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Leveraging Tpm for Increase in the Oee of Cnc Machine

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***ABSTRACT**: The manufacturing industry has gone through significant changes in the last decade. Competition has increased dramatically. Total Productive Maintenance (TPM) is a methodology that aims to increase the Overall Equipment and Effectiveness (OEE) of existing equipment. The aim of this paper is to study the effectiveness and implementation of TPM program in a manufacturing organization. Through this study of implementing TPM in manufacturing organization, the increase in efficiency of machines in terms of Overall Equipment Effectiveness (OEE) are discussed. The process of TPM is applied on the Wire cut CNC machine (Robofill-240SL) of the LT organization. The result obtained from the TPM approach showed that the OEE was improved from 43 % to 65%.To sum up, total saving per annum due to increased effectiveness was around Rs 3,78,000/-.*

***Keywords:** OEE (Overall Equipment and Effectiveness**,** TPM, Kaizen.*

I. INTRODUCTION

Today various innovative techniques and management techniques such as TQM (Total Quality Management), BPR (Business Process Re-engineering), ERP(Enterprise Resource Planning), JIT(Just In Time), TPM(Total Productive Maintenance) have become popular or we can say are practiced in many industries.TPM has been depicted as a manufacturing strategy comprising of following steps:

- Maximizing Equipment Effectiveness through Optimization of equipment Availability, Performance and Quality.
- Establishing a proper Preventive Maintenance strategy for the Equipment.
- Involving all staff members from top management to shop floor workers.
- Promoting improved maintenance through small group autonomous activities.

The main improvement we want is in the OEE which is increased due to TPM. OEE is measured in the terms of the Performance, Quality and Availability of the Equipment. OEE = Availability X Performance X Quality.

AVAILABILITY:

- Availability takes in to account the down time losses and is calculated as
- Operating time/ planned production time.
- i.e Percentage of the actual amount of production time the machine is running to the production time the machine is available.

PERFORMANCE:

- Performance takes in to account the speed losses and is calculated as
- Total count/target counter
- i.e Percentage of total parts produced on the machine to the production rate of machine

QUALITY:

- It takes in to account the quality losses and is calculated as
- Quality = Good Count / Total Count.
- Percentage of good parts out of the total parts produced on the machine.

The OEE measure is central to the formulation and execution of a TPM improvement strategy. This project aims in bringing the OEE near to 65% and gradually moves up towards world class manufacturing. TPM employs OEE as a quantitative parameter for measuring the performance of a production system. OEE is the core metric for measuring the success of TPM implementation program. The overall goal of TPM is to raise the overall equipment effectiveness. TPM is a program that "addresses equipment maintenance through a comprehensive productive- maintenance delivery system covering the entire life of the equipment and involving all employees from production and maintenance departments to top management".

There are 8 pillars of TPM or we can say that there are steps in the implementation of TPM which are shown in Fig1.We will now further see the importance of these pillars and their respective implementation.

