

A Literature Review on The Implementation of Total Productive Maintenance (TPM) In the Manufacturing Sector of India.

Dr. Rashmi. M. J

Assistant Professor Department of MBA
NITTE Meenakshi Institute of Technology
Bengaluru, Karnataka, India
drrashmimj@gmail.com
ORCID: 0000-0002-7022-0864

Dr. M. S. Yathish Chandra

Associate Professor Department of MBA
VTU Centre for Post Graduate Studies Mysuru
Mysuru, Karnataka, India
yathishchandra18@gmail.com
ORCID: 0000-0003-2429-2063

Abstract

Total productive maintenance is one of the practices adopting by manufacturing industries to achieve zero losses in the area of overall performance efficiency at production process. Hence to have depth knowledge about the implementation of TPM and its implementation in Indian manufacturing industry a depth literature survey was carried in three areas such as Approaches, Tools & Techniques of TPM, Effectiveness and General Practices of TPM and Challenges of Implementation of TPM. The study revealed that TPM implementation is creating a positive impact on the production and operation process in maintaining overall equipment efficiency along with a safe and healthy working environment. This encouraged employees to work efficiently towards maintenance equipment at the production process, which leads to improve quality, productivity, and competitiveness of the organization's performance through TPM implementation.

Keywords: Approaches, Tools & Techniques, Challenges.

INTRODUCTION

The review of the literature is carried out in the study to understand new insights and to find the direction for carrying out research. Further, literature review helps us to narrow down the study through broader perspectives and provide a way to identify variables required for the construction of the questionnaire and research methodology and the necessary research design to be adopted to carry out the study.

Further, review of literature is divided into Indian and international studies to understand how TPM practices are carried out among various manufacturing industries across the globe thus helps in identifying the research gap to construct the objectives of the study. The sources adopted for carrying out literature are as follows: Google Scholar, ProQuest, EBSCO, Knimbus, ScienceDirect, Oxford University Press (OUP), Springer, Taylor & Francis database. These databases show the means of identifying the core literature required to carry out the study.

Review of literature helps in identifying ways in which developments in manufacturing systems such as automation, integration, and flexibility have increased the intensity of competition, better quality products, and speedy delivery. Nowadays, organizations have massive pressure on creating value for customers, decreasing the cost of production without affecting the quality of products, and to focus on improving the overall effectiveness of equipment and organization as a whole. In manufacturing industries, the function of maintenance management (De Groote-1995) plays a significant role in attaining growth in the business to sustain in the emerging market trends. As a result, maintenance

management in the organizations efficiently started to make use of resources such as machinery, spare parts, workforce, and investments. Thus, the adoption of the technique called total productive maintenance began.

In this chapter, to have a better insight, a study on various aspects of TPM practices in manufacturing industries is carried out by the Indian and international study as are reviewed. This provides a road map to understand that TPM is mainly designed to assess the overall equipment effectiveness (Philip Godfrey-2002) with the participation and motivation of the organizational workforce.

The literature reviews on TPM practices have been divided into the following heads for a better understanding of the aspects of TPM.

- Approaches, Tools & Techniques of TPM
- Effectiveness and General Practices of TPM
- Challenges of Implementation of TPM

TPM - AN EVOLUTION

TPM originated in Japan way back in the 1950s. The preventive maintenance in the USA Nippondenso company was the first one to adopt preventive maintenance company-wide and later went on to implement autonomous productivity. Full-fledge TPM was introduced by the **Seiichi Nakajima (1988)**, who mentions the essential features of TPM, such as overall effectiveness, maintenance, and employee participation. For a higher efficiency, quality productivity, and the overall performance of the organization, TPM is considered an excellent tool by **Benjamin. S. Blanchard (1997)**. He mentioned that educational limitations are the challenges in TPM implementation.

The generic model indicates significant factors affecting the TPM implementation by **Bamber et al. (1999)**. Validation of the developed model conducted to provide the road map for the SMEs in the TPM implementation.

