

# Review on Enrolment of TPM using OEE as a Measure

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**Abstract :** This paper depicts a review on maximising the productivity of a machine and using OEE as a measure. The aim of this paper is to show how using TPM pillars and techniques can influence in the productivity of a machine or equipment reducing the downtime. This paper magnificently shows the applicability of TPM pillars in manufacturing industry. Availability, Performance and Quality rate of the machine can be increased with the help of TPM pillars. Such pillars include 5S, Autonomous Maintenance, Kobetsu-Kaizen, Planned Maintenance, Quality Maintenance, Safety Health & Environment, Education & Training and Office TPM.

**IndexTerms - Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE), Downtime, Jishu Hozen (JH), Root Cause Analysis (RCA), One Point Lesson (OPL).**

## I. INTRODUCTION

In today's ever growing competition in manufacturing industry, getting maximum productivity with minimal downtime can change the dynamics of any manufacturing company. Attaining the maximal productivity of any machine or equipment with the work force and time used daily can change the structure of any industry. To ensure that there should be minimal breakdowns, minor stops and free from quality defects. Acquiring superior quality and dispatching the products on time to a customer is the benchmark for many manufacturing industry. Taufik Djabatna et al. [1] depicted that how analysing the OEE in a manufacturing company has helped them getting maximum utilisation of machine. Dr Thuleswar Nath et al. [6] explained that how TPM was useful for inclination of OEE and reflecting on overcoming frequent breakdown. Dip Kumar Patel et al. [16] depicted that how using TPM productivity can be increased and how OEE is helpful in measuring it. Md Meraj Alam et al. [8] showed how implementing TPM in their boiler plant gave them significant enhancement in OEE which escalates in overall productivity. Jagtar Singh et al. [14] also exhibited in successfully enlarging OEE with the help of TPM pillars which gave them increase in availability of equipment, shrinkage of rework, refusal and enhancement of performance rate. Dr. Rajesh Buktar et al. [19] leveraged TPM to rise in availability, performance and quality rate which eventually helped in extension of productivity and OEE. Manu Dogra et al. [20] throws light on how TPM is a key to good communication between departments, developing in healthy working environment and resulting in inclination of OEE and depletion of cost and accidents.

## II. LITERATURE REVIEW OF INCREASING OEE USING TPM

There have been immense research and studies in increasing OEE. Those execution and improvising factors of TPM are perceived in literature review.

### 1) Method Study of Implementing TPM

J. Jegan et al. [7] explained why TPM was to be implanted and how OEE was increased with equipment available whenever required which led them to contributing in success with minimal downtime by implementing in following stages. 1) They implemented TPM so as to reduce breakdown, ideal time, setup time and quality defects. 2) Prepared the questionnaire in which questions were pictured in form of downtimes and OEE themes. 3) They collected the data of questionnaire which were asked to operators and executives. They also looked into the logbook calculations of OEE. 4) Then the data was pictured and analysed through charts, by the agreement of the questionnaire and logbook which helped them in calculating OEE. 5) Finally keeping in mind of availability, performance and quality rate OEE was found.

Dip Kumar Patel et al. [16] showed how executing TPM pillars can help in improving OEE in steps, which are 1) they kicked off with 5S implementation. 2) Accomplished seven steps of Jishu Hozen (JH). 3) Implemented Planned Maintenance pillar comprising of JH activities and One Point Lesson (OPL). 4) Pillar that they performed after step 3 was Kobetsu-Kaizen. 5) They also worked out on Quality, Safety and Office TPM. 6) Finally they analysed data in terms of availability, performance and quality rate to calculate OEE.

Amit Kumar Gupta et al. [5] showed how TPM execution in the industry helped them out in maintaining the high efficiency of those machines. Working out on pillars such as 5S, Autonomous Maintenance, Education and Training and Kobetsu-Kaizen increased the availability of those machines with reducing their further capital investments and inclination in OEE was seen from 58.7% which was before TPM enactment to 70% after implementation of TPM.

## 2) TPM Pillars and Techniques used

In this section, illustration of TPM pillars have been derived briefly and what all techniques that can be helpful in escalating overall productivity.

### 2.1) 5S

5S is the bedrock and it can be improved to strength out the foundation. Amit Kumar Gupta et al. [5] depicted when a work place is unorganised, problems cannot be seen clearly and it is the initial step towards improvement to make the place clean and well organised. Dip Kumar et al. [16] displayed implementation of 5S in success of productivity at the initial stage, showing the refinements and sustaining it. Ranteshwar Singh et al. [9] also showed that how they implemented 5S by making problems visible and seen to the people, which gave them the opportunity of improvement and if not done it can cause 5D i.e Defects, Delays, Dissatisfied customers, Declining profits and Demoralised employees.