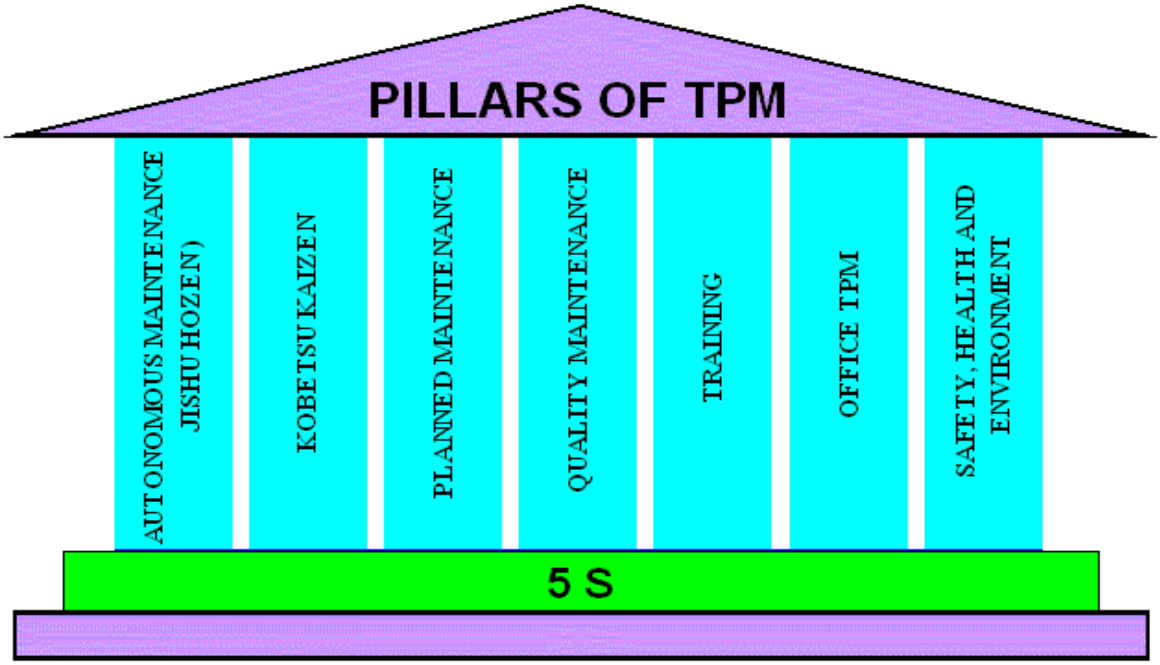

Fig1: Pillars of TPM.

II. PROBLEM DEFINITION

Historical data showed that the OEE of the wire cut CNC machine was very low compared to general manufacturing scenario. The following figure1 shows the OEE of machine. The figure clearly shows that the OEE of the machine is very low. The average OEE shown is 43% in the three months.

2.1 TPM OBJECTIVES

1. To maximize overall equipment effectiveness
2. To reduce equipment downtime while improving quality and capacity.
3. To increase competitive advantage.
4. Maintain an accident free environment.
5. Increase the operator involvement.
6. Improving the quality and reducing the cost.

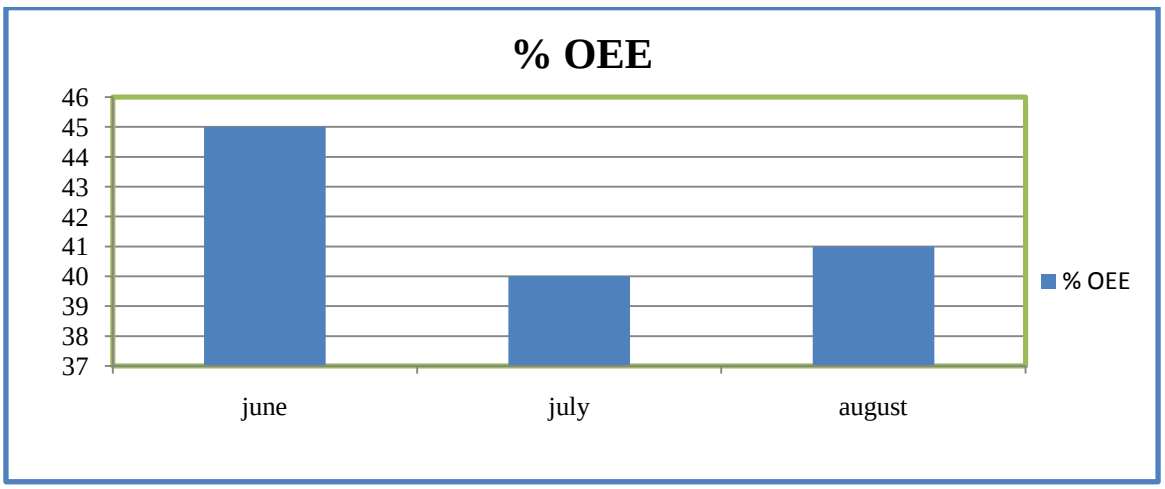

Fig 2: OEE of the machines in the last 3 months.

2.2 METHODOLGY FOLLOWED FOR ACHIEVING TARGET

1. Data collection, Machine history study.
2. Analysis the problems using Quality tools & evaluate them,
3. Training of employees to achieve autonomous maintenance of the machines.
4. Maintaining 5s in the machine surrounding.
5. Replicating success across the different machines in the cell layout.

We are going to implement the TPM on the wire cut CNC machine (Robofill 240sl)

III. IMPLEMENTATION OF TPM

We will now study the steps of TPM in detail and their implementation on the machine whose OEE has to be increased.

(i) Implementation of 5S on this Machine:

5S are defined as Sort, Set in Order, Shine, Standardize and Sustain. Because each of the five pillars begins with S, this method was appropriately named 5S. These 5S are implemented on TPM model section.

