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International
Journal
Of Modern Engineering Research (IJMER)

A Review on Implementation of TPM in Manufacturing Industry

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Abstract: *The intent of the study is to appraise the challenges faced by manufacturing industries to implement Total Productive Maintenance (TPM). The scheme of this research is to critically analyze the factors influencing TPM implementation in manufacturing organizations, and to formulate comprehensive strategy for overcoming impediments to successful TPM implementation . The introduction of several philosophies such as Corrective Maintenance (CM), Preventive Maintenance (PM) or Total Productive Maintenance (TPM) have allowed extra solutions to a process planning problem faced by company in comparison to the conventional fire-fighting syndrome. This main purpose of this study was to focus on developing a framework of maintenance strategy TPM initiatives to confront exponential global challenges.*

Keywords: *Total productive maintenance (TPM), manufacturing organizations, TPM implementation, Manufacturing performance. Maintenance management system framework*

I. INTRODUCTION

Globalization and economic turbulence is the hallmark of contemporary business environment. The manufacturing sector over the past three decades has experienced an unprecedented degree of change embracing radical changes in management approaches, product and process technologies, customer expectancies, supplier attitudes as well as competitive behavior [1]. The dynamic business environment turns out to be highly exigent and manufacturing industries are finding it acutely difficult to endure the competition and customer expectations. The global marketplace has witnessed an exponential upsurge in pressure from consumers and competitors for increased value from their purchase in terms of quality, faster delivery, and lower cost not only in manufacturing but also in the service sector [2], [3]. At present, manufacturing organizations compete on various factors such as technology, time, cost, quality, reliability, innovation, and knowledge management. There is a colossal emphasis upon manufacturing organizations to adapt Total Quality Management (TQM), lean and six sigma principles, and business process improvement strategies for achieving remarkable results in quality, cost, and delivery by focusing on process performance [4]. Rapidly changing requisites of novel manufacturing and aggrandizing global competition has stressed upon the review of the aspect of a maintenance management system towards enhancing organizational competitiveness [5].

Manufacturing organizations perceived and approbated that the equipment maintenance and its reliability are important strategies that can significantly influence the organization's dexterity to compete efficiently [6]. The maintenance processes can be streamlined to eliminate wastes thereby resulting an upswing of performance in areas valued by customers [7]. This has stimulated the manufacturing organizations to adapt Total Productive Maintenance (TPM) as a substantial process improvement and problem solving methodology for enhancing the organization's responsiveness to satiate customer needs and influencing cost optimization as part of management strategy to increase the market share and maximize profit. TPM has been acknowledged as the most propitious strategy for improving maintenance performance in order to succeed in an exceedingly demanding market arena [8]. The TPM implementation that has emerged as an operational strategy renders organizations with a guide to fundamentally transform their shop floor by integrating processes, culture, and technology [9].

II. BASIC ELEMENTS OF TOTAL PRODUCTIVE MAINTENANCE

TPM is an important world-class manufacturing program introduced during the quality revolution. TPM seeks to maximize equipment effectiveness throughout the lifetime of equipment. It strives to maintain equipment in optimum condition in order to prevent unexpected breakdowns, speed losses and quality defects occurring from process activities. There are three ultimate goals of TPM: zero defects, zero accident, and zero breakdowns. Nakajima (1988) [10] suggests that equipments should be operated at 100% capacity 100% of the

time. The benefits arising from TPM can be classified in six categories including productivity (P), quality (Q), cost (C), delivery (D), safety (S) and morale (M). TPM has been envisioned as a comprehensive manufacturing strategy to improve equipment productivity. Benchmarking on OEE, P, Q, C, D, S and M can enable an organization to realize zero breakdown, defect, machine stoppage, accidents, and pollution, which serve as an ultimate objective of TPM. The strategic elements of TPM include cross-functional teams to eliminate barriers to machine uptime, rigorous preventive maintenance programs, improved maintenance operations management efficiency, equipment maintenance training to the lowest level, and information systems to support the development of imported equipment with lower cost and higher reliability. Similar to TQM, TPM is focused on improving all the big picture indicators of manufacturing success. TPM implementation requires a long-term commitment to achieve the benefit of improved OEE through training, management support and teamwork.

