

Impact of TPM Implementation: Literature Review and Direction

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Abstract

The purport of this paper is to review the literature on impact of Total Productive Maintenance (TPM). The paper explicates the tangible and the intangible benefits achieved as a result of TPM implementation. In the end some concluding observations and directions for future research are stated. The review was done by studying the Total Productive Maintenance papers and identifying the tangible and intangible benefits of Total Productive Maintenance. This literature highlights the Total Productive Maintenance involvement in improving the Overall Equipment Effectiveness as well as employee's morale.

Keywords: Total productive maintenance; Objective of TPM; Tangible benefits; Intangible benefits

1. Introduction

At present the intent of the manufacturing industries is to increase the productivity and quality. With the development of faster means of communication, better quality computers and rapid transportation systems, manufacturing is no longer restricted at local level, but has become global in character. A manufacturing company has to become competitive for its survival. Confronting these challenges, companies world-wide are forced to find ways to reduce costs, improve quality, and meet the ever-changing needs of their customers. One successful solution has been the adoption innovative techniques like TPM [12].

TPM (Total Productive Maintenance) is approach for equipment maintenance that endeavors perfect production by reducing the rejection, proper maintenance and availability of equipment and focusing toward no defect. In addition it values a safe working environment with zero accidents. It can be

considered as treatment to improve the performance of machines. It emphasizes proactive and preventative maintenance to maximize the operational efficiency of equipment.

Total productive maintenance is practical technique aimed at maximizing the effectiveness of facility that we use within our organization .It establishes a system of productive maintenance, covering the entire life cycle of equipment, covers all department, involves participation of all employees from top to bottom and promotes small group autonomous activities [5].

TQM is an approach to improving the competitiveness, effectiveness and flexibility of an organization for the benefit of all stakeholders. It is a way of planning, organizing and understanding each activity, and of removing all the wasted effort that is routinely spent in organizations [21].

TPM is a highly structured approach, which uses a number of tools and techniques to achieve highly effective plants and machinery. A well conceived TPM implementation program not only improve the equipment efficiency and effectiveness but also brings appreciable improvements in other areas of the manufacturing enterprise. It is one of the innovative approaches to maintenance that Optimizes equipment effectiveness eliminates breakdowns and promotes autonomous maintenance by operators through day-to-day activities involving total workforce [10]. TPM with safety standards and points in their activities, the organization will achieve development and improvement in production and safety [11].

TPM is not merely a concept but a practical and down-to-the-earth technique for achieving significant savings and increase in profits [22]. TPM can be implemented at any department in the organization like administration, purchase, stores, marketing etc [49]. The word TOTAL in TPM includes three basic concepts in accordance with three specifications of TPM [11].

- **Total Effectiveness**
Financial efficiency improvement and development
- **Total Prevention**
Designing repair need-less equipments and comprehensive preventive maintenance as well
- **Total Cooperation and Collaboration**
Self-oriented and independent maintenance by the production operators in small groups in each of the industry departments and by other personnel as well.

Under TPM, machine operators carry out routine maintenance such as checking water, oil, coolant, and air levels. This may involve some training of machine operators. Through operator training to do simple maintenance on machines will promote ownership and more attention to detail. The actual maintenance teams should as a result of spending less time doing routine maintenance is in a position to concentrate on more urgent machine breakdowns [2].

The ultimate goals of TPM are zero equipment breakdowns and zero product defects. The other important goal is the total elimination of all six major losses, including breakdowns, equipment setup and adjustment losses, idling and minor stoppages, reduced speed, defects and rework, spills and process upset conditions, and startup and yield losses.

1.2 Objective of TPM

- Maintain an accident free environment.
- Increasing the operator involvement.
- Maximizing the Reliability of machine
- Improving the Quality and Reduce cost.
- Focus on Maintainability engineering.
- Improving problem solving by team
- Upgrading each operator.
- Motivating the operator
- Increasing the OEE.

TPM initially seems to be expensive activity, but after proper implementation, expenditure is justified by the gain in output and efficiency [17]. It is widely

accepted that TQM takes a long time to implement as it requires major organizational changes in culture and employee mindset. To get the benefits from TQM, one must be patient. It improves performance in the long-haul [21].