5S – Sort: The first pillar of 5S helps to clearly distinguish the items needed in a work area from those no longer needed. At work place, various items have been sorted out on the basis of priority of use. Low priority denotes the less frequency of use while high priority shows the items used daily/frequently.

5S - Set In Order: The second pillar of 5S helps to keep the needed items in the correct place to allow for easy and immediate retrieval. The correct place, position, or holder for every tool, item, or material must be chosen carefully in relation to how the work will be performed and who will use them easy identification. At company, for organizing activity, the components were stored according to their code number so assigned that the high priority items are located very near to the operator.

5S – Shine: The third pillar of 5S helps to keep work areas, all work surfaces and equipment clean and free from dirt, debris, oil, etc. At company, all the persons from managers to operators were engaged for cleaning their table, chair and cabin.

5S – Standardize: The fourth pillar of 5S defines the standard activities, procedures, schedules and the persons responsible for keeping the workplace in a clean and organized manner.

5S – Sustain: SUSTAIN is the last pillar of 5S and drives the organization to be disciplined in maintaining these new standards and procedures and in continuously improving the 5S state of the workplace.

(ii) Implementation of JISHU HOZEN:

Jishu Hozen also called autonomous maintenance is a team-based approach to maintenance activities. The goal of autonomous maintenance is to prepare operators to do some equipment care independently of the maintenance staff. Jishu Hozen implementation lays the foundation for other maintenance activities by establishing the basic conditions for a machine's operation. Various tentative standards for cleaning, inspection and lubrication are set for machine. Standards for cleaning are as follows.

Table 1: Standards for cleaning

Sr No	Location	Method of cleaning	Standard	Time	Frequency
1	Operator table	Dry cloth	No mist	1 min	Shift
2	Pedestal platform	Wire brush	No mist	2 min	Week
3	Work head	Dry cloth	No chips/oil	2 min	Daily
4	Hydraulic tank outside	Dry cloth	No mist	5 min	Week
5	Hydraulic pipe cleaning	Dry cloth	No dust/oil	5 min	Week
6	Machine back	Dry cloth	No oil	2 min	Daily
7	Electric panel	Dry cloth	No oil	2 min	Daily
8	Coolant tank	Dry cloth	No mist	10 min	Week
9	Electric motor	Dry cloth	No dust	2 min	Week

Similarly standards for inspection are produced as follows

Table 2: Standards for Inspection

Sr no	Location	Method of inspection	Standard	Time	Frequency	Action if not OK
1	Hydraulic tank oil level	visual	Max and Min	20 sec	Week	Fill oil
2	Chip collector	visual	Filled to top	10 sec	daily	Cleaning required
3	DC valve	visual	No leakage	15 sec	daily	Inform maintenance

Similarly standards for Lubrication are

Table 3- Standards for Lubrication

Sr no	Location	Method of Lubrication	Type of oil/greese	Frequency
1	X , Y , Z axis	Manual	Greese	Month
2	Ball screw	Manual	Greese	Week

After setting up of standards for all machines, Fuguai's are found in all machines. Fuguaies are the abnormalities in the machine, which is noted during the initial cleanup. Table below shows the various fuguaies found in Robofill machine.

Table 4: Fugai's found in the Machine

Fugai No	Description	Effects	Cause	How to eliminate it
1	Leakage from valves	Oil wastage	Nut loose	Tight it properly
2	Screw is open from flow control valve pipe	Oil wastage	Negligence	Tight it properly
3	Leakage found in flow knob	Oil wastage	Negligence	Repair
4	Hydraulic pipes are not clean	Looks bad	No cleaning	Clean it
5	Wire clamp broken	Wire comes out	No maintenance	Repair
6	Hydraulic connections loose	Oil leakage and wastage	Negligence	Repair and tight
7	Chips contamination in loose wire connections	Short circuit can occur	No provision to stop chip scattering	Clean wire connections and clean all connections
8	Pipe clamp bolt is missing on right side	Pipe unsafe	Poor workmanship	Repair
9	Electric wires not covered	Cause trip down	Negligence	Cover all wires
10	Oil split out while cleaning	Oil wastage	No cover	Provide cover
11	Tool table oily	Looks bad	Negligence	Clean properly
12	Hydraulic oil filter is open	Dust contamination in oil	No maintenance	Fit it at proper place

(iii) Implementation of Kobetsu Kaizen.

