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TPM Implementation to Enhance Oee in Small Manufacturing Industry

Mayur .M. Mhamunkar[1], Prof. Arun Kumar[2]
Student[1], Principal[2]
Department of Mechanical Engineering
VIVA Institute of Technology, Mumbai University, Maharashtra, India

Abstract:
Machine maintenance and in specific, implementing Associate in Nursing correct maintenance strategy has become more and more vital for producing industries. Total Productive Maintenance (TPM) is an impressive approach for maintaining plants and instrumentality's that improves the equipment effectiveness, removes breakdown and encourages autonomous operator maintenance through regular undertakings, which has the complete workforce. This paper presents the study associated summary of implementation of TPM in an automobile spare elements producing business to boost OEE. For this purpose the present OEE of machines are analyze and significant machine is chosen for implementation of TPM. Afterwards employment of TPM on the crucial machine rise in availableness, performance and quality is earned so rising overall equipment effectiveness. Analysis of OEE before and later TPM implementation authenticates the success of TPM implementation within the business.

Keywords: TPM (Total Productive Maintenance), OEE (Overall equipment Effectiveness), AM (Autonomous Maintenance), PM (Planned Maintenance). KK (Kobetsu Kaizen).

1. INTRODUCTION

The focal aim of an efficient TPM program effort is to induce vital maintenance trained trades and production staff organized. Complete worker involvement, autonomous maintenance by machinists, little cluster undertakings to extend instrumentation consistency, continuous improvement, maintainability and productivity, and are the principles incorporated by TPM. A TPM program usually enlarges the duty of production workers from merely operational machines to such areas as characteristic machine failures, effecting basic maintenance, and keeping work zones clean and arranged. The practices of TPM facilitate eliminate waste rising from a unmethodical work space, unplanned stoppage, and machine performance unpredictability thereby achieving noticeable enhancements in overall equipment performance.

1.1 Implementation of TPM

Execution of TPM relies on systematic implementation of its pillars; firms struggle to implement TPM owing to 2 key reasons. Initial has inadequate information and experience particularly in understanding the relations between the pillar activities in TPM. The second cause is that TPM needs time, resources and labors than most of those firms believe they will provide. The pillars of TPM area unit delineate below. 5S forms the bottom and is that the begin purpose for TPM implementation. It helps to uncover issues. Creating issues visible is that the initiative towards improvement. Autonomous maintenance is redeeming responsibilities of basic maintenance activities to operators. It will be enforced through establishing and maintaining basic conditions, enhancing information of operators and providing operator possession of kit. Owing to this employees become more established and reduction in downtime is achieved. Kobetsu Kaizen is structured team based mostly approach to drive elimination of known losses. It is often enforced by developing cross functional groups performing on problematic equipment and kaizen project for maintenance. This helps in promoting lean methodology to employee's thereby manufacturing massive base of workers with right tools for determination issues planned maintenance is structured approach to determine maintenance set up. It is often enforced by programing of maintenance activities and effecting maintenance once machine is idle or manufacturing very little. Owing to this breakdowns are reduced step by step and no costly elements are additional to inventory. Quality maintenance is regarding observance interactions between men material and machine & procedures that allows defects to arise. This could be earned by inspecting current state, implementing enhancements and face up to quality by standardizing factors and ways to achieve zero defects. Owing to this defects are reduced or eliminated. Obtaining quality right the primary time and quality problems with permanent solutions are the opposite advantages. Training could be a companywide initiative as well as all levels from operators to managers. Operators are instructed basic skills for maintaining equipment. Higher level coaching is provided to the technical employees and TPM skills to the managers. This successively results in eminent implementation of TPM within the business.

1.2 Overall Equipment Effectiveness

Overall equipment effectiveness (OEE) is a term coined by Seiichi Nakajima. It provides a way to measure the effectiveness of manufacturing operations from a single piece of equipment to an entire manufacturing. OEE is an operational tool used in TPM and Lean Manufacturing as a Crucial Performance Indicator. It is percentage of planned production time which is actually productive. OEE measurement is indispensible for every organization dedicated to eliminate waste & losses through implementation of TPM. Thus OEE is a function of the three elements namely availability, quality and performance.

1.2.1 Availability

$$\text{Availability} = \frac{\text{Planned Production time - Downtime}}{\text{Planned Production time}}$$

Availability losses contain equipment failures and changeovers showing situations when the line is not running though it is predictable to run.

1.2.2 Performance

$$\text{Performance} = \frac{\text{Ideal cycle time x Parts produced}}{\text{Available time}}$$

Performance losses contain Speed losses, small stops, and empty positions in the line, showing that the line is running, but it is not providing the quantity it must.