Ireland and Dale (2001) have designed practical guidelines on the process of TPM, which suits different scenarios and organizational strategies. A comparative analysis of various approaches has been also conducted during the period. **Brar and Goal (2005)** have mentioned the need for TPM in the backdrop of intense competition in the Indian industries to cope with the change. **Jain and Singh (2014)** have indicated the need for TPM implementation in the industries in both India and foreign countries.

MAINTENANCE PRACTICES ACROSS INDUSTRIES

Maintenance practices and its various approaches, evolved over the years across industries and worldwide. Effective maintenance practices result in increased productivity and minimized various losses in the production process. Thus, maintenance practices have become very significant in contributing to the overall growth of the organization. Researchers from different platforms have developed and designed new maintenance strategies, tools, and techniques to increase the overall equipment efficiency in the manufacturing system.

INDIAN STUDIES

APPROACHES AND TOOLS AND TECHNIQUES OF TPM

Kodali & Chandra., (2001) have explored TPM and its justification using the analytical hierarchical model in Indian industries. The study focus on the investigation of the feasibility of TPM practices and its implementation in the Indian manufacturing industries. The study reveals that TPM implementation has benefited the organization by enhancing quality products, equipment effectiveness, speedy delivery, and right business environment. Further, the study also identified that the self-assessment programmeme helps the manager to know the TPM status.

Mani et al., (2003) have analyzed TQM and its adoption in successful business performance, highlighting the insufficiency for the long-run survival of the business due to lack of development in the maintenance framework. In the findings, after adoption of TQM, no changes were seen in business performance. It was also noted that TQM implementation alone is not sufficient to sustain in the market

in the long run. It is thus triggered the need for a new conceptual framework that helps the organization to meet future challenges.

Wali et al., (2003) have assessed the performance of TQM using critical success factors approach in select Indian companies. The focus is on identifying critical success factors responsible for the successful implementation of TQM through existing literature and philosophies associated with it. Further, the study also revealed that the critical factors identified in the study were impacting on TQM implementation in the select companies and suggested to employ this approach for better performance.

Mahadevappa & Kotreshwar., (2004) have examined the strategic approach of quality management of select ISO 9000 certified companies. The motto behind the study is to identify how companies can overcome the challenges of quality post liberalization, using the ISO adoption and critical factors and its impact on the overall quality process. The study reveals that companies with the adoption of ISO 9000 improved quality marginally. It further suggested to improve the quality process by integrating it with total quality management.

Seth & Tripathi., (2006) have evaluated the business performance of select Indian manufacturing industries after the adoption of TPM and TQM techniques. The study reveals that these two techniques have drastically contributed in the improved performance of the business. Further, it has assessed the synergic effect on adopting both TPM and TQM on the performance of a business. The results revealed that the combined effect of TPM and TQM implementation on the business is significantly higher than that of implementing them individually. The study concluded that both these drivers be adopted for effective results.

Anand & Kodali., (2008) have conducted a study on LMS using the promethee approach. To assess how the selection of LMS helps the company's strategic manufacturing decisions at Small and medium enterprises and found that managers plan to implement LMS or computer integrated manufacturing systems. The results reveals that using promethee model identified LMS to be the best method for the present situation to make manufacturing related decision.

Nachiappan et al., (2009) have investigated the integrated approach of manufacturing tools such as TPM, lean system, and six sigma of the select companies of the manufacturing industry. The main motto is to develop a new approach for improving the manufacturing system to world class level. The result reveals that a proposed new approach called total productive lean six sigma improved the manufacturing system at the world class level. Hence, the study suggested implementing the new model in organizations to improve performance.

Dogra et al., (2011) have portrayed on TPM and its improvement aspects as a critical strategic approach of select companies in the process industry in India. The study carried out to evaluate the process of TPM implementation and its contribution to the manufacturing process. The results indicate that the implementation of TPM in select companies enhances motivation for the employees, overall equipment effectiveness, and reductions in accidents on the shop floor. Hence, it suggested implementing the TPM effectively to enhance the overall performance of the organization.

P. Kumar et al., (2012) have opined that TPM implementation in the manufacturing industry is interested in knowing the methodology adopted. Further, to have better insight into the packaging and high-end printing press machines using real time data collected from various sources. The results reveal that the range of OEE varies from 15-60% as against the 80% of world standard. The range of overall productivity lies between 0.1-3.4%. Henceforth, the study suggested that the use of appropriate methodology leads to the improvement of OEE and productivity.

