



Total Productive Maintenance: Literature Review And Directions

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Abstract

Purpose – 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 highlights appropriate enablers and success factors for eliminating barriers to successful TPM implementation.

Design/methodology/approach – The paper systematically categorizes the published literature and then analyzes and reviews it methodically.

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

Practical implications – The literature on classification of Total Productive Maintenance has been very limited. The paper reviews a large number of papers in this field and presents the overview of various TPM implementation practices demonstrated by manufacturing organizations globally. It also highlights the approaches suggested by various researchers and practitioners and critically evaluates the reasons behind the failure of TPM programs in organizations. Further, the enablers and success factors for TPM implementation have also been highlighted for ensuring smooth and effective TPM implementation in organizations.

Originality/value – The paper contains a comprehensive listing of publications on the field in question and their classification according to various attributes. It will be useful to researchers, maintenance professionals, and others concerned with maintenance to understand the significance of TPM.

Keywords Preventive maintenance, Productive maintenance, Reliability management, Critical success factors

1. Introduction

The manufacturing industry has experienced an unprecedented degree of change in the last three decades, involving drastic changes in management approaches, product and process technologies, customer expectations, supplier attitudes as well as competitive behavior (Ahuja et al., 2006). In today's highly dynamic and rapidly changing environment, global competition among organizations has led to higher demands on manufacturing organizations (Miyake and Enkawa, 1999). The global marketplace has witnessed increased pressure from customers and competitors in manufacturing as well as the service sector (Basu, 2001; George, 2002). The rapidly changing global marketplace calls for improvements in a company's performance by focusing on cost-cutting, increasing productivity levels, and quality, and guaranteeing deliveries to satisfy customers (Raouf, 1994). Organizations that want to survive in today's highly competitive business environment must address the need for a diverse product range with state-of-the-art product features, coupled with high quality, lower costs, and more effective, swifter Research and Development (R&D) (Gotoh, 1991; Hipkin and Cock, 2000). In today's fast-changing marketplace, slow, steady improvements in manufacturing operations do not guarantee sustained profitability or survival of an organization (Oke, 2005). Thus the organizations need to improve at a faster rate than their competitors if they are to become or remain leaders in the industry.

With increased global competition, attention has been shifted from increasing efficiency using economies of scale and internal specialization to meeting market conditions in terms of flexibility, delivery performance, and quality (Yamashina, 1995). The changes in the current business environment are characterized by intense competition on the supply side and heightened volatility in customer requirements on the demand side. These changes have left their unmistakable marks on the different facets of manufacturing organizations (Gomes et al., 2006). To meet the challenges posed by the contemporary competitive environment, manufacturing organizations must infuse quality and performance improvement initiatives in all aspects of their operations to improve their competitiveness (Ben-Daya and Duffuaa, 1995; Pintelon et al., 2006). In an increasingly global economy, cost-effective manufacturing has become a necessity to stay competitive.

2. Challenge of maintenance function

Maintenance is normally perceived to have a poorer rate of return than any other major budget item. Yet, most companies can reduce maintenance costs by at least one-third, and improve the level of productivity, by giving maintenance the management priority it requires. That priority must span all levels of an organization's management structure to develop an understanding at each level of the significance maintenance can have upon the success or failure of organization objectives (Al-Hassan et al., 2000). The maintenance processes can be streamlined to eliminate waste and produce breakthrough performance in areas valued by customers (Hammer and Champy, 1993). Equipment maintenance represents a significant component of the operating cost in transportation, utilities, mining, and manufacturing industries. The potential impact of maintenance on the manufacturing performance is substantial. Maintenance is responsible for controlling the cost of manpower, materials, tools, and overhead. In financial terms, maintenance can represent 20 to 40 percent of the value added to a product as it moves through the plant (Hora, 1987; Eti et al., 2006). Further, a survey of manufacturers found that full-time maintenance personnel as a percentage of plant employees averaged 15.7 percent of overall staffing in a study involving manufacturing organizations (Dunn, 1988), whereas in refineries, the maintenance and operations departments are often the largest and each may comprise about 30 percent of total staffing (Dekker, 1996). It has been found that in the UK manufacturing industry, maintenance spending accounts for a significant 12 to 23 percent of the total factory operating costs (Cross, 1988). With sobering figures like these, manufacturers are beginning to realize that maintenance organization and management, and design for maintainability and reliability are strategic factors for success in the 1990s (Yoshida et al., 1990). Thus the effectiveness of the maintenance function significantly contributes to the performance of equipment, production, and products (Macaulay, 1988; Teresko, 1992).

