation management”.

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 housekeeping. 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 abovementioned 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 everyone in the work place.

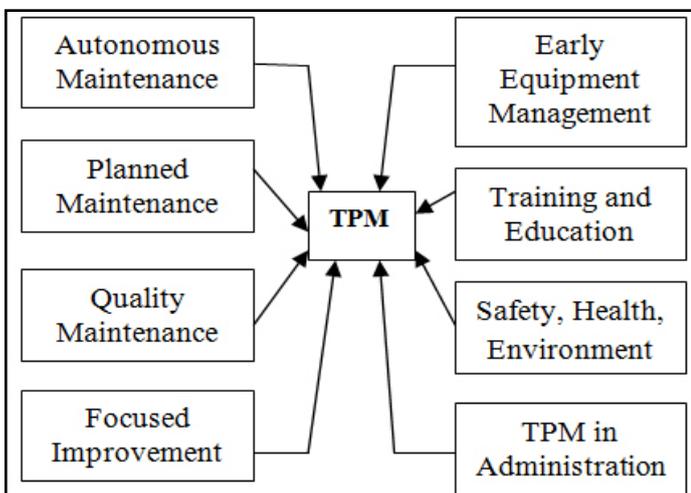


Fig.1 : Total Productive Maintenance

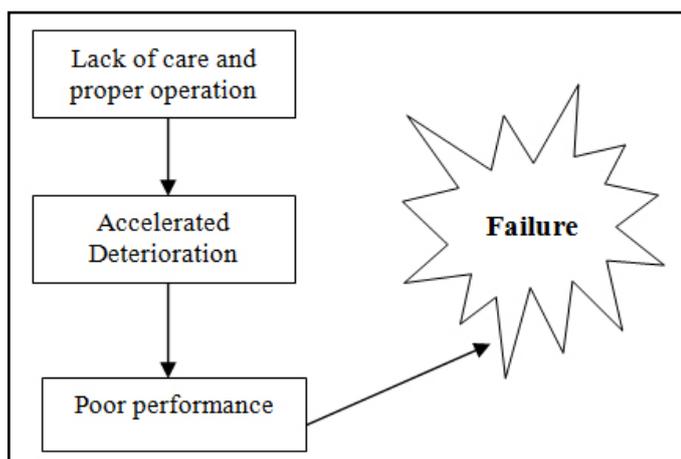


Fig. 2: Root cause of failure and the impact of ownership

The world class manufacturing concepts are:

- Total quality management (TQM)
- Total productive management (TPM)
- Just in time production (JIT)
- Total employee involvement (TEI)
- Continuous quality improvement (CQI)

III. Related Work

Schmidt, S, proposed a work on Total productive maintenance (TPM) and change over reduction engineering (CORE) are fundamental parts of the just-in-time production system and a way to increase productivity and quality. The major TPM improvement activities include maximizing equipment effectiveness, eliminating the six big equipment-related losses, autonomous maintenance by operators and small group activities, training to improve operation and maintenance skills and the promotion of maintainability from the design throughout the entire life span of the equipment. Set-up and adjustment is one of the six big losses of TPM, and single minute exchange of dies (SMED) is the heart of just-in-time production. CORE, using newly developed software, takes SMED to a new dimension. With this approach, companies have typically achieved over 50 per cent change-over reduction. Some companies are achieving success with TPM: equipment downtimes are drastically reduced, equipment productivity is strongly increased and maintenance costs are reduced, process yields and product quality dramatically improved. This paper shows the fundamentals of TPM, its successful industrial application and some selected results of maintenance benchmarking in the manufacturing and process industry, which shows the present state and future development of equipment and maintenance management. The basics and some results of CORE are presented.[1]

F. Ireland and B.G. Dale proposed paper which focuses on a study of total productive maintenance (TPM) in three companies. The companies implemented TPM because of the business difficulties they faced. In all three companies senior management had supported TPM and set up suitable organisational structures to facilitate its implementation. The companies had followed Nakajima's seven steps of autonomous maintenance, although different TPM pillars had been adopted, with the common ones being improvements, education and training, safety, and quality maintenance. The main differences in TPM implementation related to the use of ABC machine classification system and the role of facilitators. [2]

Kathleen E. McKone a, Roger G. Schroeder b, Kristy O. Cuab In this they investigate the relationship between Total Productive

Maintenance (TPM) and manufacturing performance (MP) through Structural Equation Modeling (SEM). We find that TPM has a positive and significant relationship with low cost, high levels of quality and strong delivery performance. Also find that the relationship between TPM and MP can be explained by both direct and indirect relationships[3].