Choubey., (2012) has focused on the enhancement of maintenance in manufacturing setup by using effective tool OEE to analyze the impact of TPM on OEE. The results reveal that TPM practices, considered a beneficial technique which organization can adopt to improve the overall effectiveness, and it stands between the success and failure of it. Henceforth, it is suggested that TPM can be implemented not only in the industrial domain but also in construction, transportation, and other situations.

Suresh., (2012) has investigated TPM implementation in select units producing egg related products of the food industry in south India employing the PDCA approach. Here the study highlighted the factors of implementation and performance compared with the industry's TPM certification. The results indicate

a significant correlation found in the comparison. Further, the study used the PDCA approach in identifying the areas of improvement of TPM and identified that the PDCA approach produces better results with effectiveness in implementation.

Katkamwar et al., (2013) have analyzed various implementation approaches on TPM in the select units of medium scale cotton spinning industry and data collected from the primary sources, i.e., observations and various documents. The results revealed that there is a drastic need for improvement in resources such as man, machine, money and materials, performance efficiency, and overall equipment effectiveness. Also, highlighted successful implementation of TPM leads to the direct and indirect benefits for both the equipment and employees.

Singh., (2013) has explored a study on the enhancement of the performance of manufacturing by employing TQM and TPM in the Indian manufacturing sector. To focus on evaluating the effectiveness of TPM on the overall performance of the select units. The results reveal that various activities of the manufacturing system are rated high on the percent point score except for management involvement and leadership issues, and employee effectiveness. By observing the results, few suggestions were made for implementing TPM successfully through rendering benefits out of challenges of various manufacturing activities.

Maheswaran & Mahendran., (2014) have revealed how quality can improve by employing TPM and TQM. The study carried out on pillars of TPM and TQM provides a basement to contribute towards the overall quality of the unit of production in the manufacturing system. The result reveals that the application of these pillars helps in enhancing the quality of the product.

Acharya & Bhatt., (2014) have examined different approaches, called positive approach as solutions for solving the manufacturing problems identified in the various literature reviews on TPM. Further, the study tries to explain how TPM and its pillars solve the manufacturing problems aiming zero defects with the increase in Productive and quality. The results of the study reveal the involvement of workers and support of the management are the critical areas of success of TPM. Also, it found that zero defects and overall efficiency mainly depend on the pillars of TPM.

Deepak Prabhakar & Jagathy Raj., (2014) have highlighted the strategies of maintenance management by comparing the CBM, TPM, RCM, and A-RCM. Also, to evaluate the benefits of the select maintenance strategies using a comparison method of the process industries. The study reveals that the clarity and cautious approach are needed for successful implementation of TPM. Further, it stated that this comparison would help the organization in making better maintenance strategies.

Sethia et al. (2014) have expressed that the systematic review of TPM and its components identified six significant losses in the manufacturing system. Also, to overcome these six significant losses, TPM Pillars and techniques have been adopted for improvement of the OEE equipment at the manufacturing system. The analysis reveals that successful implementations of TPM mainly depend on its major pillars connecting all the elements of the organization. It also reduces the wastage (losses) to the maximum extent and improves the overall equipment efficiency.

Poduval et al. (2015) have explored the transformation approach of TPM maintenance. The study carried out the analysis of the critical areas of TPM, such as 5s components, PDCA technique, Kaizen, Benchmarking, and OEE. The results of this transformational approach of TPM revealed many benefits of TPM implementation. Further, the organizations face a hard time in their implementation and operations due to lack of commitment from top management and lack of knowledge of the importance of TPM.

Sharma & Singh., (2015) have portrayed how 5S practice of Japan have impacted on the TPM and its components to find out the relationship between 5S practice and TPM activities. The results indicated that 5S practices had made an impact on the different pillars of TPM directly or indirectly. Hence 5S practice has been recognized as an essential tool for evaluating the overall performance of TPM. The study suggested that the 5S practice considered as a basement for successful TPM implementation.