### 2.2) Autonomous Maintenance (AM) / Jishu Hozen (JH)

P. Guariente et al. [13] demonstrated that using autonomous maintenance was a helping hand in inclination of OEE and declining of breakdowns and in search of ever increasing productivity and with less cost. The action were taken in seven steps, the steps are 1) Initial cleaning. 2) Elimination of dirt sources and area of difficult access. 3) Standardisation of cleaning and inspection. 4) General inspection of equipment. 5) Overall inspection of the process. 6) Systematic autonomous maintenance. 7) Autonomous management. Venkateswaran N [12] showed how cleaning and inspection time was reduced from 30 mins to 10.4 mins due to regular maintenance done. P. Guariente et al. [13] explained how seven steps of autonomous maintenance in an automotive component manufacturing helped in increasing of availability of their machines and equipment. This seven steps gave them the proposed goals and reduced the problems of breakdowns which also resulted in inclination of OEE by 8% in the monthly rate and 10% of machine availability during the same period of the time. Ranteshwar Singh et al. [9] gave the operators responsibility to upkeep their equipment on daily basis which resulted in prevention of deteriorating and eliminating the defects at source through active employee participation. This resulted in lesser work load during preventive maintenance.

Sarang G. Katkamwar [11] enacted 3 steps policy in JH activity which caused them less number of breakdowns. Steps that included were 1) They prepared abnormality sheet which consisted of frequent problems and also considered the nature which helped them in problem solving. 2) Using symbolic representation for the operation Cleaning, Lubrication, Retightening and Inspection and doing it regular time of interval gave them less breakdown. 3) They prepared OPL to help out operators to do the right thing in right manner which will eliminate the failure or minor stops at the machine.

### 2.3) Kobetsu-Kaizen

Kobetsu-Kaizen is another pillar that seeks in reducing downtime with continuous improvement. Pramod Kumar et al. [10] elucidated with enforcing Kaizen in which they achieved depletion of time and cost reduction upto 50-60%. They overcame the main problem which was excessive cycle time and poor quality. Dip Kumar Patel et al. [16] implemented Poka-Yoke, which is a mistake proofing technique where a tool board was setup according to the dimension which could easily be notified to the operators in taking the right tool in space of less time. Ranteshwar Singh et al. [9] also enforced Poka-Yoke technique and was helpful, which usually warned the operators or helper if they are putting spanners at wrong place. They also suppressed coolant leakage problem by drawing down the fish bone diagram as a corrective measure.

Manu Dogra et al. [20] launched a procedure of filling forms of topic registration and focused improvements consisting of kaizen to be filled by employees and submitting it to the chairperson of the committee. This led to focus in advancements in terms of profitability and involvement of employee to participate in improvement process. This strategy made a huge impact which led to inspire employees at all levels.

### 2.4) Quality Maintenance

Quality Maintenance is a pillar which is aimed for upbringing the best quality products to the customer which will be a satisfactory and trustworthy factor for the upcoming days. Ranteshwar Singh et al. [9] showed how through focused improvement, defects were eliminated from the process, which than led to transition from Quality Control to Quality Assurance. Condition of product was checked and to confirm that measured values are within limits they used time series to verify. Anil Badiger et al. [15] faced poor quality issues in threading which was damaging the final outcome. They applied TPM and than they compared the data of 15 days. They found out implementing TPM, 15% of production rate was improved and not only that there was a depletion of a machine and a labour.

### 2.5) Planned Maintenance (PM)

Planned Maintenance pillar enlarges on reliability and availability of machine. The final outcome of this leads to better quality and less number of frequent breakdowns. Dip Kumar Patel et al. [16] exhibited performance to achieve prevention of equipment failures/breakdown, consisted of 1) Support and guidance of JH activity, including key activities like putting red and green tags, proper knowledge of maintenance person, training operators and developing One Point Lessons (OPL). 2) Evaluated machine failure status and understood the situation by collecting data and which all equipments to be kept in PM which were causing production loss.

Dr. Thuleswar Nath et al [6] executed Root Cause Analysis (RCA), for findings of breakdown and further they added into PM schedule based on the findings of RCA. For RCA, WHY-WHY technique was being used with the help of machine operators and maintenance personnel. Sathish Kumar .N et al. [17] similarly used RCA to reduce the recurrence of failures and used WHY-WHY technique for RCA.