Focused improvement includes all activities that maximize the overall effectiveness of equipment, processes, and plants through uncompromising elimination of losses and improvement of performance (Suzuki 1994). Kaizen in Japanese context simply means change (kai) for the better (zen). Some of the Kaizens performed on machine are shown in Table.

Table 5 : Problems and their respective solution.

Kaizen no	Kaizen theme	Problem	Idea	Results	Benefits
1	To provide Cover for machine head	Chips and oil split out while working	Design of proper covering system	Splitting of oil and chips is avoided	More clean space. Machine works properly
2	To provide plastic cover on control panel	Oil can go in to control panel which causes short circuit	Plastic cover should be provided	Panel looks more neat and clean more safe	Less cleaning is required and more safe
3	To change the design of the water tank	Oil comes with chip and is not separated	To separate oil and chips in water tank by changing its design	Chips don't get mixed with the oil	Wastage of oil is reduced
4	To fix filter	Oil becomes contaminated	Fix the filter	Contamination stopped	Clean oil
5	To replace glass of load pane	Looks bad	Provide glass	Easy to visualise	Looks good
6	To provide bolt on motor	Improper working	Provide bolts	Motor works properly	Motor safe
7	To change the design of coolant nozzle	Difficult to operate	Design a new nozzle	Coolant directly falls on job	Wastage of coolant reduced
8	To replace the scale of worktable	Not properly visible, misadjustment	Replace it	Easy to take readings	Proper readings available
9	To provide bulb and cover on control panel	Indication is not achieved	Provide bulb and cover	Indication is received	Indication is received
10	To change the headstock scale	Scale no are totally damaged due to dust	Replace an old scale	Operators machine set up time reduced	Improved efficiency
11	To provide nut on column	Vibrations	Provide nut on right side of the column	Vibrations stopped	Easy to work
12	Clean and check nozzle size,check moisture.	Machine giving faulty edges on the job	Due to pressure, Moisture content in gases, or Movement of machine. X axis parallel movement not ok due to dirty	Machine not giving faulty edges	Quality product
13	Adjust the clearance between nozzle and plate.	Machine giving rough edges.	Clearance between nozzle and plate too high.	Machine giving smooth product	Quality product.
14	Control the feed rate and speed.	Incomplete cut and end not cut through.	Feed rate too high	Machine giving complete cut.	Quality product
15	Oxygen Pressure high	Adhering Slag, Slag burrs.	Cutting Oxygen Pressure too low.	No slags.	Cutting Nozzle safe.
16	Sufficient Preheating	Cracks in the cut surface.	Insufficient Preheating.	No Cracks.	Quality product.
17	Cutting Oxygen supply to be continous.	Cut surfaces undulating in the direction of the cut.	Cutting oxygen supply briefly interrupted	Clean cutting surfaces.	Cutting nozzle safe.

(iv) Planned Maintenance.

This pillar aimed toward to have a trouble free machine and equipments for improving the reliability and maintainability and also for total customer satisfaction for the products. Planned Maintenance are mainly divided into four categories:

(1) Preventive maintenance
(2) Breakdown maintenance
(3) Corrective maintenance
(4) Routine Maintenance.

(v) Quality Maintenance.

This pillar aimed toward achieving the customer requirement through highest Quality through defect free manufacturing. Through focused improvement, defect the process after identifying the parameters of machine which mainly affect the products. QM activities are to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The condition is checked and measure in time series to very that measure values are within standard values to prevent defects.

(vi) Training

This pillar aimed toward developing a multi skill employee whose morale is high and who has eager to come to work and perform all required function effectively. In this an operator is educate as per required. So that he/she will be able to solve the problem. The goal is to create a factory full of expert. Training policy are focus on improvement of knowledge, skills and technique. The different phase of skill is,

(1) Do not know.
(2) Know the theory, but cannot do.
(3) Can do but cannot teach.
(4) Can do and also teach.

(vii) Office TPM

This pillar should be started after its successful activating of four pillar of tpm which are JH, KK, QM, PM office tpm must be followed to improve productivity and efficiency of the administrative functions. Due analyzing process and procedures towards increasing in the office automation office TPM has some major losses such as processing loss, cost loss, idle loss, setup loss, office equipment breakdown.

(viii) Safety, Health and Environment

This pillar focuses towards to create a safe workplace and a surrounding area so that our process does not damaged that area. This pillar plays an important role in each of the other pillar on a regular basis- Manager or any other higher authority looking after function related to safety.