The TPM benefits can be characterized as tangible and intangible benefits.

2. Impact and evaluation of TPM

Evaluation of TPM involves in assessing objectives set before the implementation by the organization. The evaluation consists of both tangible and intangible benefits. Tangible benefits, intangible benefits flowing from implementation of TPM were studied from various journals and detailed.

2.1 Tangible benefits

The review of various journals shows that the implementation of TPM results in Tangible benefits in the different aspects, such as productivity, minor stoppages, breakdowns, accidents, water and steam-consumption, lubricant consumption, defect rate, labour productivity, overall equipment effectiveness.

Application of TPM methods of machine production is the most effective step to the factory because this approach reduces production defects and damages the machine. This method can also achieve the objectives of each month to increase production by preventing the transmission delay caused by machine failure and it can improve the efficiency of production machines in the factory to increase production, productivity, save costs and promote company's image in the eyes of the world [15].

In Small Scale Polymer Industry OEE value was only 75% approximately, after TPM implementation it is improved to 83%. A better quality rate was achieved as a result of implementing TPM. [16].

In Steam Power Plant for first three months the efficiency of Boiler was approximately equal to 82 %. After the implementation of TPM, 1 % rise in efficiency of boiler is registered. Similarly efficiency of Turbine is also increased by 0.8 % after the implementation of TPM [17].

Upon successful implementation of TPM, profitability of the company is increased by 12 % as breakdown and maintenance costs plummeted by 80% and 20 % respectively. There three aspects of TPM, namely production volume, OEE and labour efficiency is increased by 26%, 21% and 40 %

respectively and product defects went down by 74. On top of all these lies the issue of safety which improves excellently with the implementation of TPM in the plant as accidents drastically reduced by 90%. And the company gains \$249,550 in terms of enhancement of OEE [20].

The implementation of TPM leads to more equipment effectiveness in the company thereby the quality and profit is also improved. The results shown above can be much more improved and may reach a world class OEE value (85%) by continuing with TPM [19].

In a TPM awarded company increase in speed or performance of the equipment increases the performance of the company [64]. After the implementation of TPM 87.84% of availability, 75.75% of performance efficiency and 98% rate of quality are noted this results in the increase of OEE to 65% and also if the company reaches the world-class target of 85% OEE then the 20% increase of OEE would represent an earning capacity of Rupees 3000000 per year [25].

Increase in work efficiency (by 150 %), breakdown reduction (drop by 90% or even 99 %), drop in the number of accidents at work (62888 persons injured in accidents at work in industry in 1995, 42871 persons in 2006, drop by 20017 persons), reduction of internal waste (by 90 %), improvement of work quality and reduction of complaints (by 75 %), reduction of production costs by 30 %, reduction of materials kept on-stock by 50 %, drop or lack of environment-related breakdowns, increase in the number of proposals for new organizational solutions, development of workers initiative in search of innovation are noted after the successful implementation of TPM [26].

The results TPM in long term leads to decrease the price and increase the quality of output that can be the key factor to keep up the organization with competitors. Additionally, this situation follows by improved customer satisfaction and then increasing the profit of organization, which salaries of workforces can be gone up and causes the higher job satisfaction level [27].

There is 83% improvement in equipment productivity improvement after TPM implementation. Also, the equipment stoppage rate is reduced from 517 to 89 times. This tremendous improvement enhanced the equipment in both effectiveness and quality in product produced [28].

Through TPM process focus, the cost and quality are improved significantly by reducing and minimizing equipment deterioration and failures. Cost of rework and repairs reduced due to very limited products rejected due to equipment failure. Thus, the overall effectiveness of equipment also improved significantly. Additionally, equipment deterioration is eliminated as the equipment operated efficiently [29].

As a result of TPM implementation, the Company achieved about 93% in average quality rate of overall equipment effectiveness equation and about 87% in availability in October 2012 where in average performance efficiency in October 2012 it achieved about 87.5 % [30].