Thomas R. Pomorski introduce the paper for examines the basic concepts of TPM and reviews the significant literature related to design, implementation, and maintenance of TPM programs in manufacturing operations. Investigation includes the organizational structures, human interactions, analytical tools and success criteria associated with the implementation of Total Productive Manufacturing programs.[4]

Tamer H. Haddad and Ayham A.M. Jaaron, they proposed work where they introduce the investigation implementation of the Total Productive Maintenance (TPM) program in the healthcare industry. The study was carried out at a major hospital in Jordan using semi-structured interviews coupled with documents collection and analysis. A TPM implementation methodology has been developed for increasing medical devices utilization and decreasing their failures where this paper is one of a few studies that investigate the applicability of manufacturing maintenance systems in other settings and that they can generate significant operational benefits.[5]

Ahuja, I.P.S. and Khamba, J.S., The purpose of this paper is to review the literature on Total Productive Maintenance (TPM) and to present an overview of TPM implementation practices adopted by the manufacturing organizations. It also seeks to highlight appropriate enablers and success factors for eliminating barriers in successful TPM implementation.[6]

Halim Mad Lazim*, T. Ramayah** and Norzieiriani Ahmad, defines the objective of TPM is to create an active participation of all employees in maintenance and production functions, including the operators who operate the machines and equipments. This paper discusses part of a preliminary study finding focusing on two main TPM practices namely autonomous maintenance and planned maintenance in a Malaysian SME. The results suggest important aspects of autonomous maintenance and planned maintenance activities that contributed to the improvement in quality and cost. [7]

Chompu-inwai, proposed Total productive maintenance (TPM) is a method to improve and enhance productivity. TPM permanently improves the overall effectiveness of equipment, with the active involvement of operators. This paper describes the pilot implementation and evaluation of TPM for the dental units in the Dental Hospital, Faculty of Dentistry, Chiang Mai University, Thailand. The paper aims to develop a methodology for increasing the dental unit utilization and availability, as well as decreasing unplanned equipment downtime. The methodology was developed based on the first two phases of the phased equipment management approach; improvement of existing equipment and maintaining improved equipment. Both autonomous maintenance (AM) by operators and preventive maintenance (PM) were implemented. Documents such as PM manual, procedures and forms were developed. Both quantitative and qualitative research methods were used to evaluate the performance of the implemented maintenance program. The experiences from this will be useful for other healthcare organizations that would like to implement TPM. Furthermore, through a pilot study of implementing TPM in a dental hospital, the practical aspects within and beyond basic TPM theory, difficulties in the adoption of TPM and the problems

encountered during the implementation are discussed. [9]

T. Ahmed and S.M. Ali¹ M.M Allama² M.S. Parvez³ introduce the critical factors which affect the overall equipment efficiency (OEE) of the pharmaceutical industry are loading time, down time, standard cycle time, actual cycle time, unit produced and defect unit. Overall equipment efficiency (OEE) is an indication of eight major equipment related losses which are equipment failure, set-up and adjustment, cutting blade change, start-up, minor stoppage and idling, speed, defect and rework and equipment shutdown. In the second phase of TPM implementation, a planned maintenance program has been suggested to make the production process quite smooth and proficient with increased efficiency. [10]

Manu Dogra,¹ Vsihal S. Sharma², Anish Achdeva², J.S. Dureja³, proposed strategy of maintaining the equipment of a plant is crucial for the effectiveness of manufacturing. Total productive maintenance (TPM) is a maintenance program, which involves concepts for maintaining plant and equipments effectively. In this paper detailed implementation of TPM in the cold rolling plant is discussed. Results achieved are quite encouraging in terms of motivated employees, improvement in overall equipment effectiveness (OEE) and reduction in no. of accidents on shop floor. [11]