The rapidly changing needs of modern manufacturing and the ever-increasing global competition have emphasized the re-examination of the role of improved maintenance management towards enhancing an organization's competitiveness (Riiset et al., 1997). Confronted with such reality, organizations are under great pressure to enhance their competencies to create value for customers and improve the cost-effectiveness of their operations continuously. In the dynamic and highly challenging environment, reliable manufacturing equipment is regarded as the major

contributor to the performance and profitability of manufacturing systems (Kutucuoglu et al., 2001). Its importance is rather increasing in the growing advanced manufacturing technology application stages (Maggard and Rhyne, 1992). Therefore, equipment maintenance is an indispensable function in a manufacturing enterprise (Ahmed et al., 2005). The recent competitive trends and ever-increasing business pressures have been putting maintenance functions under the spotlight as never before (Garg and Deshmukh, 2006). For maintenance to make its proper contribution to profits, productivity, and quality, it must be recognized as an integral part of the plant production strategy (Kumar et al., 2004). Thus achieving excellence in maintenance issues has to be treated as a strategic issue for manufacturing organizations to create world-class manufacturers (Brah and Chong, 2004).

3. Detailed literature review of total productive maintenance

The literature has revealed that manufacturing organizations worldwide are facing many challenges to achieve successful operations in today's competitive environment. Modern manufacturing requires that to be successful, organizations must be supported by both effective and efficient maintenance practices and procedures. Over the past two decades, manufacturing organizations have used different approaches to improve maintenance effectiveness (Roup, 1999). One approach to improving the performance of maintenance activities is to implement and develop a TPM strategy. The TPM implementation methodology provides organizations with a guide to fundamentally transform their shopfloor by integrating culture, process, and technology (Moore, 1997).

TPM is considered to be Japan's answer to US-style productive maintenance (Wal and Lynn, 2002). TPM has been widely recognized as a strategic weapon for improving manufacturing performance by enhancing the effectiveness of production facilities (Dwyer, 1999; Dossenbach, 2006). TPM has been accepted as the most promising strategy for improving maintenance performance to succeed in a highly demanding market arena (Nakajima, 1988). TPM is a proven manufacturing strategy that has been successfully employed globally for the last three decades, for achieving the organizational objectives of achieving core competence in the competitive environment (Ahuja et al., 2004). TPM is a highly influential technique that is at the core of "operations management" and deserves immediate attention from organizations across the globe (Voss, 1995, 2005). TPM is a methodology originating from Japan to support its lean manufacturing system since dependable and effective equipment is an essential pre-requisite for implementing Lean manufacturing initiatives in organizations (Sekine and Arai, 1998). While Just-In-Time (JIT) and Total Quality Management (TQM) programs have been around for a while, the manufacturing organizations off late, have been putting in enough confidence upon the latest strategic quality maintenance tool as TPM. Figure 1 shows the relationships between TPM and Lean Manufacturing building blocks. It is revealed, that TPM is the cornerstone activity for most of the lean manufacturing philosophies and can effectively contribute towards the success of lean manufacturing.

TPM is a production-driven improvement methodology that is designed to optimize equipment reliability and ensure efficient management of plant assets (Robinson and Ginder, 1995). TPM is a change philosophy, which has contributed significantly towards the realization of significant improvements in the manufacturing organizations in the West and Japan (Maggard and Rhyne, 1992). TPM has been depicted as a manufacturing strategy comprising of following steps (Nakajima, 1989; Bamber et al., 1999; Suzuki, 1992):

- maximizing equipment effectiveness through the optimization of equipment availability, performance, efficiency, and product quality.
- establishing a preventive maintenance strategy for the entire life cycle of equipment
- covering all departments such as planning, user, and maintenance departments;
- involving all staff members from top management to shop-floor workers; and
- promoting improved maintenance through small-group autonomous activities.

Nakajima (1989), a major contributor to TPM, has defined TPM as an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous maintenance by operators through day-to-day activities involving the total workforce (Conway and Perry, 1999, Bhadury, 2000). The emergence of TPM is intended to bring both production and maintenance functions together through a combination of good working practices, teamwork, and continuous improvement (Cooke, 2000). Willmott (1994) portrays TPM as a relatively new and practical application of TQM and suggests that TPM aims to

promote a culture in which operators develop “ownership” of their machines, learn much more about them, and in the process realize skilled trades to concentrate on problem diagnostic and equipment improvement projects. TPM is not a maintenance specific policy, it is a culture, a philosophy, and a new attitude toward maintenance (Chowdhury, 1995). TPM is a system (culture) that takes advantage of the abilities and skills of all individuals in an organization (Patterson et al. 1995). An effective TPM implementation program provides for a philosophy based on the empowerment and encouragement of personnel from all areas of the organization (Davis and Willmott, 1999).