Figure1 shows the framework of TPM implementation and depicts tools used in TPM implementation program with potential benefits accrued and targets sought. TPM initiatives as suggested by Japan Institute of Plant Maintenance (JIPM) involve an eight pillar implementation plan that results in substantial increase in labor productivity through controlled maintenance, reduction in maintenance costs, and reduced setup and downtimes. The basic principles of TPM are often called the pillars or elements of TPM. The entire edifice of TPM is built and stands on eight pillars. TPM paves the way for excellent planning, organizing, monitoring, and controlling practices through its unique eight pillar methodology involving: autonomous maintenance; focused improvement; planned maintenance; quality maintenance; education and training; safety, health and environment; office TPM; and development management (Rodrigues and Hatakeyama, 2006) [11]. The eight pillar Nakajima model of TPM implementation has been depicted in Figure .2 (Ahuja and Khamba, 2007)[1].

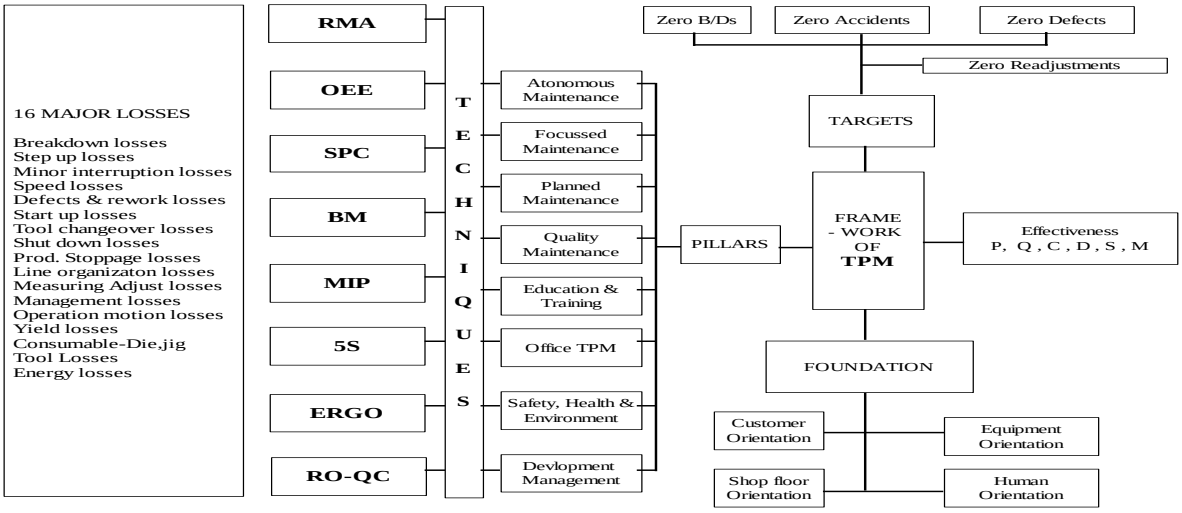

Figure1. Framework of total productive maintenance

Figure1. Framework of total productive maintenance TPM initiatives aim at achieving enhanced safety, asset utilization, production capacity without additional investments in new equipment, human resources and continuing to lower the cost of equipment maintenance and improving machine uptime. It provides an effective way of deploying activities through its TPM promotion organization involving 100% of employees on a continuous basis. The main goal of an effective TPM program is to bring critical maintenance skilled trades and production workers together. Total employee involvement, autonomous maintenance by operators, small group activities to improve equipment reliability, maintainability, productivity, and continuous improvement (Kaizen) are the principles embraced by TPM. There are a variety of tools that are traditionally used for quality improvement. TPM uses the following tools among others to analyze and solve the equipment and process related problems: pareto analysis; statistical process control (SPC - control charts); problem solving techniques (brainstorming, cause-effect diagrams, and 5-M approach); team based problem solving; poka-yoke systems (mistake proofing); autonomous maintenance; continuous improvement; 5S; setup time reduction (SMED); waste minimization; benchmarking; bottleneck analysis; reliability, maintainability and availability (RMA) analysis; recognition and reward programs; and system simulation. TPM provides a comprehensive, life cycle approach to equipment management that minimizes equipment failures, production defects, and accidents. The objective is to improve continuously production system availability and prevent