Overall Equipment Effectiveness is improved from 63% to 79% indicating the improvement in productivity and improvement in quality of product [31].

The implementation of the TPM 9001:2008 model will not affect the ISO 9001:2008 standard-based QMS, but will bring the company benefits such as an increased OEE of the equipment, enhanced safety and health levels of the environment, and interruption-free production [32].

By implementing the TPM strategy an organization can eliminate most of the waste happened like the time waste while changeover or the downtime losses, with this maintenance strategy the responsibility of maintain the equipment is all operator and engineering responsibility, there will be no more "his or my" fault the break down will be solved as fast as possible [33].

Comparison of research in Sabarmati gas Distribution Company before and after implementing TPM shows, 80% of major problems are reduced with improved OEE by TPM based corrective action plan [9].

After the implementation of TPM OEE value is encouraging and with the passage of time results will be quite good and may reach a world class OEE value of 85%-90%. Additionally, equipment deterioration is eliminated as the equipment operated efficiently. Cost of rework and repairs is reduced since very limited products are rejected due to equipment failure [4].

Successful implementation TPM in "Manipal Packaging Solutions", improves the OEE for Printing Machine, Punching Machine, Gluer Machine and Lamination Machine [5].

TPM is capable of bringing a machine back to original condition and even better, successful TPM implementation can achieve better and lasting result as compared to other isolated program because there is an ultimate change in people (knowledge, skills, and behavior) during the progress [3].

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, and lower costs, reliable deliveries, motivating working environments, enhanced safety and improved morale of the employees [45].

TPM implementation program included OEE improvement: 14-45%, inventory reduction: 45-58%, improvement in plant output: 22-41%, reduction in customer rejections: 50-75%, reduction in accidents: 90-98%, reduction in maintenance cost: 18-45%, reduction in defects and rework: 65-80%, reduction in breakdowns: 65-78%, reduction in energy costs: 8-27%, increase in employee suggestions: 32-65% and total savings resulting from effective implementation of kaizen themes as a result of significantly enhanced participation across the organization: Rs. 80 million [43].

Maintenance programs have long been used as a means to control manufacturing costs. But TPM does more than control costs; it can improve dimensions of cost, quality, and delivery. TPM can be a strong contributor to the strength of the organization and has the ability to improve maintenance [36].

2.2 Intangible benefits

Intangible Benefits also known as "soft benefits"; gains that are nonmonetary or that cannot be sufficiently quantified for purposes of accounting or other financial reporting, but that contribute to increases in quality, performance, and profit. Examples of intangible benefits may include, e.g., improved employee morale, heightened customer satisfaction, better vendor relationships, etc.

Implementation of TPM in the paper manufacturing plant resulted in a number of intangible benefits. Some of the important ones are: developing an eye for identifying equipment related abnormalities, avoiding fire fighting approach, focusing on the root cause and eliminating the problems, being conscious of costs and losses, maintaining transparency of information, approaching with a more analytical tools

and improving infrastructure, teamwork by cross functional and TPM circles and an awareness about unsafe conditions in the plant [20].

TPM is a small group activity has imbibed the habit of better communication among the different departments at all levels, which has lead to increase in the team working spirit of the employees and healthy organizational environment. Implementation of TPM motivated the employees for maximum involvement in order to achieve the common organizations goal [23].

TPM Implementing approach in Spinning Industries leads to following development [2]

1. Employees confidence level increases.
2. A clean, neat and attractive work place.
3. Favorable change in the attitude of the operators

Implementing Approach of Total Productive Maintenance in Indian Industries marked some Indirect Benefits of TPM [1]

1. Higher confidence level among the employees.
2. Favorable change in the attitude of the operators.

Successful TPM implementation can achieve better and lasting result as compared to other isolated program because there is an ultimate change in people (knowledge, skills, and behavior) during the progress [3].

- Achieve goals by working as team.
- Horizontal deployment of a new concept in all areas of the organization.
- Share knowledge and experience.
- The workers get a feeling of owning the machine.

Autonomous maintenance activities were carried out with total employee participation. The investment in training and education managed to boost operator's morale and the commitment towards company's goals [4].