1.2.3 Quality

$$\text{Quality} = \frac{\text{(Total units started-Defective units)}}{\text{Total units started}}$$

Quality losses mention to the state when the line is fabricating, but there are quality losses due to in-progress production and warm up discards.

Therefore OEE= Availability × Performance × Quality.

2. LITEARTURE STUDY

Ashwin B. Virupakshar and Anil Badiger, have such that that to realize overall equipment potency, TPM is ideal tool. TPM aids the management to extend the performance of the firm and by correct implementation of TPM theories the producing industries will gain nice profits with the less investment. They achieved decrease of cycle time for every operation by conjoining 2 or a lot of operations and by providing special attachment where probable for a traub machine thereby increasing its output [1]. Rishi J and Dr. T R Srinivas, explicit that TPM will be best fitted to achieving lean producing. They with success enforced TPM in Automotive Axles and achieved higher efficiency by reducing setup time and increasing OEE. They dole out SWOT analysis is order to analyse the matter related to the first equipment manufacturers [2]. Dr. Ramachandra, Dr. T. R. Srinivas, Raghavendra M J, did a review on assortment of journals associated with TPM revealed in span of fifteen years and have such that that improvement of OEE is perceived through accessibility, performance & quality thereby demonstrating an efficient tool for evaluating effectiveness is TPM [3]. Vijay Lahri and Dr. Pramod Pathak, have explicit that OEE tool is route map to boost the effectiveness of producing method and instrumentality. OEE abstracts all the cause for delay of the task and not simply solely measures unskillfulness however conjointly classifies those into 3 classes for well understanding of producing method. They dole out OEE on CNC Table sort boring & shaping machine to search out out the block and hidden losses and earned redoubled in OEE when implementing varied proposals [4]. Parth N Chandegra and Vivek A. Deshpande, have calculated that with the help of Total Productive Maintenance (TPM) approach cycle time reduction will be achieved. They did the identical for PCF gear assembly using 5S methodology and different pillars and complex the assembly in acceptable manner. They conjointly found that by applying the strategy of TPM, improvement in production effectiveness by detection and removing production losses within the production system through active contribution of all workers will be earned [5].

3. CASE STUDY

3.1About Company

XYZ Engg. Pvt. Ltd. may be a high manufacturer of exactness turned & cold shaping parts, automobile spare components and varied different parts like studs, taper plugs, stringed instrument bolts, dowel pins, pins, nuts, shafts, screws, adapters, connectors, bushes, spacer, filler & magnetic plugs. it's been quite twenty years that the corporate is producing parts for varied sectors particularly automotive, farm instrumentation, switchgear etc. a number of the businesses reputable purchasers are Mahindra & Mahindra Ltd. (Automotive Division), Piaggio Vehicles Pvt. Ltd. and Larsen & Turbo restricted.

3.2 Problem definition

After closing many visits and direct observations of machines on the assembly workplace and analyzing previous machine utilization records at XYZ Engg. Pvt. Ltd it absolutely was found that machines weren't operational up to its full production capability owing to following issues related to the machines

a) Housekeeping of the machines is allotted throughout machining hours that accounts for production delay.

b) Time loss happens throughout loading and setting of job on machines that accounts for setup loss.

c) Time loss throughout conversion from one job to different on machine accounts for setup loss.

d) Break downs of machines owing to improper cleansing and lubrication of machine components that accounts for availability loss.

e) Lack of arranged maintenance plan for machineries that accounts for performance loss.

f) Frequent tool damage owing to operator unskillfulness that accounts for performance loss.

Thus there's got to implement total productive maintenance strategy so as to beat the higher than mention glitches and attain improvement in overall equipment effectiveness.

3.2 Methodology

In order to beat issues mentioned in earlier section a quick study was meted out and implementation of TPM methodology to enhance OEE was all over. To start out with TPM few kinds of machinery were elite. These machines were elite on the idea of most vital activities performed on the assembly workplace including bolt forming, drilling, thread rolling and surface grinding. Thence the subsequent machines were elite for TPM study.

Table.1. Machines Selected for TPM Study

Sr .No	Name of Machines	Product	Brand
1	Thread Rolling	M6 to M28 Studs	Raco Smith
2	3/8 Bolt Former	banjo bolt, pins	National
3	2 Spindle Drilling Machine	Banjo bolt	Glider
4	Grinding	Plunger, Banjo bolt, Stud	Satnam

3.3.1 Steps for employment of TPM

In order to realize success TPM ought to be enforced in correct stepwise manner. In every stage one TPM pillar is to be enforced as per requirement of the corporate.

Step 1: Choice of critical machine
From the machines elect in table no a pair of crucial machine is confirm by computing OEE of all the four machines. The information is to be collected for all the four machines and kept in standout format. excel sheet for knowledge assortment includes machine name, product name, duration, observer name, date, shift length, break time, down time, ideal run rate, total items and reject items. After assortment of information OEE is be calculated in excel sheet that contains planned production time, in operation time, good items, availableness, quality and overall OEE. The OEE calculated for the four machines is shown within the following table.