Melesse Workneh Wakjira, Ajit Pal Singh they proposed significant contributions of TPM implementation success factors like top management leadership and involvement, traditional maintenance practices and holistic TPM implementation initiatives, towards affecting improvements in manufacturing performance in the Ethiopian industry. The study establishes that focused TPM implementation over a reasonable time period can strategically contribute towards realization of significant manufacturing performance enhancements. The study highlights the strong potential of TPM implementation initiatives in affecting organizational performance improvements. The achievements of Ethiopian manufacturing organizations through proactive TPM initiatives have been evaluated and critical TPM success factors identified for enhancing the effectiveness of TPM implementation programs in the Ethiopian context. [12]

P.K. Suresh proposed the work for global competition is based on the innovation of advanced products, processes etc. and technology support is the essential requirement for any advancement in product or process. The advancement in technology had lead to the industrial revolution and higher level competition for survival. The implementation of these P.D.C.A approach will make results definitely and the time period for getting results will depends upon how fast the organization is adopting the changes as well as the effectiveness of this implementation. [13]

Suzaituladwini Hashim¹, NurulFadly Habidin², they proposed maintenance concept is important in the manufacturing environment and it provides support for productivity. The purpose of this paper is to identify the TPM constructs and innovation performance measures for Malaysian automotive industry and also to develop research model of the TPM and innovation performance measures relationship for Malaysian automotive industry. A conceptual model based on previous studies has been proposed. This model will be used to study the relationship between TPM practices and innovation performance for Malaysian automotive industry. Based on the proposed conceptual model and reviewed, research hypotheses are being developed. The paper culminates with suggested future research work. [14]

Kapil Sharma*, Gaurav Gera**, Rajender Kumar they proposed work for 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. [15]

Tamer H. Haddad proposed TPM implementation methodology has been developed for increasing medical devices utilization and decreasing their failures. The developed employees' working system and new responsibilities were explained through Autonomous Maintenance (AM), Preventive Maintenance (PM) and 5S Modeling, with a suggestion for additional working performance indicators. This paper is one of a few studies that investigate the applicability of manufacturing maintenance systems in other settings and that they can generate significant operational benefits. [16]

Badli Shah M.Y introduces the work for survey through questionnaires has been applied to this study to determine the level of TPM practices in automotive industry. The Statistical Package for Social Sciences (SPSS) software was utilized to perform the required statistical analysis of the data from surveys. The paper systematically categorized the TPM knowledge and understanding and critical success factors (CSFs) in TPM implementation. This research would provide new data and findings on the TPM implementation that could be use for future study towards improving manufacturing competencies through equipment maintenance in the automotive organizations. [17]

Murugadoss K Panneerselvam proposed critically analyse the factors influencing TPM implementation in Indian manufacturing organisations and to formulate comprehensive strategy for overcoming impediments to successful TPM implementation. The analysis focuses on systematic identification of barriers encountered by Indian manufacturing industries in their attempt to implement TPM practices and devises success factors towards amplifying manufacturing performance in Indian industries through optimal strategic TPM initiatives to confront exponential global challenges. The paper divulges that TPM implementation is by no means an easy task, which is heavily hampered by behavioural, organisational, cultural, technological, departmental, operational and financial obstacles. [18]

Ahmad, M.F. a, Zakuan, N.b , Jusoh, A. proposed relationship between TQM practices and business performance with mediators of Statistical Process Control (SPC), Lean Production (LP) and Total Productive Maintenance (TPM) based on extensive review of the literature. Study on TQM, Lean Production, TPM and SPC generally investigate the practices and business performance in isolation. This proposed conceptual model will help the academicians and industry players to have better understanding on the relationship between the practices and step by step implementation to improve business performance. The structural equation modeling (SEM) techniques are used to examine the relationships of the practices. [19]

Miss Ashwini Mate, 2Suhas Bamrotwar proposed concise exploit for implementation of total productive maintenance (TPM). From a practical study, it is naked that challenging superiority in maintenance practices is still a far cry. Need of sympathetic of the technique and implementation rule emerge to be the major factors accountable for this state therefore, it is strappingly felt that TPM

justify more attention both in practices and research. [20]