degradation of equipment to realize maximum effectiveness. These objectives require strong management support as well as continuous use of work teams and small group activities to achieve incremental improvements.

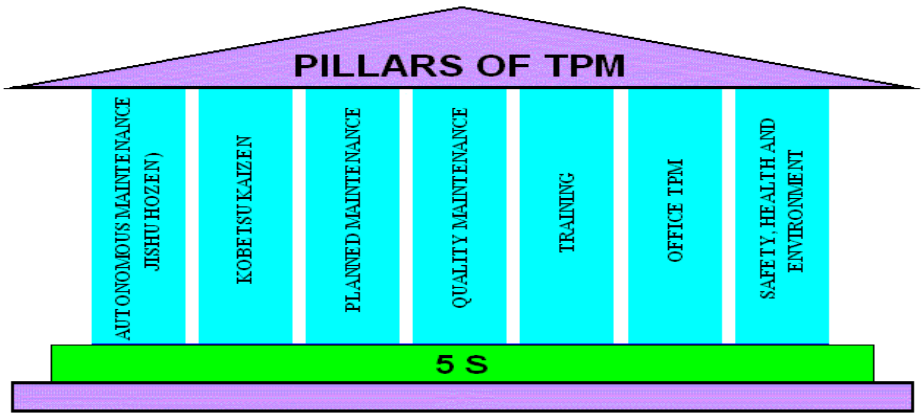

Figure 2. Eight pillar approach for TPM implementation (suggested by JIPM)

TPM employs OEE as the core quantitative metric for measuring the performance of a productive system. OEE has been widely accepted as an essential quantitative tool for measurement of productivity of manufacturing operations. The role of OEE goes far beyond the task of just monitoring and controlling. OEE measure is central to the formulation and execution of a TPM improvement strategy. It provides a systematic method for establishing production targets and incorporates practical management tools and techniques in order to achieve a balanced view of process availability, performance rate, and quality. OEE has been used as an impartial daily snapshot of the equipment and promotes openness in information sharing and a no-blame approach in handling equipment related issues. OEE is the measure of contribution of current equipment to the added value generation time, based on overall consideration of time, speed performance, and non-defective ratio of the equipment. The improvement of OEE is essential to drive a lean production system and is calculated by multiplying availability of equipment, performance efficiency of process and rate of quality products (Gregory, 2006).[12]

With equipment availability, utilization and reliability becoming critical issues in capital-intensive operations, TPM evolves to be strategically imperative in such businesses. The inception of TPM is destined to actualize collaboration between production and maintenance functions by an amalgamation of team working, continuous improvement, and good working practices [13].

The philosophy of TPM shifts the paradigm of an organization's conventional maintenance system from being reactive to being more proactive by maintaining the equipment in optimum condition at all times. TPM methodology embraces an array of techniques that assures each piece of equipment in a production process is always able to perform its required task. It also articulates all other maintenance and reliability processes and methodologies together for a new business strategy that focuses on results and changes the work culture along the line. TPM promotes the participation of all employees to I improve production equipment's availability, performance, quality, safety, and reliability. TPM is a long-term program that strives to tap the "hidden capacity" of unreliable and inefficient equipment. It capitalizes on proactive and progressive maintenance strategies and calls for the knowledge and collaboration of operators, maintenance technicians, equipment suppliers, engineering, and support personnel to optimize equipment performance, thereby resulting in elimination of breakdowns, reduction of unscheduled and scheduled downtime, improved utilization hence productivity and enhanced product quality. The bottom-line accomplishment of a successful TPM implementation in an organization embodies lower operational costs, prolonged equipment life span and lower overall maintenance expenditure [14].

