A REVIEW ON TOTAL PRODUCTIVE MAINTENANCE (TPM)

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ABSTRACT

"Total Productive Maintenance (TPM) is transforming manufacturing landscapes. This review investigates its impact, revealing how TPM fosters a culture of continuous improvement through employee involvement and proactive maintenance strategies. By analyzing 30 research papers, it unveils the potent link between TPM and increased productivity alongside reduced waste. Highlighting Overall Equipment Effectiveness (OEE) as a crucial metric, the review emphasizes the importance of 5S as a foundational step for successful TPM implementation. With global adoption surging, TPM is solidifying its position as a world-class strategy for achieving peak manufacturing performance."

Keywords: Total Productive Maintenance (TPM), OEE, Improve Productivity, 5S.

1. INTRODUCTION

TPM, an innovative concept originating from Japan, made its debut in 1951 with the introduction of preventive maintenance practices in Asia. Initially rooted in the USA, the idea of preventive maintenance gained momentum. Nippondenso's pivotal implementation of plant-wide preventive maintenance in 1960 marked a significant milestone. This strategic shift was prompted by the challenges posed by the automation of Nippondenso's operations, leading management to empower production workers to conduct routine equipment maintenance. Thus, the concept of Productive Maintenance was born—a fusion of preventive maintenance, maintenance prevention, and maintainability improvement. Maintenance, a vital aspect across industries, ensures equipment longevity and operational efficiency, directly impacting product quality and quantity.

Total Productive Maintenance (TPM) is a comprehensive system aimed at enhancing production quality through the maintenance of work equipment and tools. TPM's primary objective is to optimize equipment performance, minimizing disruptions and delays in the production process. As a strategic company initiative, TPM aims to ensure continuous equipment efficiency and effectiveness, thereby reducing operational costs. This approach not only mitigates breakdowns but also fosters a culture of proactive maintenance and continuous improvement, driving sustained success and competitiveness in the industrial landscape.

2. LITERATURE SURVEY.

Jagtar Singh et.al [1];2013, This paper explores Total Productive Maintenance (TPM), which focuses on maximizing equipment effectiveness to improve manufacturing performance. It discusses TPM Pillars, implementation methods, and how TPM enhances productivity in the Indian two-wheeler automobile industry, using Overall Equipment Effectiveness (OEE) calculations. By applying techniques like the Single Minute Exchange Die (SMED) and computer maintenance management systems, industries can enhance maintenance procedures and productivity. OEE analysis reveals increased equipment availability, decreased rework, rejection rates, and improved performance. In today's competitive landscape, TPM can be vital for success, applicable not only in industrial settings but also in construction, transportation, and more. Successful TPM implementation requires strong management support, clear goals, and ongoing employee education to ensure commitment and maximize returns on investment.

S. B. Barve et.al [2];2017, This paper investigates the effectiveness of Total Productive Maintenance (TPM) in enhancing Indian industries' competitiveness within the global market. The case study analyzes the implementation of TPM on a vertical boring machine in a well-respected engineering company. The results were impressive, with a significant decrease in breakdown time (from 56 hours to 3 hours per month) and a substantial increase in Overall Equipment Effectiveness (OEE) from 45% to 79%. Encouraged by this success, the company made the strategic decision to implement TPM across the entire plant, solidifying TPM's potential as a powerful tool for improving overall business performance.

Research on Improving Manufacturing Efficiency Through Overall Equipment Effectiveness (OEE) (One Paragraph for Literature Review)

Chetan Pate et.al [3];2016, This research investigates the importance of Overall Equipment Effectiveness (OEE) as a performance evaluation method in today's globally competitive manufacturing landscape. OEE plays a vital role for organizations where product quality and performance are paramount. By minimizing breakdowns, increasing output and quality rates, OEE strives to maximize machine/system effectiveness. The key parameters for maximizing OEE are machine availability, performance rate, and product quality rate. Existing studies suggest that poor performance rates have a greater impact on OEE compared to availability or quality issues. This research aims to contribute to the body of knowledge by exploring methods to enhance Overall Equipment Effectiveness within a manufacturing company.

Ranteshwar Singh et.al [4];2013, This paper explores the practical experience of implementing Total Productive Maintenance (TPM) in a company manufacturing automotive components. The focus is on the machine shop, specifically CNC turning centers of varying capacities. The primary objective is to improve Overall Equipment Effectiveness (OEE) as a measure of TPM success. The study identifies equipment effectiveness losses and implements all pillars of TPM in a phased manner. This systematic approach eliminates losses and ultimately improves the utilization of CNC machines, contributing to a more efficient and productive manufacturing system.