TPM is about communication. It mandates that operators, maintenance people, and engineers collectively collaborate and understand each other’s language (Witt, 2006). TPM describes a synergistic relationship among all organizational functions, particularly between production and maintenance, for the continuous improvement of product quality, operational efficiency, productivity, and safety (Rhyne, 1990; Labib, 1999; Sun et al., 2003). According to Chaneski (2002), TPM is a maintenance management program to eliminate equipment downtime. TPM is an innovative approach to plant maintenance that is complementary to Total Quality Management (TQM), Just-in-Time Manufacturing (JIT), Total Employee Involvement (TEI), Continuous Performance Improvement (CPI), and other world-class manufacturing strategies (Maggard et al., 1989; Schonberger, 1996; Ollila and Malmipuro, 1999; Cua et al., 2001). Lawrence (1999) describes TPM as the general movement on the part of businesses to try to do more with fewer resources. According to Besterfield et al. (1999), TPM helps to maintain the current plant and equipment at its highest productive level through the cooperation of all functional areas of an organization.

4. Overall equipment effectiveness

TPM initiatives in production help in streamlining the manufacturing and other business functions, and garnering sustained profits (Ahuja and Khamba, 2007). The strategic outcome of TPM implementations is the reduced occurrence of unexpected machine breakdowns that disrupt production and lead to losses, which can exceed millions of dollars annually (Gosavi, 2006). Overall equipment effectiveness (OEE) methodology incorporates metrics from all equipment manufacturing states guidelines into a measurement system that helps manufacturing and operations teams improve equipment performance and, therefore, reduce equipment cost of ownership (COO). TPM initiatives are focused on addressing major losses, and wastes associated with the production systems by affecting continuous and systematic evaluations of the production system, thereby affecting significant improvements in production facilities (Ravishankar et al., 1992; Gupta et al., 2001, Juric et al., 2006). The evaluation of TPM efficiency can facilitate significantly enhanced organizational capabilities across a variety of dimensions (Wang, 2006). TPM employs OEE as a quantitative metric for measuring the performance of a productive system. OEE is the core metric for measuring the success of the TPM implementation program (Jeong and Phillips, 2001). The overall goal of TPM is to raise the overall equipment effectiveness (Shirose, 1989; Huang et al., 2002; Juric et al., 2006). OEE is calculated by obtaining the product of availability of the equipment, performance efficiency of the process, and rate of quality products (Dal et al., 2000; Ljungberg, 1998).

This metric has become widely accepted as a quantitative tool essential for the measurement of productivity in manufacturing operations (Samuel et al., 2002). The OEE measure is central to the formulation and execution of a TPM improvement strategy (Ljungberg, 1998). TPM has the standards of 90 percent availability, 95 percent performance efficiency, and 99 percent rate of quality (Levitt, 1996). An overall 85 percent benchmark OEE is considered a world-class performance (Blanchard, 1997; McKone et al., 1999). OEE measure provides a strong impetus for introducing a pilot and subsequently company-wide TPM program.

A key objective of TPM is to eliminate or minimize all losses related to the manufacturing system to improve overall production effectiveness. In the initial stages, TPM initiatives focus on addressing six major losses, which are considered significant in lowering the efficiency of the production system (Gupta et al., 2001). The six major losses include equipment failure/breakdown losses, setup and adjustment losses, idling and minor stoppage losses, defect and rework losses, and start-up losses. TPM endeavors to increase efficiency by rooting out losses that sap efficiency. The calculation of OEE by considering the impact of the six major losses on the production system is indicated in Figure 4 (McKellen, 2005). Using OEE metrics and establishing a disciplined reporting system helps an organization focus on the parameters critical to its success.

However, with time, many manufacturing organizations have started focusing on all the losses including the planned downtime for scheduled maintenance activities, as well as focusing upon the unplanned downtime and losses for affect ultimate improvements in the production system (Holmgren, 2005). While OEE measures the effectiveness of planned production schedules, Overall Plant Efficiency (OPE), measures the overall equipment effectiveness relative to every minute of the clock, or calendar time (Hansen, 2002). Overall Plant Efficiency is also referred to as Total Effectiveness Equipment Performance (TEEP). The terms OPE or TEEP are used to evaluate how well the organization's assets are used relative to the total calendar time.