Goyal & Jindal., (2015) have assessed the systematic approach in TPM of the automobile industry in India. The study has focused on how a systematic approach, considered as one of the crucial factors, towards the successful implementation of TPM in the automobile industry. The finding reveals that employing a systematic approach leads to more productivity in all the areas of TPM. The second

findings reveal that lack of exposure, employee resistance, and commitment are considered significant constraints in the TPM implementation. Further, the study suggested that the systematic approach solves these constraints to a large extent.

Pandey & Raut., (2016) have expressed the root cause of downtime losses by implementing TPM in the manufacturing sector in India. The study adopts Keikaku Hozen activities as a solution to overcome the losses from downtime in the label manufacturing industry. Further, in the study, the performance of printing machines and issues in maintenance is measured. The results reveal that after the implementation of TPM reduction in the downtime, losses observed.

Srinivas & Raghavendra., (2016) have analyzed that OEE, considered as very effective techniques in the performance measurement of TPM, and how it improves the availability, quality, and performance rate in the manufacturing and service industry. Further, the study reveals that OEE helps in depth analysis of the effectiveness of TPM and the root causes of production failures. Further, the study suggested that the OEE technique considered one of the powerful tools for the start-up industry for a smooth production process.

Vittaleshwar et al., (2016) have evaluated the TPM effectiveness in a water bottling industry, India, using the tool of OEE. The study is carried out through survey method to examine the workflow of TPM and its activities during the production process. The result reveals that OEE values lie between 14-70% against the standard of 85%, and for TPM, the range was 9-34%. Thus indicates that the OEE tool is helping the industry to find out the inefficiencies and manufacturing losses. Henceforth, the study advised for making use of high quality inputs to enhance the performance of TPM.

S. Kumar et al., (2017) have portrayed a case study approach in equipment break down analysis of TPM and its components of the steel manufacturing industry in India. To understand how to reduce the delay in different processes of manufacturing employing section wise, equipment-wise breakdown analysis. The study reveals that more than 60% breakdowns occurred on the shop floor and suggested that the corrective and preventive measures could reduce the breakdowns and improves the delay of the process.

A. Kumar., (2017) has focused on how TPM implementations enriched through the organization development interventions. The study indicates that TPM pillars are acting as a technique along with the attributes of OD interventions. The results reveal that the lack of knowledge and training about the TPM operations in the production process observed. Hence, to overcome problems along with TPM implementation, some of the OD interventions are taken into consideration as they contribute to the ROI.

Venkateswaran., (2017) has attempted to understand the different approaches and practices adopted by the manufacturing unit in TPM. To analyze the analytical data method of research techniques such as histogram chart, fishbone graph, and why-why analysis have been used. The result indicates that the OEE has gradually increased due to the better maintenance of machines and process wastages minimized. The study suggested that by reducing cleaning, setting, and inspection time, the overall equipment efficiency can be further enhanced.

EFFECTIVENESS AND GENERAL PRACTICES OF TPM

Deshpande & Modak., (2002) have explored the study on reliability centered maintenance and its application in the steel shop of medium-scale industry. In the study, preventive maintenance does not schedule and tends to fail in various components of the equipment. This made to adopt a method for better understanding RCM of the ways of equipment failures. Further, the study suggested that RCM provides a better strategy for the optimization of preventive maintenance.

Palo & Padhi., (2003) have examined the TQM training effectiveness of the select steel manufacturing PSUs of India. To study the significance of training and how it affects successful implementation of TQM and further to collect the data, survey method is used to assess training effectiveness using correlation method. The results reveal that training helps in creating awareness about the culture of TQM, which leads to maximizing employee commitment in improving the quality, teamwork, and

communication system in the industry. This helps in adopting the new Japanese technique known as TPM to attain the overall efficiency of the organization's performance.

Barve et al., (2004) have expressed that the TPM application has created massive changes in organization performance at verticle boring machine. The reason behind the study is to provide the TPM conceptual framework, which was applied to verticle boring machines to reduce the breakdown time and better utilization of the machine. The findings revealed that after the implementation of TPM, there was a reduction in the breakdown time significantly and improvement in OEE was observed. Hence, it suggests implementing TPM successfully to enhance overall performance.