III. REVIEW ON IMPLEMENTATION OF TPM IN MANUFACTURING INDUSTRY

1. Hurdle to TPM implementation: A review

Literature states that TPM implementation is not an effortless task by any means. The failure of TPM implementation is primarily due to the lack of a support system to facilitate learning and transform the same into effective TPM practices followed by its diffusion. Many organizations that attempted to implement TPM initiatives experienced difficulties and are unable to gain the anticipated benefits. The failure of an

organization to successfully implement TPM philosophy has been attributed to various barriers including lack of management commitment and understanding, lack of adequate training, failure to allow adequate time for its evolution [15]. Some of the conspicuous hurdles in TPM implementation includes partial implementation of TPM, inordinate expectations, lack of a systematic approach for achieving the objectives of implementation, cultural resistance to change, inadequate training and education, lack of organizational communication, and implementation to conform to societal norms rather than for its instrumentality to achieve world class manufacturing [16].

A further cogent influencing factor for failure of TPM implementation program is the organization's ineffectualness to obviate resistance to change. There are different dimensions of resistance to change such as, individual's reluctance to change roles [5], [13], inability to change organizational roles and culture [17], [18] and inability to create dissatisfaction with the current situation [19], [20]. Bamber et al. [21] has carried out a study intended to reveal the factors affecting the successful implementation of TPM in UK small-to-medium size enterprises (SME). Davis [22] has epitomized a range of reasons for the failure of TPM within UK manufacturing organizations including lack of top management support and commitment, use of inexperienced consultants, failure to implement change on the shop floor, inadequate training and education for employees, lack of structured approach to support TPM initiatives and lack of employee involvement. According to Cooke [13], the failure of TPM implementation program is prominently due to the inability of management to holistically implement the TPM practices at the workplace. He also emphasize that considerable deviations have been observed between the official TPM policies and the actual practices deployed at workplace. McAdam and Duffner [23] have outlined that copious issues arise while trying to implement TPM in a union environment. Workers perceive that the TPM mainly strives to improve production efficiency, reduce labor, and increase employee workload. Some operators are not keen for additional responsibilities and are satisfied with the current situation. Furthermore, the skilled trades like maintenance technicians enjoy feeling indispensable and believe that the autonomous maintenance approach is posing a threat to their jobs

2. Success factors for TPM implementation: A review

Several generic success criteria for TPM implementation is presented in the TPM literature. For an organization to realize the true potential of TPM philosophy and ensure successful TPM implementation, the goals and objectives of TPM need to be integrated into its overall business strategy because TPM influences the whole organization, not just production. Lycke and Akersten [24] have recommended that cautious, thorough planning and preparation are indispensable for a successful company-wide TPM implementation and so is top management's belief and understanding in the philosophy. For TPM to be successful, the improvement processes need to be re- marked as availing not only to the organization but also to the employees [25]. Groote [26] suggests an approach to evaluate maintenance performance based on quality audit and quantifiable maintenance performance indicators. He proposes that the effectiveness of maintenance functions ought to be defined through relative economic and technical ratios, to allow the management to track the evolution of its performance and to make crucial decisions for improved maintenance management. Bohoris et al. [27] enunciates, significance of inducing a change in the management structure, managing synergy between production and maintenance functions, concentrating on continuous production system improvements, use of efficient computerized maintenance management system (CMMS) and gradual TPM implementation as a pilot project on a few machines at a prescribed time acts as catalysts for successful TPM implementation. A typical TPM development program should emphasize the need for top management's initiative in launching and implementing TPM, formulation of TPM policies, goals and concepts and its effective communication within the organization and frame a system for training and employee involvement [28]. Building of teams, inducing synergy, recognizing them and enabling them to display their efforts supports TPM's success [29]. Top management's support and commitment in fortifying a suitable environment for the introduction of TPM in conjunction with its planning and co-ordination is regarded as a key success factor. Hansson et al. [30] have emphasized upon effective management of organizational change in pursuance of an improved organization's performance for strategic survival in the competitive environment.