Growth of employee's involvement, new skills learned and creativity released. TPM program provides the first opportunity to actively engage in corporate life and feel ownership at a workplace [26].

Improvement in the performance of equipment also increases the involving the employees makes improved the job satisfaction or in other words outcome that leads to improvement in the employee moral [27].

The intangible benefits resulted from the change of organizational culture, change of paradigm for production people in realizing the importance of maintenance activities and the relationship between maintenance, productivity and quality. Em-powering the workforce caused a development of a bright, cheerful and relaxed workplace for production people. Growth of work habits, technical skill development and promotion of cross-functional team created an enthusiastic workforce to enhance the company in both competitive power and image [28]. The implementation of TPM in the paper manufacturing plant resulted in a number of intangible benefits. Some of the important ones are: developing an eye for identifying equipment related abnormalities, avoiding fire fighting approach, focusing on the root cause eliminating the problems, being conscious of costs and losses, maintaining transparency of information, approaching with a more analytical tools and improving infrastructure, teamwork by cross functional and TPM circles and an awareness about unsafe conditions in the plant [7].

TPM methodology not only increases the effectiveness of the gas distribution system but also increases the effectiveness of the entire organization through mandatory participation and continuously improves efficiency, cost, delivery, health, safety and morale of the employees [8].

Under TPM production workers become involved in performing maintenance work allowing them to play a role in equipment monitoring and upkeep. This raises the skill of production workers and allows them to be more-elective in maintaining equipment in good condition [13].

TPM initially seems to be expensive activity, but after proper implementation, expenditure is justified by the gain in output and efficiency. Training of workers on regular basis helps them to learn new skills and a positive inclination in their morale is registered [18].

TPM increases operator involvement and ownership of the process. It improves the problem-solving ideas and also upgrades the operator's skills [34].

TPM work cultivates a sense of ownership in the operator by introducing autonomous maintenance. Use cross-functional teams consisting of operators, maintainers, engineers and managers to improve individual employee performances [35].

Employees learn how to perform a variety of tasks/jobs. Employees receive training to perform multiple tasks. Employees are cross-trained so that they can fill in for others if necessary. Employee teams are encouraged to solve their problems on their own [36].

The ultimate goal of education and training for maintenance personnel and operators should be the development of capable human resources that can maintain equipment and control it with strict attention to detail, and can cope with changing work conditions with new products and/or new machines [37].

TPM can go beyond maintenance: excerpt from a case implementation" shows that Increases the skill and confidence of individuals [38].

TPM will keep up the morale of the team members, to encourage them to continue their hard work. Each person becomes a 'stakeholder' in the process and is encouraged to do his or her best to contribute to the success of the team effort [39].

Confidence level among employees gets improved after the TPM implementation. Keep the work place clean, neat and attractive. Favorable changes in the attitude of the operators. Achieve goals by working as team. Share knowledge and experience. The workers get a feeling of owning the machine [40].

Motivation is higher, because the responsibility and rights are delegated and the investment in the personnel is done, in the form of education. Better understanding of the performance of their equipment can be achieved by operator. Employees will feel better about where they work [41].

As a result of TPM implementation there is an improvement in team work between the operators and maintenance people. Increase in job satisfaction with the improved safety [42].

3. Conclusions

The literature spots the tangible and intangible benefits attained after TPM implementation. It is clearly noted that the tangible benefits such as availability performance efficiency and quality rate increases considerably on TPM implementation which impacts in the improvement of OEE. It also reaches the main goal of TPM program zero breakdowns and zero product defects. Comparably TPM implementation increases the employee morale and their confidence level. Clean and attractive work

place is maintained after the TPM implementation. The study clearly shows that the successful TPM implementation program can improve the manufacturing organization's performance by the spotted benefits.

4. Future development and expansion

So far as only the benefits were detailed on TPM implementation, the next step is to circularize the

various intangible benefits and their impact in the manufacturing sector. It is important to investigate the competency improvement on TPM implementation among the employees. For this purpose a survey methodology has been developed and aimed to measure the competencies of the employees.

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