OPE/TEEP are the metrics that indicate opportunities that might exist between current operations and world-class levels. The calculation of OPE by considering the impact of the eight major losses on the production system is indicated. In the quest to achieve world-class manufacturing, the organizations world over, are now, relying upon exhaustive analysis of the manufacturing systems to ascertain the inefficiencies associated with the enterprises. It has been observed that other than equipment-related losses, losses affecting human performance and energy/yield inefficiencies also need to be accounted for appropriately for achieving world-class performance. In all 16 losses are identified and strategies are developed for reducing the impact of the losses or eliminating the losses from the manufacturing systems. For this purpose, 16 major losses have been identified to be impeding the manufacturing performance and efficiency. These losses have been categorized into four categories, which include seven major losses impeding equipment efficiency (failure losses, setup/adjustment losses, reduced speed losses, idling/minor stoppage losses, defect/rework losses, start-up losses, and tool changeover losses), losses that impede machine loading time (planned shutdown losses), five major losses that impede human performance (distribution/logistic losses, line organization losses, measurement/adjustment losses, management losses, and motion-related losses) and three major losses that impede effective use of production resources (yield losses, consumable – jig/tool/die losses, and energy losses) (Shirose, 1996). A brief description of various losses in the context of manufacturing organizations, The OEE metric offers a starting point for developing quantitative variables for relating maintenance measurement to corporate strategy. OEE can be used as an indicator of the reliability of the production system. Analyzing OEE categories can reveal the greatest limits to success. Forming cross-functional teams to solve the root causes/problems can drive the greatest improvements and generate real bottom-line earnings. A comparison between the expected and current OEE measures can provide the much-needed impetus for manufacturing organizations to improve the maintenance policy and affect continuous improvements in the manufacturing systems (Wang, 2006). OEE offers a measurement tool to evaluate equipment corrective action methods and ensure permanent productivity improvement. OEE is a productivity improvement process that starts with management's awareness of total productive manufacturing and their commitment to focus the factory workforce on training in teamwork and cross-functional equipment problem-solving.

5. An overview of TPM implementation practices

Lycke (2000) points out that TPM is a highly structured approach and careful, thorough planning and preparation are keys to successful company-wide implementation of TPM and so is senior management's understanding and belief in the concept. One of the most significant elements of the TPM implementation process is that it is a consistent and repeatable methodology for continuous improvement. A driving consideration for TPM is the fact that successful TPM implementation takes from three to five years, with an average of three and a half years from introduction to achievement of TPM Prize-winning results (Society of Manufacturing Engineers, 1995; Wang and Lee, 2001). TPM is a long-term process, not a quick fix for today's manufacturing problems (Horner, 1996).

The organizations across the world have been struggling since long to evolve the best possible strategy for successful implementation of TPM. However, TPM experts and practitioners around the world have now acknowledged problems regarding a cookbook-style TPM in organizations due to factors like highly variable skills associated with the workforce under different situations, age differences of the workgroups, varied complexities of the production systems and equipment, altogether different organization cultures, objectives, policies and environments and the differences in prevailing status of maintenance competencies (Wireman, 2004).

Although “there is no single right method for implementation of a TPM program” (Wireman, 1990b) and there has been “a complexity and divergence of TPM programs adopted throughout the industry” (Bamber et al., 1999) it is clear that a structured implementation process is an identified success factor and a key element of TPM programs. “For world-class competitors, minimal performance requirements include repetitive and predictable year-over-year actual per-unit cost reductions, ever-reducing variation, improved product quality, and extraordinary customer service. Winning requires an institutionalized management proof process that is sustainable despite changes in leadership, strategy, and business conditions – a corporate culture dedicated to manufacturing excellence” (Elliott, 2001). To introduce the principles and practice application of TPM, an implementation method is necessary.