Seth & Gupta., (2005) have analyzed the concept of value stream mapping and its effectiveness of productivity in select auto sector companies in India. The study was carried to find out about the effectiveness of VSM in eliminating wastages and assembly facilities with an improved productivity. The results reveal that time calculation analysis indicated an improvement in production gain per person and a reduction in the work in progress, leading to an increase in productivity.

Mohapatra., (2006) has conducted a study on Japanese Management Practices and its adoption in the select units of the Indian manufacturing industry. The study focused on Kaizen, TPM, Poka-Yoke, 5S, Kanban, Quality circles, and TQM. Further, data was collected from existing documents, observations, and interviews by employing correlation and descriptive study. The study found that Japanese practices like Kaizen was given importance, followed by 5S, TPM, and others. The statistical results reveal that there is a significant relationship between production and JMP. Hence it suggested adopting JMP to improve the overall growth of the organization.

Pramod., (2007) has identified how the MQFD model solved the problems of TPM by integrating it with QFD cultural aspects using sensitivity analysis. The results reveal that the MQFD model has validated using suitable means, and employed in the companies for better results. It also indicated that the MQFD model helps in overcoming the limitations of TPM.

I. P. S. Ahuja & Khamba., (2008) have investigated on TPM initiative for enhancing the core competitiveness of the manufacturing industry in India. Further, it identified various dimensions of impacting TPM. The study reveals that commitment on part of the management, leadership, maintenance practices, and active TPM initiatives can contribute significantly to enhance the core competencies of the organization.

B. Singh et al., (2010) have expressed how a lean system can be considered for an effective method for minimizing waste in select manufacturing companies in India. The study has identified the lean team addressing the parameters such as issues of suppliers, priorities of investment set by the lean expert team, and types of wastages. Further, the study identified how fuzzy theory is adopted to remove the biases in human judgment. The finding highlights that the lean system is only a weapon used by assessing lean performance and the overall efficiency of the manufacturing industry.

Gajendran., (2011) has examined the impact of TPM to enhance the OEE and productivity of select units of the engineering industry. The study carried out to identify significant losses incurring during the production process and performance measurement of TPM. Further, it identified that TPM exists in both tangible and intangible context in the manufacturing system. The study suggested that TPM implementation is a drastic need to enhance the performance of productivity and other management aspects of an organization.

Gnanaguru., (2011) has evaluated the 6S system and Toyota's A3 report for improving the 6S performance in the manufacturing industry. The study expressed that 5S practices plus 6S as the safety of the workplace, which is one of the necessary techniques to estimate the performance of equipment in the organization. The findings reveal that after implementing 6S practices in the organization has reduced searching, movement of man and parts, downtime, and mistakes. Further, it has improved safety in the workplace, and the A3 report of Toyota helped in improving the 6S performance. Hence, the study has recommended adopting the 6S software to avoid the ambiguity in the 6S auditing, which enhances efficiency.

E., (2011) has identified factors affecting the OEE of the select industry. The study has tried to assess the relationship between the select factors, such as equipment-related losses and losses affecting human elements through OEE. Further, OEE estimated availability, quality, and performance rate using

regression analysis. The results reveals that there is a positive relationship between the select factors and OEE.

I. S. Ahuja., (2012) has investigated how TPM strategies make an impact on the performance of select manufacturing industries in India. The study identified that TPM initiatives are helping in building up strong potentials towards improving organizational performance and creating a safe work environment to overcome the obstacles facing during the production process.

A. K. Sharma., (2012) has evaluated the effectiveness of training and education pillars of TPM. Also, to enhance the skills of human resources for the adequate performance of the manufacturing process. In the study, maintenance and operational development programmes throw light on how workers should change their working style to improve organizational performance. Further, variables such as OEE, availability, quality, and performance rate are identified to evaluate the performance of the organization. The findings reveal that constant monitoring of training and education pillar will create a positive impact on performance and provides a space for workers to adopt TPM culture.