## 2.6) Safety Health and Environment

Safety is the major concern for any industry in this world. Doing the work in a healthy environment can give better performance and due to good health employment attendance would gradually increase and availability of employees can give an industry a better performance rate. Dip Kumar Patel et al. [16] assessed some safety measures like 1) mock drills for fire, electric shocking and bone fractures. 2) Provided sufficient number of fire extinguishers. 3) Provided sufficient number of first aid box to certain intervals. 4) Provided a Near miss station, where victim filled up the form to help to make prevention from happening it next time. Ranteshwar Singh et al. [9] presented some measures like 1) sufficient no. of fire extinguisher at the shop floor and training them how to use it when required. 2) Management organised one mock drill every year. 3) Workers were advised to keep toilets clean. 4) Workers were advised not to use tobacco and avoid smoking in shop floor premises.

## 2.7) Education and Training

Sustaining and to achieving the process accordingly to the requirements is very important and that is the reason giving education and keeping updated with latest methods and technologies training is essential. Education and Training is an essential pillar when it comes to TPM because operators should be well aware of the losses and their meaning when they pen down in logbook because writing downtime where it is not supposed to be can cause to misleading of directions. Ranteshwar Singh et al. [9] showed how continuous improvement in knowledge and skill of people is the key to continuous improvement, therefore every week they arranged training for quality department regarding implementation of QC tools and instructing them regarding the use of measuring instrument. They also gave training to operators for various parameters like, 1) To detect visual faults, 100% visual examination is must. 2) 100% observation is required, therefore trained them for using Go & No go gauges. 3) Shop floor training is given, regarding mounting of chucks, jaws, blocks etc. 4) Trained them to set the mean value where by the products were made according to the specifications given by customer and due to that refusals were avoided.

## 2.8) Office TPM

Office TPM is another dominant pillar because to implement and to do things in a right manner is essential but maintaining and improving the productivity and efficiency is also very important when it comes to administrative consequence. Dip Kumar Patel et al [16] manifested reduction in losses of Office TPM by, 1) making operators filling the daily job cards which contained no. of produced quantity, no. of rejected quantity and no. of ok quantity. 2) Maintenance department had a new computer system with SAP attachment so that data can be collected in soft copy instead of notebooks. 3) Weekly report was made to impart perfect data. 4) Finally precise data of breakdown was found. Ranteshwar Singh et al. [9] also illustrated how they started, 1) Writing daily rejected report by the operators which resulted in sparing less time by quality department to procure the rejection data. 2) New computer system were implemented where by risk of losing data was eliminated. 3) Reports were made in excel sheet which resulted in saving enormous amount of time rather than writing daily data report and sitting with a calculator to sum off at the end of the month. 4) Employees details were placed at the notice board with their mobile number and with this they were able to contact them easily whenever required.

## III. OEE ANALYSIS

E.Sivaselvam et al. [18] demonstrated how OEE is known as a method to measure performance of production equipment. Here they measured OEE in their 5 bottleneck machines to find out which one is creating more downtime and where the manpower was to be focused. Using OEE they found out the factors affecting the productivity of the company and had a clear identification of the problem at the right time which led them to increase quality of their machine. Disha M. Nayak et al. [3] depicted how analysing the losses of OEE gave them idea about the machine efficiency and in turn gave the bottlenecks and the correct percentage of machine utilisation.

In order to achieve performance and quality rate, S. R. Vijayakumar et al. [4] illustrated how they improved both the rate in an injection moulding process in an automotive manufacturing sector. Analysing the previous OEE and accumulating changes according to the losses of bottlenecks and eventually increased OEE after making some changes in it. Calculating OEE helped them bringing down machine breakdowns, minor stops and quality defects. It also increased productivity, employment involvement and customer satisfaction. Chetan S Sethia et al. [2] showed how in a rolling mill a survey was conducted with collection of data which causes most downtime. Here they used OEE as a quantitative measure to find out the availability, performance and quality rate. After calculating and comparing with world class OEE they found out their weaknesses, which was the availability rate that was harming their overall productivity rate.

## IV. CONCLUSION

Incorporating all the interest in up bringing the productivity of any product by TPM, it can be recognised well in this fiery competition. Although it has its fencing but, if it is implemented successfully and a good supervision is being marked it can change the dynamics of any industry by gaining its productivity and setting a benchmark for other competitors. TPM is a road which is never ending because it keeps on improving more and more as of you walk over that path. Any industry can implement TPM pillars or some of those pillars and can attain enormous productivity. Considering present scenario in the market OEE should be calculated with the present data and the losses should be seen as an opportunity to improve the availability, performance and quality rate.

Thus, it can be concluded that, with initial efforts and hurdles to start TPM and time taken to measure OEE by gathering data can be seen as an extra amount of work, but the upside of TPM and OEE is much giant and can be considered to any industry that wants to leave its mark in this competitive world with customer satisfaction.

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