Wasim.S.Hangad¹, Dr.Sanjay Kumar² they proposed implementing TPM program in terms of increased plant efficiency and productivity are outstanding. Depending on size, industries are mainly classified into three categories, small, medium, and large industries. Of the entire business population of 3.7 million enterprises, only 24,000 were medium sized (having 50 to 249 employees) and fewer than 7,000 were large (having 250 or more employees). Small businesses, including those without employees, accounted for over 99% of businesses, 45% of non-government employment and (excluding the finance sector) 38% of turnover. In contrast, the 7,000 largest businesses accounted for 45% of non-government employment and 49% of turnover. [21]

Prof. A.Bangar¹, Hemlata Sahu proposed tool to improve equipment reliability by redesign the workforce in equipment care and improve the maintenance function. The OEE is product of equipment availability, performance efficiency of process and quality performance of manufacturing operations. In this research we have reduced the production losses and improve OEE of industry upto 96% by TPM based corrective action have been planned through this case study in an Jamna auto industry. [22]

Halim Mad Lazim, Mohamed Najib Salleh, Chandrakantan Subramaniam proposed resource-emphasized approach moves the paradigm of maintenance by putting emphasis on total employee involvement in the maintenance activities. We studied the relationship between TPM practices and manufacturing performance. We investigated the moderating effect of the level of technical complexity in the production process in the TPM practices and manufacturing performance relationships as well. [23]

Ravikant V. Paropate¹, Dr. Rajeshkumar proposed A total productive maintenance (TPM) is a fundamental component of world-class manufacturing which has been recognized as one of the significant operation strategy to regain the production losses due to equipment inefficiency. TPM is the methodology aims to improve the accessibility of the existing equipment and in consequence curtail the further capital investment. The case study has been carried out at cotton spinning plant to identify the extensive deficiency associated with equipment effectiveness. The paper intends on analyzing the practical problems accomplishing TPM program and improved the effectiveness for critical machine by significant value. [24]

Sarang G. Katkamwar¹, Sadashiv K. Wadkar², Ravikant V. Paropate they proposed overview for the implementing approach of Total Productive Maintenance in Indian spinning industries. The study is carried out in medium scale cotton spinning industry using the observations coupled with documents collection. The TPM implementation methodology is suggested for improvement in the availability, performance efficiency and the quality rate, results in improvement of the overall equipment effectiveness of the equipment. The aim of this paper is to suggest and study the implementation of the TPM program in the spinning industry. Using a See through, JH-Check sheet, PM-Check sheet, One Point Lessons, empirical and comprehensive approach toward the methodology results proper implementation of TPM. After implementation of TPM on model machine, both direct and indirect benefits are shown to be obtained for equipment and employees respectively. [25]

Goyal Ravi Kumar^{1*}, Maheshwari Kapil² proposed Literature on maintenance management practices evolution from total productive maintenance to world class maintenance has so far

been very limited. This paper reviews a large number of papers in this field and suggests the retrospective growth in this field. Subsequently, the need of maintenance, TPM attributes with its different pillars, shortcoming of TPM are discussed in details then the world class maintenance system with its components, modules, factors for success and how to implement the world class maintenance system in any industry are discussed. A survey of CMMS Implementation is discussed by considering factors affecting implementation success, important aspect of CMMS implementation and benefits obtained from CMMS implementation. The paper provides many references and case studies on maintenance management. It gives useful references for maintenance management professionals and researchers working on maintenance management. [26]

K.Arunraj, M.Maran, G.Manikandan proposed research paper addresses the TPM implementation how it improves the competency level for employees at the Leading belt manufacturing company located in Madurai. A literature survey was undertaken into the elements and tangible and intangible benefits of TPM implementation. Role competency gap for the employees, an intangible benefit of TPM for employees were discovered and the questionnaires were formulated. Based on the questionnaire, competency level for the employees assessed together with industrial people. From that survey information the role competency gap of each employee has been calculated by using Analytic Hierarchy Process (AHP) & Role Competency Matrix (RCM). [27]