G. R. Kumar & Kapil., (2013) have considered lean tools as the manufacturing performance improvement indicators in the select garment industry in India. The study started with the identification of lean tools to reduce wastage in the value chain process, and the re-engineering process conducted to implement lean tools at every stage of manufacturing systems. Further, to increase the overall performance of the manufacturing system Kaizen, 5S practices, and TPM of JIPM were adopted. The result indicated that after implementation of lean tool reduction in production cycle time, wastages, accidents, scraps, and breakdowns were observed. Hence, the study recommended to implement lean tools to improve production performance.

Paropate & Sambhe., (2013) have focused on the implementation and evaluation of TPM of mid-sized Indian enterprise as a case study of the spinning plant. Here, the study was carried out to know how successful implementation and evaluation of TPM benefits in finding out the deficiency of equipment and how it enhances the overall effectiveness. The results reveal that TPM implementation improves efficiency, quality, and overall equipment effectiveness at the manufacturing system.

Dave., (2013) has analyzed the significant benefit of achieving overall equipment effectiveness in a manufacturing system. The results indicated that the implementation of all eight pillars of TPM helps in improving overall equipment efficiency in the manufacturing system. Further, the study recommended that implementing TPM in the manufacturing system leads to an improved equipment effectiveness and helps in providing a safe working environment.

Sugumaran., (2013) has shown how integrating TPM with the analytical hierarchy process of an organization leads to achieving world class performance and also on the approaches on quality function development. Further, components of the TPM pillar house of quality and AHP technique was investigated to identify any change in the manufacturing system. The findings reveal that TPM is playing a prominent role in making the organization perform better. The study indicates that integration leads to achieve zero defects, breakdowns, higher profit, and continuous improvement. The study suggested implementing the 14 steps AMQFD model, which helps organizations accomplish a world class level.

Vijayakumar & Gajendran., (2014) have observed the performance of the OEE injection molding process, India. The three components of OEE, such as availability, quality, and performance, are examined during the study. Further, to have an in depth knowledge, the study focused on the analysis of breakdown, defects in equipment, and poor working conditions using the OEE. Results reveal that the performance of OEE has improved from 61-81%, in all the components of OEE. Hence, the study recommended the use of OEE in other areas of the manufacturing process to improve the performance of the production system.

Jegan & Muthukumar., (2014) have carried out the study on TPM implementation for improvement in OEE in-cylinder bay. The study intends to know how TPM implementation improves the OEE in the select unit. Further, the data was collected from questionnaires, observations, and documents maintained at the unit. The results reveal that TPM is playing a important role in improving performance efficiency, quality, and availability which, further results in the improvement of OEE.

D. Kumar et al., (2014) has identified the methodology for improving OEE with the help of TMP implementation of the select units of plastic pipe manufacturing industries, India. Further, to know the

difference between pre and post TPM implementation was carried out. The results reveal that after the implementation of TPM, significant problems were solved and also improved the OEE performance in the manufacturing system. The study suggested that TPM not only helps in improving the OEE but also enhances the effectiveness of the organization.

P. Kumar et al., (2014) have identified various trends in OEE and total productivity of machines in Udayavani Newspaper company as a case study. The questionnaire method is incorporated to collect data and analyze it with a suitable technique. The results indicated an average range of OEE (63-71%), which is below the industry standard across the world. Hence, the study suggested educating the workers on OEE operations will reduce downtime and consequently improve productivity.

Varotaria & Barelwala., (2014) have recognized barriers in implementations of TPM, and how they resolved in a PNG distribution company is assessed. The result reveals that while adopting the TPM practices in the manufacturing system, the organization has faced many difficulties in communicating on how to adopt it in the existing work culture. Hence, the organization decided to provide education and training to overcome communication barriers to the shop floor workers.

Mukhedkar., (2015) has analyzed TPM and its impact on the performance of the organization of the select industries of the Nashik zone, in Maharashtra, India. The study identified various tangible and intangible benefits of TPM implementation to enhance the performance of the select units. The study indicates that while large scale units have implemented TPM to the entire organization, the medium and small units implemented TPM for machine maintenance only.