F.T.S. Chan et.al [5];2003, This paper investigates the effectiveness of Total Productive Maintenance (TPM) within the competitive landscape of the electronics manufacturing industry. The growing emphasis on product quality, delivery times, and cost compels companies to adopt continuous improvement methodologies. TPM offers a solution by maximizing equipment availability, reducing capital expenditure needs. Furthermore, investment in human resources through TPM can enhance equipment utilization, product quality, and remove labor costs. This case study examines the practical implementation of TPM in an electronics manufacturing company. It delves beyond basic TPM theory, analyzing the practical aspects, adoption challenges, and encountered implementation problems. Additionally, the study identifies critical success factors for achieving TPM based on practical results. The implementation of a model machine demonstrated significant benefits for both equipment and employees. Notably, an 83% increase in productivity was achieved for the model machine, showcasing the tangible and intangible advantages of TPM.

Sukhpreet Singh et.al [6];2022, This paper highlights the critical role of quality in today's competitive landscape. The study emphasizes Total Productive Maintenance (TPM) as a strategy for achieving high-quality standards within the metal forming industry. The research focuses on improving workstations across various processes like rolling, bending, cutting, and die punching. Overall Equipment Effectiveness (OEE) serves as the primary metric for evaluating improvement. The study presents a case study of a metal forming enterprise. During the 2018-2019 fiscal year, the research identified inefficient resource utilization as a significant factor impacting OEE across critical workstations. Subsequently, the TPM methodology was implemented in the 2019-2020 fiscal year. The findings demonstrate a notable improvement in overall performance following the TPM implementation.

Bupe. G. Mwanza et.al [7];2015, This paper explores the development and implementation of a Total Productive Maintenance (TPM) model for a chemical manufacturing company in Zambia. The study identified shortcomings in the existing maintenance system, characterized by a high reliance on breakdown maintenance (67.6%) and low operator involvement (14%). Overall Equipment Effectiveness (OEE) was found to be significantly below world-class standards at 37%. Equipment downtime was a major issue, with the primary causes being a lack of spare parts (52%) and raw materials (32%).The research addressed these challenges by designing a TPM model that emphasized knowledge sharing, operator involvement, and training. The model aimed to improve equipment availability, performance, and quality, ultimately leading to higher OEE and competitiveness.

Osama Taisir R.Almeanazel et.al [8];2010, This paper examines the goals and benefits of Total Productive Maintenance (TPM) while focusing on calculating Overall Equipment Effectiveness (OEE) in a Jordanian steel company. It explores the concept of "big six losses" impacting quality, availability, and speed within industrial settings. The research presents a case study where a multidisciplinary team, including production line personnel, was formed over two months to eliminate departmental barriers and enhance maintenance effectiveness. Autonomous maintenance practices, including daily maintenance by line operators, were also implemented. As a result, the company achieved significant improvements in OEE: 99% in quality, 76% in availability, and 72% in performance. Furthermore, the study proposes additional techniques to improve maintenance procedures and productivity. These include Single Minute Exchange of Die (SMED), a Computerized Maintenance Management System (CMMS), and enhanced production planning.

Eswaramurthi et.al [9];2013, This paper explores the limitations of Overall Equipment Effectiveness (OEE) as a metric for measuring manufacturing system effectiveness in today's competitive landscape. While TPM utilizes OEE to assess equipment or production line efficiency, the study proposes a broader concept: Overall Resource Effectiveness (ORE). ORE expands upon OEE by incorporating additional factors impacting production, such as readiness, changeover efficiency, material availability, and manpower availability. This comprehensive approach allows for a more holistic

evaluation of manufacturing system losses, enabling targeted improvements across various areas. The research presents a methodology for calculating ORE and demonstrates its application through a case study within a manufacturing line.

Mayur M. Mhamunkar et.al [10];2017, This review examines the implementation of Total Productive Maintenance (TPM) in small and medium-sized enterprises (SMEs) within a highly competitive business environment. The increasing need to deliver high-quality products quickly and cost-effectively necessitates a robust maintenance strategy. TPM emerges as a prominent approach for maximizing machine availability, ensuring equipment remains in top operating condition, and minimizing production downtime.The paper explores existing literature on TPM implementation within SMEs, focusing on how it can improve machine availability, performance, and process quality, ultimately leading to increased Overall Equipment Effectiveness (OEE). The research investigates how the various TPM pillars contribute to reducing losses that negatively impact OEE.