Chetan S Sethia¹, Prof. P. N. Shende², Swapnil S Dange³ they proposed TPM is a technique which helps us in maintaining and improving production system through machine, process, and employee which add a positive value to the organization. TPM has been developed to meet the new maintenance needs by keeping the equipment in top condition so as to avoid breakdown and delay in production. This paper focusing on calculating the overall equipment effectiveness in Rolling Mill, and it also discuss what called the big six losses in any industry (the quality, availability and speed). A case study has been taken in the rolling mill and the main objective of this is to study the manufacturing process and the problem occurs during the production process which causes stoppage. The data taken along fifteen working days after calculating the OEE of the company a result company achieved 93.48% in quality factor of overall equipment effectiveness equation and 70.90% in availability where in performance it got 90.03% and the result is compared with the World class OEE. Suggestion is given to company so as to improve their maintenance procedures and improve the productivity. [28]

Arunraj K.1, Maran M proposed short review paper aims to study the tangible benefits of Total Productive Maintenance (TPM) in the manufacturing industry. In this short review, an attempt was made to critically discuss the previous literature related to the TPM. The review was done based on a range of journals related to TPM, published from 1988 up to 2013. A total of 33 papers were studied, specifically related to TPM. The review process starts by studying the TPM papers and identifying the tangible benefits of TPM. Overall Equipment Effectiveness (OEE) improvement is one of the main benefits in TPM implementation and has been discussed in most of the literature. However, TPM implementation methodology is suggested for improvement in the availability, performance efficiency and the quality rate, results in improvement of the overall equipment effectiveness of the equipment. This literature review-based research highlighted a TPM will improve the OEE. Based on this short review, it is

suggested that more benefits are addressed by future research related to TPM in order to solidify its philosophy towards a more realistic practical applications. [29]

Abhijeet K Digalwar, Padam V Nayagam they proposed paper aims to understand the usage of Total Productive Maintenance (TPM) tools and extent of its implementation in manufacturing industry. The paper reviews in detail the various cases of implementation of TPM through the existing literature. The tools utilized for the implementation of TPM are selected from literature. A detailed metadata analysis of the 42 cases of implementation of TPM using these tools is carried out in this study to analyze the frequency, pattern and importance of certain tools in a holistic way. Again, the companies are segregated on the basis of region/zone and type of industry. The frequency of various tools used and the extent of TPM implementation under the various scenarios as obtained from the metadata analysis; demonstrate the current trend of the tools usage and TPM implementation in the industries. The results provide an increased understanding of how to better the implementation of TPM in the manufacturing industry and provide managers with improved guidelines for identifying the most important tools that will lead to success. [30]

IV. Initiative of Total Productive Maintenance

a) Autonomous maintenance

Fostering operating skills

Fostering operating ownership

Perform cleaning- Lubricating- tightening- adjustment- inspection- readjustment on production equipment.

b) Planned Maintenance

Planning efficient and effective PM, Pd.M& TBM systems over equipment like cycle

Establishing PM check sheets

Improving MTBF, MTTR

c) Quality maintenance

Achieving Zero defects

Tracking and addressing equipments problems and root cause

Setting 3M (machine/man/material) condition

d) Education and training

Imparting technological, Quality Control, Interpersonal skills

Multi skilling of employees

Aligning employees to organizational goals

Periodic skilled valuation & updation.

V. Conclusion

It observes that there is a need for further study on the role of TPM in manufacturing industries. TPM increases the availability, performance efficiency and the quality rate, results in improvement of the overall equipment effectiveness of the equipment. TPM also used to achieve zero breakdowns, zero defects and zero accident. TPM aims to create corporate environments able to respond positively to the changing business climate, technological advances, equipment sophistication, and management innovation. TPM is a maintenance system which promotes productive maintenance but it also contributes to a positive safety culture through management incentive, management commitment, participation of management and workers, communication, education and training, working conditions and procedures, morale and job satisfaction, and attitude and risk perception. Here using the T-test method which

was used to compare the results obtained from the two different sample groups where to verify the effectiveness of TPM on safety culture. Finally a framework of TPM activities was developed for manufacturing organizations to improve safety performance.

It increases the availability, performance efficiency and the quality rate, results in improvement of the overall equipment effectiveness of the equipment. TPM also used to achieve zero breakdowns, zero defects and zero accident. However, it is observed that there is a need for further study on the role of TPM in manufacturing industries. Based on the findings of this review therefore it is suggested that more tangible benefits to be addressed by future research related to TPM.

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