C G, Ramachandra & Pai, M., (2016) have evaluated the effectiveness of TPM implementation in the manufacturing and service industry in India. The intention behind the study is to understand the purposes, processes, and benefits of TPM. The study indicates that the OEE tool is one of the fundamental pillars that helps in improving productivity during TPM implementation. Further, it suggested that the support of management and involvement of workers were considered as critical indicators of successful TPM implementation.

Gupta & Vardhan., (2016) have examined the OEE, production cost, and productivity for enhancing the sales performance in the automobile industry, in India adopting TPM. The study tried to find out how sales performance was enhanced through OEE. The study noticed that the OEE tool has remarkable potentials to improve the equipment effectiveness, as well as helps in reducing the production cost to enhance the sales performance of the select units of industry.

R. Sharma., (2016) has analyzed the need and significance of a maintenance management system in a flexible environment regarding TPM of Hero Motocorp Ltd, India. The study reveals that OEE considered an operational tool to evaluate various losses and overall performance related to the manufacturing system along with TPM pillars.

R. K. Singh et al., (2016) has identified challenges of maintenance management in the manufacturing industries and ranked them for effective maintenance strategies using the TOPSIS method. The finding indicated the top three challenges, such as the lack of management commitment, lack of OEE measurements, and ineffective strategic planning facing by manufacturing industries. Addressing these challenges, the study suggested that the manufacturing industries must adopt proper maintenance management.

Bajwa., (2017) has conducted a study on TPM implementation and its effectiveness in the select units of milk industry in India. The study was carried out to increase the rate of production by reducing the downtime and breakdown of machines with an increase in OEE. It also employed the autonomous maintenance strategy for enhancing OEE. The analysis reveals that TPM is contributes towards improvement in the rate of production, enhancement in quality of the product, reduction in wastages, and decrease in breakdown of machines. Hence, the industry recommended to implement TPM at the initial stage.

CHALLENGES OF IMPLEMENTATION OF TPM

Ramaswamy et al., (2002) have evaluated issues in JIT implementation in SMEs. The study found that SMEs are facing problems in implementing JIT techniques in the manufacturing process. The results reveal that promoting and applying JIT in itself is one of the biggest challenges for SMEs. Further, the

study also found that buffer stock removal and reduction in the lot size are considered critical issues in the implementation of JIT.

Nath et al., (2003) have conducted a study on the cost of quality and its implementation in industries in India. Survey method is used to assess the various models on the cost of quality and to estimate the present cost of quality in the study. The study also reveals that Indian industries are not aware of the evaluation of the cost of quality. Hence, the study recommended adopting methods to evaluate the cost of quality, which helps the industries evaluate the overall performance of its workers.

Dhandapani et al., (2004) have shown the application of lean thinking in Indian steel plant. The study focused on how companies can improve in its competitiveness to reach the global standard by adopting lean thinking in its steel plants. Action research method was employed for data analysis. The study reveals that the annual cost of production is reduced by 8% sales, along with working capital of 3.5% of the sales further, about 50% reduction in the lead time observed.

Tripathi., (2005) has evaluated quality management practices of Indian manufacturing units using the experience and collaboration techniques. Further, analysis carried out on the TQM and its support to the TPM in meeting the challenges of maintaining competitiveness and how TPM supports in meeting the effectiveness. The findings identify that TPM implementation is still in the initial stage, and it requires high investments, and management efforts to establish a place for itself worldwide, and the nature of operations differ from country to country. Hence, the study recommended setting up long term benefits, which in turn allows to face challenges at the global market.

R. K. Sharma et al., (2006) have conducted a study on the analysis of TPM through manufacturing excellence using a practical approach. The study showed a way to identify maintenance strategies that benefit organizations by reducing sporadic failures, maintenance costs, and operational costs. Further, through a case study approach, various issues and challenges associated with the TPM in a semi-automated cell were studied. The results reveal that TPM is helping in improving efficiency and OEE by reducing the wastages to meet the challenges.

I. P. S. Ahuja & Khamba., (2008b) have articulated about various challenges of TPM implementations and measures for overcoming the challenges of select manufacturing units, India. The study was carried out only on critical evaluation of factors affecting TPM implementation. The study reveals that TPM implementation is not an easy task as it is influenced by human, cultural, operational, and technical factors. The study highlighted that successful TPM implementation leads to improvement in the overall organizational performance.