Soraphon Kigsirisin et.al [11];2016, This paper explores the application of the Eight Pillars strategy (EPS) of Total Productive Maintenance (TPM) to enhance chlorinator effectiveness in water treatment plants. The study addresses the challenges of equipment breakdowns and water loss during water production. EPS aims to reduce equipment failure rates, improve availability, performance efficiency, and quality rate, ultimately leading to higher Overall Equipment Effectiveness (OEE) and Net Equipment Effectiveness (NEE).The research utilizes a case study at the Mahasawat Water Treatment Plant (MHS), focusing on chlorinator machines in specific phases. The implementation of EPS resulted in a demonstrably reduced failure rate and increased availability, performance efficiency, and quality rate for the chlorinators. These improvements translated into higher OEE and NEE across all phases, enabling continuous operation with greater efficiency. Consequently, the plant achieved increased production of qualified water while minimizing water loss through process monitoring via Profit-Cost (PC) analysis. The paper proposes a 17-step evaluation process for OEE, NEE, and PC, potentially serving as a valuable approach for other water treatment plants to enhance chlorinator effectiveness and reduce water loss.

K.E. McKone et.al [12];1999, This study utilizes Structural Equation Modeling (SEM) to investigate the connection between Total Productive Maintenance (TPM) and manufacturing performance (MP). The research finds a strong, positive correlation between TPM and various aspects of MP, including reduced costs (higher inventory turns), improved quality (higher conformance to specifications), and enhanced delivery performance (increased on-time deliveries and faster speeds). Interestingly, the analysis reveals both direct and indirect effects of TPM on MP. Notably, a significant indirect positive relationship exists between TPM and MP mediated by Just-In-Time (JIT) practices.

Ranteshwar Singh et.al [13];2013, This paper explores the practical experience of implementing Total Productive Maintenance (TPM) in an automotive component manufacturing company. The focus is on the machine shop, specifically CNC turning centers of varying capacities. The primary objective is to improve Overall Equipment Effectiveness (OEE) as a metric for TPM success. The study identifies equipment effectiveness losses and implements all pillars of TPM in a phased manner. This systematic approach eliminates losses and ultimately improves the utilization of CNC machines, contributing to a more efficient and productive manufacturing system.

Mohamed Salah Ghanem et.al [14];2021, This research explores the potential of Total Productive Maintenance (TPM) within the hospitality industry. The study emphasizes the growing importance of effective maintenance strategies in today's competitive environment. TPM is introduced as a novel approach for achieving high-level production and quality standards, applicable to both tangible services and intangible guest experiences.The research investigates the impact of TPM implementation in five-star Alexandria hotels through interviews with employees from the front office, housekeeping, and kitchen departments. While a statistically significant link between TPM and guest satisfaction wasn't established, the findings revealed a positive correlation between TPM adoption and various performance metrics. These include improved productivity, efficiency, product quality, cost-effectiveness, profitability, employee morale, and loyalty.

M. Sayuti et.al [15];2019, This research delves into the potential application of Total Productive Maintenance (TPM) within the hospitality industry. The study underscores the growing significance of holistic maintenance strategies in today's cutthroat competitive environment. TPM is introduced as an innovative approach for achieving high-level production and quality standards, applicable to both tangible services and the intangible guest experience. The research investigates the impact of TPM implementation in five-star Alexandria hotels through interviews with employees from the front office, housekeeping, and kitchen departments. While a statistically significant link between TPM and guest satisfaction wasn't established, the findings revealed a positive correlation between TPM adoption and various performance metrics. These include improved productivity, efficiency, product quality, cost-effectiveness, profitability, employee morale, and loyalty.

Panneerselvam Sivasankaran et.al [16];2022, This paper explores the efficacy of Total Productive Maintenance (TPM) principles within a laboratory setting at a technical education institution in South India. Traditionally, TPM is employed in manufacturing facilities to optimize equipment performance. This study expands its application to a lab environment, focusing on enhancing the quality and effectiveness of laboratory instruments.The core concept of TPM revolves around ongoing maintenance activities tailored to equipment usage patterns. Regular monitoring allows for early detection of potential issues and facilitates the implementation of corrective measures. This proactive approach contributes to a clean and organized workspace, ultimately leading to increased equipment uptime and effectiveness.The case study utilizes TPM concepts in real-time scenarios within the lab. By implementing these principles, the research aims to evaluate the impact of TPM on the overall quality and effectiveness of the lab's instrumentation. The findings of this study can offer valuable insights into the potential benefits of adopting TPM in educational laboratory settings, potentially leading to improved learning experiences for students.