Table.2. Oee Before Tpm Implementation

Sr.No	Name of Machines	Performance	Availability	Quality	% OEE
1	3/8 Bolt Former	0.9899	0.8065	0.9865	78.75
2	Thread Rolling	0.9565	0.9135	0.9897	86.47
3	2 Spindle Drilling Machine-BDR-	0.7665	0.4935	0.9960	37.67
4	Grinding CG	0.9428	0.9658	0.9985	90.91

After analysing the upper table it's found that crucial machine is BDR-01 whose OEE is 37.67%. This machine is known as TPM model machine who's OEE is to be augmented by implementation of TPM.

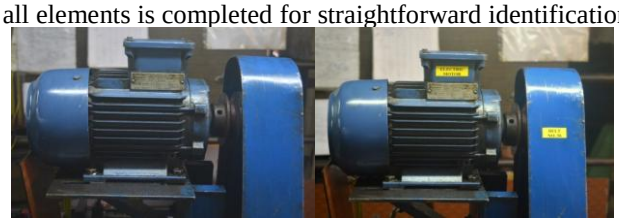
Step 2: Employment of 5S on model machine
a) **Seiri/Sort:** initial pillar of 5S is enforced to prepare among things required within the work space from those not required on priority basis. Items not required are red tag and placed to red tag space.

Before After
Figure.1. Employment Of 1s

b) **Seiton/Set in Order:** Second pillar of 5S is to be enforced to stay required things in correct place for simple and immediate retrieval. The proper position for each tool, item and material is chosen in relevancy how work is to be performed.

Before After
Figure.2. Employment Of 2s

c) Seiso/Clean: Third pillar of 5S is utilized to keep work areas, work sides and equipment clean and free from dirt, wreckage, oil etc.
d) **Seiketsu/Standardize:** Fourth pillar of 5S is enforced to standardize activities, procedures, schedules. Machine diagram is ready and new SOP is about for operative machine. Labeling of all elements is completed for straightforward identification.



Before After
Figure.3. Employment Of 4s

e) **Shitsuke/Sustain:** This fifth and final pillar of 5S is enforced so as to be focus to keep up new standards & procedures and unceasingly improve 5S state of work in disciplined manner. For this purpose person who wrote it for 5S is outline and posters of 5S are displayed in regional language.

Before After
Figure.5. Employment Of 5s

Step 3: Employment of AM on model machine
After implementing 5S on the model machine successive step is implementation of autonomous maintenance (AM). This pillar relies on the idea that if operators beware of little maintenance tasks it will unlock the virtuoso maintenance folks to focus on additional price supplementary activity and technical repairs. For this CLITE tool is employed below that improvement, lubrication, scrutiny and modification standards are set to be followed by operators on day to day.

Step 4: Employment of KK on model machine
After winning implementation of AM successive step is implementing Kobetsu Kaizen pillar additionally called targeted improvement, Kaizen i.e. continuous improvement involves little enhancements to be meted out on continual basis by folks of all levels within a company. The results of KK implementation is shown below.

Step 5: Employment of PM on model machine
The next step when implementation of KK is to implement Planned Maintenance pillar. Supported the previous expertise of service staff breakdown details associated with machine failures are recorded. Root cause Analysis (RCA) tool is employed to see all potential root causes of the matter.

Table.3. Tightening Standards

Sr. No.	Location	Tool to use	Frequency
1	Limit switches	Spanner	Daily
2	Part grippers	Allen Keys	Daily
3	Collet	Collet Spanner	Daily

Table.4. Cleaning Standards

Sr No.	Location	Standard	Mode of Cleaning	Rate
1	Rollers of Limit Switches	No dust, chips	Air gun	Daily
2	Work piece Area	No dust, chips	Air gun	Daily
3	LM guide ways of component loading cylinders	No dust	Dry cloth	Daily
4	Table	No chips , coolant mist	Chip remover	Daily
5	Motor	No dirt, mist	Dry cloth	Daily
6	FR Unit	No moistness	Knob release	Daily

Table.5. Lubrication Standards

Sr No.	Location	Type of Lubricant	Mode of lubrication	Rate
1	Right and Left spindle	Oil	Manual	Daily
2	LM guide ways of component loading cylinders	Oil	Manual	Daily