After applying the 8 pillars of TPM , we are now calculating the new OEE(Overall Equipment and Effectiveness) in the below table

Table 6: OEE Calculation sheet

A	**Shift time(General)**	**480 min**
B	Planned downtime	60 min
C	Running time(A-B)	420 min
D	Running time losses	58 min
E	Operating time(C-D)	362 min
F	Availability(E/C) x100	86.2
G	Output	207 Pieces
H	Machine speed(no of components/min)	0.75
I	Expected output(H x E)	271 (No of pieces)
J	Performance(G x 100)/I	76.38
K	Rejection	3 Pieces
L	Quality(G-K x 100)/G	98.5

OEE= Availability X Performance X Quality
= 86.2 X 76.38 X 98.5 =65%.

The cost savings achieved through TPM are as follows

Table 7: Cost Savings sheet

A	**The cost of component after machining**	**220 Rs**
B	Casting cost	140 Rs
C	Machining Contribution	190-110 = 80 Rs
D	Machining contribution of machine	0.15*80 = 12 Rs/pc
E	Expected output	140 pc/shift
F	Added value per shift	140 * 12 = 1680 Rs
G	Added value per Day	1680* 3 = 5040 Rs
H	Value added per day before the project	5040* 0.40 = 2016 Rs
I	Present value added per day	5040* 0.65 = 3276 Rs
J	Extra income	3276-2016 = 1260 Rs
K	Net Saving Per Annum	1260*300 = 378000 Rs

Hence, Net saving of Rs 378000/-.

IV. RESULTS AND CONCLUSION

From the previous records the Efficiency was only 43%, the availability was 68%, Performance was 65% and Quality was 98%.After successful implementation of TPM, it is found that Overall Equipment Effectiveness is increased. The following graphs below gives the availability, performance and OEE before TPM implementation and after TPM implementation.

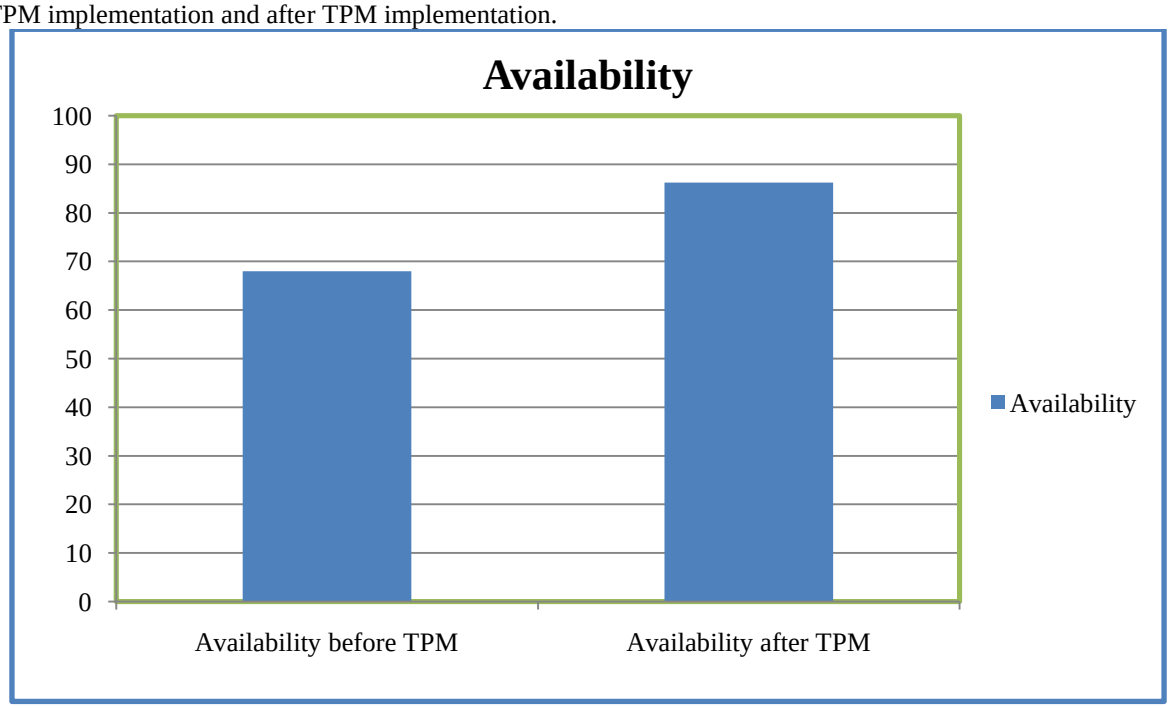

Fig 3: Availability before and after TPM.