Bhat & Rajashekhar., (2009) have carried out a study on TQM and various challenges of TQM implementation in Indian industries. The purpose is to find out managers awareness on these challenges. The survey was conducted on those industries which won quality awards. The study reveals that challenges faced by these industries are as follows: no proper benchmarking, employee resistance to change, and the companies traditional practices.

Pophaley & Vyas., (2010) have analyzed various dimensions of maintenance practices, benefits, issues and present status in the industry. The study reveals that in the industry, no guidelines were framed on setup time, human factors, cost aspect, and other related issues on the maintenance system. Hence, the study proposed to adopt innovative maintenance practices in the industry to improve the overall performance of the organization.

Panneerselvam., (2012) has investigated on the various challenges encountered by the manufacturing industry in India. It also examined the significant factors affecting the implementation of TPM in the industry and also remedial measures to overcome these challenges. The study reveals that human factors and maintenance activities followed by organizational, departmental, technologically are considered as significant challenges facing Indian manufacturing industry towards TPM implementation.

Attri et al., (2013) have highlighted about adopting the ISM approach to understand the relationship between factors driving and factors dependent in TPM implementation. The questionnaire was constructed using ISM and ranking as variables influencing the study. Further, ISM was used for identifying key factors and managerial implications for successful TPM implementation.

Sampath., (2013) has focused on various aspects of TPM to compare with world class maintenance practices. The study reveals that policy and leadership, preventive and predictive maintenance, workflow, control of finance, operational effectiveness, staffing, and continuous improvement are contributing to the betterment of TPM culture. Hence, they suggested that the parameters observed were creating a drastic impact on successful implementation of TPM for world class performance.

Attri et al., (2014) have analyzed the impact of the theoretic approach on examining the challenges in TPM implementation. Further, a detailed analysis was carried out to measure the intensity of each challenge and its effect on the TPM. The study revealed that challenges are due to lack of awareness on how to make human assets to adopt TPM culture in a work environment.

Waghmare et al., (2014) have expressed that TPM has emerged as the best method to enhance production to world standard. Further, the study identified that TPM was widely used to improve OEE in the manufacturing process and to provide safety and a healthy work environment. Hence, the study suggests implementing TPM to reduce breakdown of equipment and downtime losses during the production process.

Pathak., (2015) has explored how TPM practices help in improving manufacturing performance in the Indian manufacturing industry. The study was carried to find out about the challenges facing by the industries in implementing TPM. The study revealed that TPM implementation is a difficult task that encountered behavioral, organization, cultural, technological, and financial challenges.

Muniraju., (2017) has conducted a study on lean management practices and its challenges in the TPM implementation process. The study indicates that lean techniques are used as an improvement tool to improve the quality of output. Hence, the study suggests implementing lean practices leads to quality improvement in production system.

RESEARCH GAP

The literature survey reveals that TPM implementation is creating a positive impact on the production and operation process in maintaining overall equipment efficiency along with a safe and healthy working environment. This encouraged employees to work efficiently towards maintenance equipment at the production process, which leads to improve quality, productivity, and competitiveness of the organization's performance through TPM implementation.

Further, TPM was involved in all stages of the production process to obtain OEE. However, the drawback is involving human resources, which is a difficult task, this is a deterrent in attaining overall efficiency at the individual level and organization as a whole. Convincing the human mindset to adopt to a new kind of work environment is a challenging task. Indeed, there is bound to be chances of technical issues arising in terms of operating and handling machines, which will lead to creation of a gap in the production process.

Various researches carried out on different aspects of TPM, such as OEE, production cost, downtime losses, maintenance approaches, failure, and breakdown, and challenges of TPM throws light on the significance of TPM implementation in the manufacturing industries. It is also observed that until now, no studies have been carried out on the human aspects and its integration with the other activities of TPM in manufacturing industries in India in general and Karnataka in specific. Therefore, the study on **"Evaluation of Total Productive Maintenance (TPM) Practices in Select Manufacturing Industries in Karnataka"** is considered necessary to fill the above gap.

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