There have been many approaches suggested by different practitioners and researchers for implementing TPM in different organizations having varying environments for garnering manufacturing competencies to accomplish the organizational goals and objectives. It has been observed that many organizations follow a strict JIPM-TPM implementation process, by strategically employing the eight-pillars approach towards TPM implementation (Wakaru, 1988; Ireland and Dale, 2001). The eight pillars involved in achieving the goals of TPM include autonomous maintenance; focused maintenance; planned maintenance; quality maintenance; education and training; safety, health, and environment; office TPM and Development Management (Nakajima, 1988). The Nakajima model of TPM implementation has already been depicted. Nakajima has also outlined 12 steps involved in developing and implementing a TPM program in four stages (Nakajima, 1988; Shirose, 1996). These 12 steps support the basic developmental activities, which constitute the minimal requirements for the development of TPM. The various steps involved in the TPM implementation methodology have been depicted in Table V. Hartmann has outlined another TPM implementation process that simplifies the Nakajima implementation model (Hartmann, 1992).

6. Benefits of TPM implementation

TPM is a world-class approach, which involves everyone in the organization, working to increase equipment effectiveness. TPM implementation in an organization can ensure higher productivity, better quality, fewer breakdowns, lower costs, reliable deliveries, motivating working environments, enhanced safety, and improved morale of the employees (Tripathi, 2005). The ultimate benefits that can be obtained by implementing TPM are enhanced productivity and profitability of the organizations. TPM aims to increase the availability of existing equipment in a given situation, reducing in that way the need for further capital investment. Instrumental to its success is the investment in human resources, which further results in better hardware utilization, higher product quality, and reduced labor costs (Bohoris et al., 1995).

The literature documents dramatic tangible operational improvements resulting from successful TPM implementation programs. Companies practicing TPM invariably achieve startling results, particularly in reducing equipment breakdowns, minimizing idling and minor stops (indispensable in unmanned plants), lessening quality defects and claims, boosting productivity, trimming labor and costs, shrinking inventory, cutting accidents, and promoting employee involvement (Suzuki, 1994). When the breakdowns and defects are eliminated, many benefits are presented: equipment productivity improvement, cost reduction, quality improvement, and inventory reduction, etc. The TPM approach helps increase the uptime of equipment, reduce machinery set-up time, enhance quality and lower costs. Through this approach, maintenance becomes an integral part of the team. The ultimate benefits obtained by implementing TPM are increased profitability and improved productivity.

After successful TPM implementation, some cases show that companies achieved a 15-30 percent reduction in maintenance cost, while others revealed a 90 percent reduction in process defects and a 40-50 percent increase in labor productivity (Nakajima, 1988). Also, some Japanese companies that have applied major TPM programs have seen a general increase in equipment productivity of 40-50 percent (Willmott, 1994). Chowdhury (1995) reports that organizations with a TPM culture have experienced benefits to the extent of an 80 percent reduction in defect rate, a 90 percent reduction in routine breakdowns, and a 50 percent increase in production output.

Ahuja and Khamba (2007) have conducted a case study in the Indian Manufacturing Industry and revealed that there has been significant improvement in overall equipment effectiveness of all the production facilities as a result of TPM initiatives. The benefits realized through an effective TPM implementation program included OEE improvement: 14-45 percent, inventory reduction: 45-58 percent, improvement in plan output: 22-41 percent, reduction in customer rejections: 50-75 percent, reduction in accidents: 90-98 percent, reduction in

maintenance cost: 18-45 percent, reduction in defects and rework: 65-80 percent, reduction in breakdowns: 65-78 percent, reduction in energy costs: 8-27 percent, increase in employee suggestions: 32-65 percent and total savings resulting from effective implementation of kaizen themes as a result of significantly enhanced participation across the organization: Rs. 80 million.

The outstanding results of TPM implementation have led many firms facing competitive pressures to adopt TPM (McKone et al., 1999). Several Japanese companies with rich experience in implementing TPM programs have realized significant improvements including a 50 percent rise in equipment availability and a 90 per cent decline in process defects, 7a 5 percent decline in customer complaints, a 30 percent decline in maintenance costs and 50 percent reduction in maintenance inventories (Windle, 1993). Koelsch (1993) has reported that companies that adopt TPM are seeking 50 percent reductions in breakdown labor rates, 70 percent reductions in lost production, 50-90 per cent reductions in setups, 25-40 per cent increases in capacity, 50 percent increases in labor productivity, and 60 percent reductions in costs per maintenance unit. Tennessee Eastman expanded its capacity by 8 percent and estimated savings of \$11 million per year from TPM. Nissan Motor reduced the number of breakdowns by 80 per cent, cut inventory by 55 percent, reduced defects by 85 percent, and decreased work hours by 50 percent within the first three years of TPM implementation (Suzuki, 1992). Nippondenso decreased the percentage of maintenance time spent on breakdowns from 57.6 to 15.3 percent after two years (Teresko, 1992). Moreover, successful TPM implementation programs have contributed towards the realization of intangible benefits such as continuous improvement of workforce skills and knowledge, clarification of the roles and responsibilities for employees, a system for continuously maintaining and controlling equipment and manual work, an enhanced quality of work life, an improved participation rate, and reduced absenteeism caused by stress, and more open communication within and among workplaces (Suzuki, 1994; Carannante, 1995). Greater job satisfaction can translate into higher productivity and quality and ultimately contribute to lower manufacturing costs (Hamrick, 1994). Companies need to consider the human aspect of TPM in combination with the technical and financial impacts.