Blanchard [31] proposes a provision of suitable training to the employees at an early phase of TPM implementation in order to obtain shop floor's buy in. Hence, the whole of shop floor should receive a comprehensive suite of new skills, new knowledge and new abilities apropos to TPM even before the pilot implementation program embarks. Davis [22] strongly suggested to approach TPM realistically and to establish a practical and comprehensive training program for all employees. Furthermore, he propose to accept that the TPM program will take a long time to be diffused across the organization. Davis [22] stated

that the success factors for TPM implementation include refinement of maintenance systems and culture, and developing a network of TPM coordinators thereby promoting and supporting TPM activities. Developing impeccable performance measures, continuous monitoring of its progress and frequent publishing of the benefits in terms of financial gains caused by TPM fosters the success and sustainability of TPM implementation. The TPM methodology also accentuates the importance of conducting audits and benchmarking activities that cater cardinal measures for invigorating maintenance productivity to achieve world-class competitiveness [32]. Nevertheless, there has not been any reference to the challenges faced, lessons learnt and strategies for overcoming impediments to successful implementation of TPM from an industrial frame of reference. Along these lines, the present study assumes significance as it emphasize upon formulation of critical success factors to overcome the barriers to implement TPM in manufacturing organizations.

IV. CONCLUSION

TPM is not a quick solution. It necessitates a change in both the company's and employee's attitude, and their values, which takes time to bring about. Hence, it entails long-term planning. Rapid and organization wide benefits should not be stressed during the initial phases of implementation. Holistic TPM implementation can lead to the establishment of strategic proactive maintenance practices in the organization for avoiding future system and equipment related losses and marshal the organizations towards capability building for sustained competitiveness. TPM is not a radically new idea; it is simply the next step in the evolution of good maintenance practices. TPM is indispensable to sustain just-in-time operations. TPM facilitates immensely the organizations in improving the synergy between maintenance department and rest of the production functions, resulting in eliminating defects, improving manufacturing process reliability, improving overall equipment effectiveness, and reducing costs, thereby affecting sustainability efforts of the organization to meet cut-throat global Competition for business excellence. TPM has proved to be a means to supplement the concerted improvement efforts by addressing equipment and other related problems that adversely affect the performance of the manufacturing system. Thus, in a highly competitive scenario, TPM can prove to be the best proactive strategic initiative that can lead organizations to scale new levels of achievements and could really make the difference between success and failure of organizations .The research has critically evaluated various barriers and challenges that influence the successful implementation of TPM in manufacturing industries.

REFERENCES

[1] I.P.S. Ahuja, J.S. Khamba and R. Choudhary, Improved organizational behavior through strategic total productive maintenance implementation, (Proc. International Mechanical Engineering Congress and Exposition (IMECE), November. 2006.), 1-8,

[2] R. Basu, Six Sigma to fit Sigma,(IIE Solutions, vol. 33, no. 7, , 2001) , 28 -33.

[3] M. George, Lean Six Sigma: Combining Six Sigma Quality with Lean Speed,(New York ,McGraw-Hill, 2002).

[4] M. Kumar, J. Antony, R.K. Singh, M.K. Tiwari and D. Perry, Implementing the Lean Sigma framework in an Indian SME: A case study, 17(4) (Production Planning and Control, 2006),407-23.

[5] J. Riis, J. Luxhoj andU. Thorsteinsson, A situational maintenance model, International Journal of Quality & Reliability Management, vol. 14(4), 1997, 349-366,.

[6] C.N. Madu, Competing through maintenance strategies, International Journal of Quality & Reliability Management, vol. 17(9), 2000, 937-949,

[7] M. Hammer and J. Champy, Reengineering the Organization,(New York: Harper Business , 1993).

[8] S. Nakajima, Introduction to Total Productive Maintenance (TPM),(Portland :Productivity Press, 1988).