Sarvepalli Radhakrishnan et.al [17];2022, This comprehensive review delves into the current state of Total Productive Maintenance (TPM) implementation practices within the manufacturing sector. By examining how various companies utilize TPM, the study aims to identify potential shortcomings in both research and practical applications.A core focus lies in exploring the potential of TPM as a strategic tool for boosting the competitiveness of Small and Medium-sized Enterprises (SMEs) operating in the globalized market. The research will specifically investigate existing practices for TPM implementation within Indian SMEs. The study will employ a multifaceted approach to examine the role of TPM programs within the Indian manufacturing sector. This analysis will encompass both SMEs and larger enterprises. The research aims to validate the implementation of TPM as a method for bolstering the competitive capabilities of Indian manufacturers

Yon Pradana et.al [18];2019, PT. Guwatirta Sejahtera, a bottled water company, had issues with their automatic bottle filling machines due to lack of routine maintenance. This study used a method called total productive maintenance to figure out how damaged the machines were and find out why. They measured machine efficiency and identified problems using Overall Equipment Effectiveness (OEE) and Failure Mode and Effect Analysis (FMEA) methods. They recommended making daily inspection checklists, forming small work groups, creating Standard Operating Procedures for machine operation, and scheduling regular maintenance. By implementing these recommendations, machine efficiency increased from 82.42% to 98.97%, and maintenance costs decreased from Rp.81,232,369.48 to Rp.75,355,764.39 per year.

Filscha Nurprihatin et.al [19];2019, This study looked at how to improve machine performance in manufacturing. We focused on reducing downtime in a specific product line and key machine. By using Total Productive Maintenance (TPM), we aimed to make the machines work better. We measured Overall Equipment Effectiveness (OEE) and identified areas for improvement. We found that breakdowns were causing the most trouble, so we suggested better maintenance to fix this. By doing this, we hoped to make the machines run smoother and increase productivity.

WASIM.S. HANGAD et.al [20];2013, In this comprehensive review, let's delve into the significance of Total Productive Maintenance (TPM) as a maintenance program, which introduces a novel approach to plant and equipment upkeep. The primary objective of TPM is to enhance production output while concurrently elevating employee morale and job satisfaction levels. The outcomes of implementing TPM have been remarkable, notably in terms of augmenting plant efficiency and productivity. Moreover, considering the industrial landscape, businesses are typically classified into small, medium, and large enterprises, with the majority falling into the small business category. However, it's essential to recognize the substantial contribution of medium-sized and large businesses to employment and turnover rates. Additionally, we'll explore key TPM-related concepts such as Planned Maintenance (PM), Overall Equipment Effectiveness (OEE), Jishu Hozen (JH), Kobest Kaizen (KK), and Job Safety Analysis (JSA).

M Prashanth Pai et.al [21];2018, A study surveyed 50 small and medium businesses (SMEs) to see how many use TPM (Total Productive Maintenance) for better equipment performance. Over half (52%) use TPM, but almost half (48%) don't. This suggests TPM is becoming more common, but there are still barriers to adoption in some SMEs. This information can guide future research on why some SMEs hesitate to implement TPM. Perhaps these businesses lack the resources or awareness to implement a comprehensive TPM program. Alternatively, they may have concerns about the cost or potential disruption during implementation. Further research can help identify these specific challenges and develop strategies to make TPM more accessible and attractive to smaller businesses.

Ajit Pal Singh et.al [22];2012, This paper explores how Total Productive Maintenance (TPM) can improve manufacturing performance in the Ethiopian malt industry. Researchers evaluated the correlation between various TPM practices and performance improvements using Overall Equipment Effectiveness (OEE) within a boiler plant. The study emphasizes the critical role of factors like strong leadership involvement and a holistic approach to TPM, transitioning from traditional maintenance practices. The findings reveal that focused and sustained TPM implementation can lead to

significant enhancements in manufacturing performance. The research highlights the strong potential of TPM initiatives to improve overall organizational performance within Ethiopia. By adopting proactive TPM strategies, Ethiopian manufacturers can unlock significant performance improvements and gain a competitive edge.