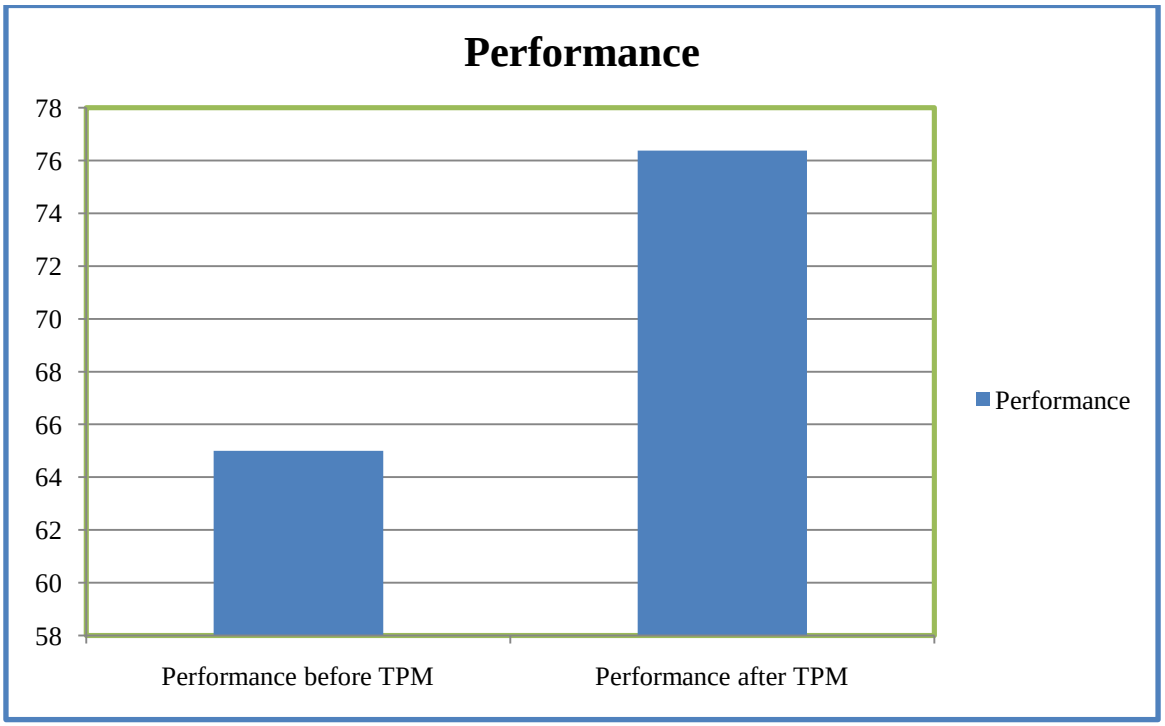

Fig4: Performance before and after TPM.