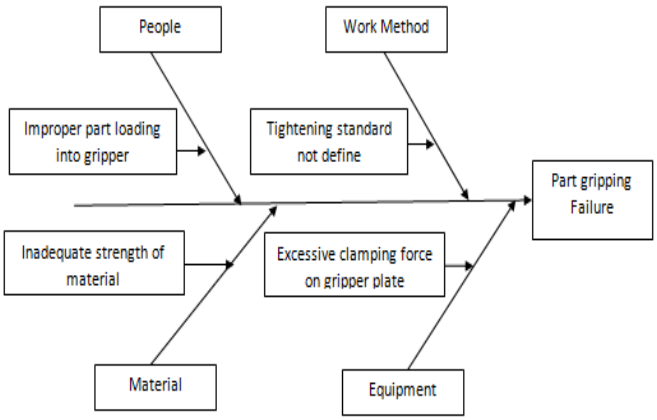


Figure.6. Root Cause Analysis of Issue

Table.6. Kaizen's Execution on Model Machine

Sr No	Type of irregularity	Effect	Causes	Remedies	Advantages
1	Trial and error method for setting up limit switches	Time consuming to get right depth of cut	No standard set for setting up limit switches	Scale mounted perpendicular to limit switches and provided with standard markings	Performance & Quality
2	Wear and tear of limit switches	Improper functioning of limit switches	Continuous and prolonged use	New limit switches setup	Performance
3	Pressure gauge of FR unit not visible	Unable to adjust air pressure	Improper location of FR unit	Position of FR unit change so that air pressure can be easily visible and controlled	Performance
4	Piston wear of de clamping cylinder	Improper decamping of finished parts	Continuous and prolonged use	Piston of decamping cylinder replaced and spare pistons made in-house	Availability & Performance
5	Air leakage through pneumatic cylinder used for part gripping	Insufficient pressure leading to lose gripping of parts	Wear and tear between piston rod and seal	Piston rod seals made in house and kept in spare parts list for instant replacement	Performance

Table.7. Machine Failure Details

Sr. No.	Problem	Frequency of breakdowns	Corrective Action
1	Limit switches failure	5	Replaced
2	Part gripping failure	10	New bolting done
3	Spindle run out	4	Readjust play between bearing & spindle
4	Coolant pump motor failure	1	Replaced

Table.8. Preventive Maintenance

Sr No	Issues(failure)	Remedial Action	Preventive Action
1	Run out Spindle	Readjust play between bearing & spindle	Weekly inspection of check nut
2	Limit switches stop working	Changed	Daily clean and switches kept in spare
3	Component gripping	New bolting done	Daily tightening
4	Coolant pump motor	Replace	Weekly cleaning of pump surface

Based on root-cause analysis of the problems preventive maintenance schedule is prepared for the machine.

Step 6: Education and Coaching

Education and coaching is vital pillar of TPM. TPM are often misunderstood by workers as a result of lack of correct coaching and education. Thence there's want for companywide initiative to involve everybody right from operators to manager. Coaching and Education is disbursed throughout implementation of various pillars of TPM.

4. RESULTS AND DUSCUSSION

Once implementation of TPM on the model machine OEE is recalculated. The results therefore obtained are as follows.

Table.9. Comparison of OEE before and after TPM

Sr .No	Factors	Before TPM Execution %	After TPM Execution %
1	Availability	49.35	94.56
2	Performance	76.65	87.59
3	Quality	99.60	99.89
4	OEE	37.67	81.26

The table 10 shows that there's increase in availability and performance of the model machine.

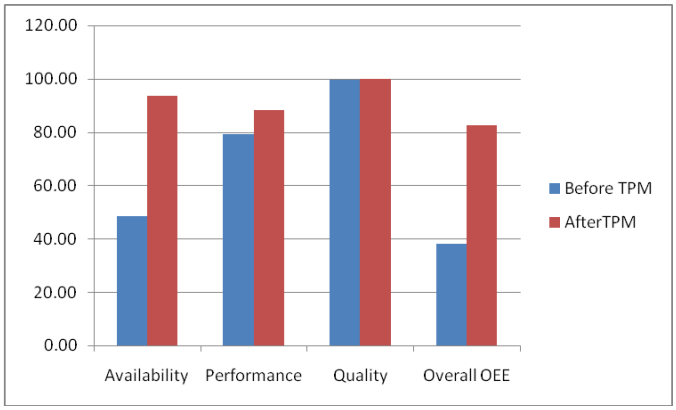


Figure.7. Assessment of Oee

5. CONCLUSION

Today within the era of globalisation, to contend with alternative industries it is necessary to manoeuvre towards trendy ways in which of maintaining plants and equipment's. TPM forms the most effective strategy for industries to stay competitive and effective once it involves overall effectiveness of the corporate. Through this study a medium scale producing trade is studied and analysed to assess maintenance and overall instrumentality effectiveness of machines. So once winding up stepwise implementation of TPM within the company marked enhancements in convenience, performance potency and quality degree are often achieved thereby resulting in increase in OEE of model machine and which is able to additional lay down basis for companywide implementation of TPM.

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