7. Future directions for TPM

After the successful institutionalization of TPM programs in the organizations, concerted efforts must be made to ensure sustained TPM deployment in the manufacturing organizations, as manufacturing improvements are only possible through the persistent deployment of world-class TPM initiatives. The goal of the organization at this stage, after the successful deployment of TPM, is to continue the TPM Program into the incremental process improvement phase, using a Continuous Quality Improvement (CQI) approach. It is extremely important for an organization to consistently move forward after attaining the TPM Excellence award for sustaining the levels attained and to reach higher levels of achievement. The changes introduced into the organization by TPM activities must be anchored thereby becoming an established part of everybody's daily routine. TPM has to be regarded as a "change process", rather than a "project" otherwise the competencies gained by the organization might fade away after the project is completed.

Once the crucial achievements through strategically implemented and institutionalized TPM programs have been realized, the TPM team should continue to work progressively to look for ways to improve upon their success. The organization must consistently send a strong message to employees that openness, trust, teamwork, continuous improvement, and learning are the core values of the company. To sustain continuous improvement, a positive attitude throughout the organization must be evident. The manufacturing organizations must prepare for, implement, and sustain improvement and their competencies cover a broad range of issues including: Innovative Thinking (structured problem solving, creative problem solving, visioning sessions, concurrent design, rapid product/service design); Developing Teams and Individuals (change agent development, cultural assessment and alignment, change management, flexible working, performance coaching, emotional intelligence, multi-function teams, project-based team building); Effective Leadership (strategic planning, operational planning, policy deployment, strategic negotiation, strategic procurement, future state planning, leadership potential, performance coaching); Access to Knowledge and Expertise (lean service, lean manufacturing, risk management, process redesign, Six Sigma, project and program management, concurrent design, supply chain management, strategic procurement, outsourcing, knowledge management) and specific skills (value stream analysis, process analysis, 5S/visual management, SMED, Jidoka, SPC, DMAIC, Kanban, DFMA, FMEA/FMECA) for attaining long-term core competencies and market leadership. Similarly, the

manufacturing performance can also be evaluated by simultaneous implementation of TPM and other related lean manufacturing initiatives like JIT, TQM, QFD, TEI, and CI, etc. for enhancing overall manufacturing competencies.

Further, the TPM audit process and TPM Gap Analysis must be put into place to evaluate the evolution of permanent changes taking place in the organization. The appropriate auditing and monitoring system should be developed to improve TPM results continuously. This TPM audit process brings structure and metrics to TPM implementation and allows the steering team to place focused effort to move the implementation forward. Thus sustained TPM programs can achieve “world class organization” and assume leadership roles in competitive environments.

8. Conclusions

The literature highlights the contributions of various TPM implementation initiatives for accruing strategic benefits for meeting the challenges posed by global competition. TPM has emerged as a key competitive strategy for business organizations in the global marketplace. An effective TPM implementation program can focus on addressing the organization’s maintenance-related problems, to optimize equipment performance. TPM has become a new management paradigm in all types of organizations. In recent years, many organizations have demonstrated that significant improvements in business can be achieved through TPM. TPM concepts and philosophy can be effectively employed to realize fundamental improvements in manufacturing performance in the organization, thereby leading to the organization's success in a highly competitive environment. TPM can prove to be an effective global strategy for rendering firms a consistent enhancement of performance in terms of achieving strategic core competencies. Thus, in the highly competitive scenario, TPM might prove to be one of the best proactive strategic initiatives that can lead the organizations to scale new levels of achievements and could make the difference between the success and failure of the organizations. The study validates the relevance of strategic TPM initiatives in the manufacturing strategy for the realization of organizational objectives in successful organizations. The study reveals that the successful TPM implementation program can facilitate the manufacturing organization’s quest for achieving enhanced manufacturing performance leading to competitive advantage.

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