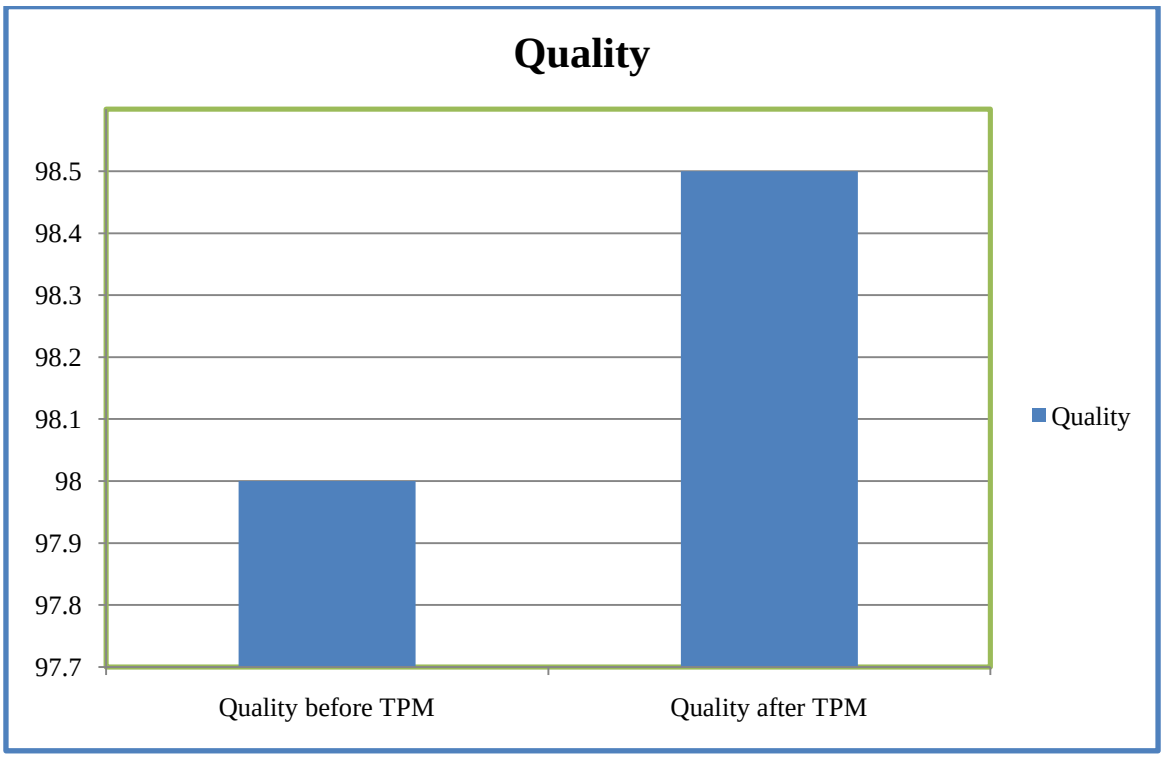

Fig5: Quality Before and after TPM

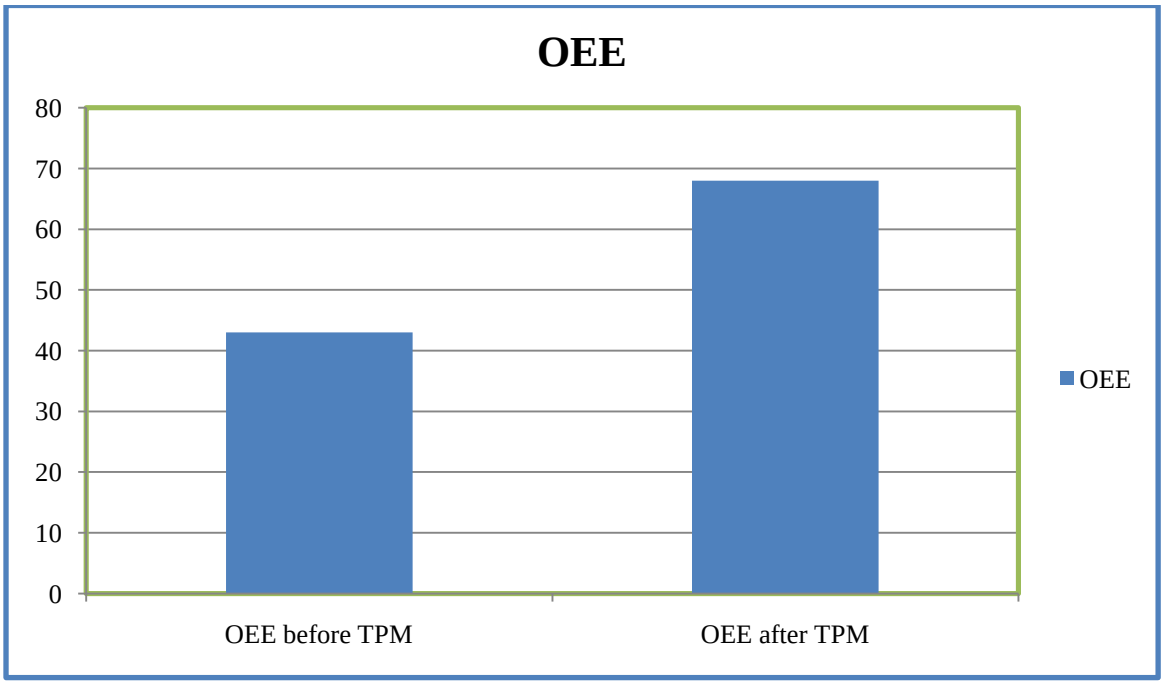

Fig6: OEE Before and after TPM

Also the Net saving was of Rs 378000/-.

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