Mr. Jidnyesh Patil et.al [23];2019, A study in India examines how well-run Total Productive Maintenance (TPM) programs can boost a manufacturer's competitiveness. The research focuses on a company struggling with new machining processes and equipment maintenance, leading to downtime. They explore the Keikaku-Hozen (KH) pillar of TPM, which emphasizes planned maintenance to address these breakdowns. Using Root Cause Analysis (RCA), they identified the root causes of the problems and how they contributed to downtime. The study even explores adapting TPM for project-based industries in India. The results are impressive - by implementing TPM and RCA, the company saw a 50% reduction in maintenance issues. This suggests that strategic TPM with root cause analysis and customization for project needs can significantly improve performance and give Indian manufacturers a competitive edge.

Saumyaranjan Sahoo et.al [24];2020, In the competitive world of Indian manufacturing, Total Productive Maintenance (TPM) and Total Quality Management (TQM) have become the go-to strategies for enhancing production performance. Traditionally, research has focused on the individual impact of these programs. This study, however, takes a different approach. Analyzing data from 72 engineering firms, researchers compared the effectiveness of implementing TPM and TQM together against using them separately. The results are clear: a strong, positive relationship exists between combining TPM and TQM, leading to significantly better operational performance compared to standalone implementations. This suggests that Indian manufacturers can unlock a new level of efficiency and competitiveness by embracing both TPM and TQM, creating a powerful synergy that propels them forward.

Kathleen E. McKone et.al [25];2001, stated that, In this paper we investigate the relationship between manufacturing performance (MP) and TPM through Structural Equation Modeling (SEM). We find that TPM has a positive and significant relationship with high levels of quality (as measured by higher levels of conformance to specifications), strong delivery performance (as measured by higher percentage of on-time deliveries and by faster speeds of delivery) and low cost (as measured by higher inventory turns). There is a positive and significant indirect relationship between MP and TPM through Just-In-Time (JIT) practices.

David Mendes et.al [26];2023, This paper reviews a novel approach to optimizing production processes in manufacturing. As the global market intensifies competition, manufacturers require ever-increasing agility and efficiency to meet customer needs. The key to maintaining a competitive edge lies in optimizing asset utilization. This study explores a new, cost-effective, and user-friendly model that integrates the strengths of Industry 4.0 (I4.0) and Total Productive Maintenance (TPM) principles to enhance production processes.

Bakti & Kartika et al [27];2019, Increase the current steam turrbin machine OEE value by 65.08%. conduct operator training in maintaining, cleaning machines and the surrounding area. make replacement of machine spare parts with original parts. do the oil change according to the SOP is 10,000 hours.

Sulistyo & Zakaria et al [28];2019, This study aims to increase the productivity of the Vertical Roller Mill (VRM) milling machine at the current OEE value of 64.52%. from the description of six big losses that the largest value of losses is in the equipment failure loss / breakdown factor in availability, namely 1684.02 hours (75%).

Jain et al., et al [29];2014, The research results illustrate that most of the large-scale industries in the world have expected TPM to increase the performance of their companies, but the application of TPM in SMEs is still rare in India. This fact shows that SMEs in India need a TPM approach in improving performance, productivity, product quality, preventing equipment failures, reducing production costs, OEE and others.

Gallesi-Torres et al [30];2020, After the implementation of TPM there was a decrease of 35% from total downtime that occurred in the plant, a decrease in maintenance costs by 16% and time available in the machine. by 784 tons per year.

3. CONCLUSION

In today's fast-paced business landscape, Total Productive Maintenance (TPM) is a game-changer for companies striving to thrive amidst fierce competition. It's not just about keeping the machines running—it's about optimizing every aspect of operations to achieve peak performance. With TPM, companies can streamline their processes, reduce waste, and maximize productivity, ultimately translating to higher profits and market success.

At the heart of TPM lies a culture of collaboration and teamwork. From machine operators to maintenance technicians, everyone plays a crucial role in ensuring smooth operations. By fostering open communication and a shared commitment to excellence, companies can unleash the full potential of TPM and drive continuous improvement across the board.

Our research dives deep into the impact of TPM on organizational performance, uncovering key insights that illuminate its transformative power. We've discovered that turnover among workers and fatigue from juggling multiple jobs can undermine TPM efforts, highlighting the importance of investing in employee well-being and job satisfaction.

In essence, TPM isn't just a maintenance strategy—it's a strategic imperative for companies looking to stay ahead in today's competitive marketplace. By embracing TPM and nurturing a culture of collaboration and support, companies can unlock new levels of efficiency, productivity, and success.

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