[9] R. Moore, Combining TPM and reliability-focused maintenance, Plant Engineering, 51(6),1997, 88-90.

[10] Nakajima S , Introduction to TPM(Cambridge :Productivity Press In,1988).

[11] Rodrigues M and Hatakeyama K, Analysis of the fall of TPM in companies (J of Mate Process Techno,2006), 276–279.

[12] Gregory, A Number cruncher – overall equipment effectiveness and total productive maintenance,59(7)(Work Manage, ,2006), 18–20.

[13] F.L. Cooke, Implementing TPM in plant maintenance: some organizational barriers, International Journal of Quality & Reliability Management, 17(9), 2000, 1003 -1016.

[14] I.P.S. Ahuja and J.S. Khamba, Strategies and Success Factors for Overcoming Challenges in TPM Implementation in Indian Manufacturing Industry, Journal of Quality in Maintenance Engineering, 14, 2008, 123-147.

[15] R. Bakerjan, Tool and Manufacturing Engineers' Handbook, 7(4)(ASME: Fairfield, 1994).

[16] K.M. Crawford, J.H. Jr Blackstone and J.F. Cox, A study of JIT implementation and operating problems, International Journal of Production Research, 26(9), 1988,1561 -1568.
[17] J.W. Patterson, W.J. Kennedy and L.D. Fredendall, Total productive maintenance is not for this company, Production and Inventory Management Journal, 36(2), 1995, 61-64.
[18] J.J. Lawrence, Use mathematical modeling to give your TPM I implementation effort an extra boost, Journal of Quality in Maintenance Engineering,5(1), 1999, 62-69.
[19] B.N. Maggard and D.M. Rhyne, Total productive maintenance: a timely integration of production and maintenance, Production and Inventory Management Journal, 33(4), 1992, 6-10.
[20] F. Ireland and B.G. Dale, A study of total productive maintenance implementation, Journal of Quality in Maintenance Engineering , 7(3), 2001, 183-192.
[21] C.J. Bamber, J.M. Sharp and M. Hides, Factors affecting successful implementation of total productive maintenance: a UK manufacturing case study perspective, Journal of Quality in Maintenance Engineering, 5(3), 1999, 162-181.
[22] R. Davis, Productivity Improvements through TPM (Englewood Cliffs: Prentice-Hall, 1995).
[23] R. McAdam and A.M. Duffner, Implementation of total productive maintenance in support of an established total quality programme,7(6)(Total Quality Management, 1996), 613-630.
[24] L. Lycke and P.A. Akersten, Experiences of implementing TPM in Swedish industries, International Journal of Reliability and Application , 1(1), 2000, 1-14.
[25] C.J. Robinson and A.P. Ginder, The North American Experience (Portland: Productivity Press, 1995).
[26] P.D. Groote, Maintenance performance analysis: a practical approach , Journal of Quality in Maintenance Engineering , 1 (2), 1995, 4-24.
[27] G.A. Bohoris, C. Vamvalis, W. Tracey and K. Ignatiadou, TPM implementation in Land-Rover with assistance of a CMMS, Journal of Quality in Maintenance Engineering, 1(4),1995, 3-16.
[28] L.D. Fredendall, J.W. Patterson, W.J. Kennedy and T. Griffin, Maintenance modelling, its strategic impact, Journal of Managerial Issues , 9(4), 1997, 440-453.
[29] D. Hutchins, Introducing TPM, 77(1)(Manufacturing Engineer, 1998) ,34-37.
[30] J. Hansson, F. Backlund and L. Lycke, Managing commitment: increasing the odds for successful implementation of TQM, TPM or RCM, International Journal of Quality & Reliability Management , 20(9), 2003, 993-1008.
[31] B.S. Blanchard, An Advance Approach for Implementing TPM in Manufacturing Environment, Journal of Quality in Maintenance Engineering, 5, 1997, 162-181.
[32] M. Ben-Daya and S.O. Duffuaa, Maintenance and Quality: The Missing Link, Journal of Quality in Maintenance Engineering,1,1995, 20-26.