Introducing Total Productive Maintenance on OKK-1 MCV 820

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Abstract* – Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction. Total Productive Maintenance (TPM) has been recognized as one of the significant operation strategy to regain the production losses due to equipment inefficiency. Many organizations have implemented TPM to improve their equipment efficiency and to obtain the competitive advantage in the global market in terms of cost and quality. In the implementation of TPM in a manufacturing organization, both Human-oriented and Process-oriented Strategy has been identified as critical success factors. The above studies focuses on the two TPM operational strategies which are posted, will improve the extent of TPM implementation in manufacturing organizations. The purpose of this report is to analyze and develop the importance of Overall Equipment Effectiveness (OEE) and critical performance indicators availability, performance and quality. In the early 1990s, OEE was bounded only as measurement tool for Total Productive Maintenance (TPM), but now it is viewed as a standalone tool for measuring true performance of the production in any department or organization. This report systematically categorizes the literature, case studies and findings with respect to OEE and its factors, and then analyzes and reviews it methodically. It seeks to highlight the implementation practices adopted by large enterprises. In later chapters, the approaches, results and evaluation of the reason behind failure of the OEE programs has been mentioned. Finally, best efforts have been made to sum up the ideal system for OEE, practical problems and theories from researchers and practitioners in comparison to real world industrial inefficiencies. The study clearly reveals that successful utilization of OEE measurements and its key performance indicators can facilitate the manufacturing organization's chase for achieving performance goals leading to competitive advantage.

Key terms- CNC, Total Productive Maintenance, Overall Equipment Effectiveness, etc .

I. INTRODUCTION

CNC automation facilitates higher levels of precision in the machining process as well as closer tolerances and better repeatability. Production manufacturers as well as custom machine shops benefit from the higher control and speed of the precision machining made possible through CNC technology.

The CNC milling machine performs complex operations quickly and efficiently whether for slot cutting, planning, drilling, milling, etc. The most basic form of CNC milling machine utilizes a rotating cutter, also called an end mill, which rotates around a spindle axis, and a worktable capable of moving in multiple dimensions around the part being machined view examples of DMP's CNC milled parts.

State-of-the-art CNC milling machines perform complex precision machining operations through relatively simple processes that include slot cutting, drilling, threading, milling, and more. With CNC machining, DMP has dramatically decreased the frequency of manual errors as well as the time required to alter a machine to produce specific parts. DMP's commitment to technology results in shorter runs and faster turnaround as well as greater flexibility in how a part is positioned during the machining process. Today, CNC milling operators use files created by CAM software, which allows assembly to run directly from design to manufacturing. The result is consistency in dimension, shape, and size for the entire job, regardless of volume.

1.1 WORKING

As a milling technique, CNC functions via a design that is specified on a computer with cad tools. This technique uses a computer program written in a notation called G-code. During CNC milling, the computer translates the design into instructions on how the drill needs to move to create desired shape. The drill moves up and down or can tilt at an angle, while the table typically moves the part laterally.

The language of computer numerical control specifies the movements that the drill and table must make. Because CNC technology utilizes advanced high performance software programs, a greater degree of accuracy is achieved. High spindle speed serves two advantages: first, CNC milling provides shorter production times due to fast digital servo control and high spindle speeds as well as optimum tools and accessories. Second, through a precision drive system and high frequency spindle speeds; these centres are ideal for high-speed machining.

1.2 SPECIFICATION OF OKK-1, 3-AXIS MCV 820

Figure 1.1 OKK-1 MCV 820

Make	OKK, JAPAN
Year of installation	May 1985
Total cost	47 lakhs

Features

Spindle taper	BT-50
Type	Vertical Single Spindle
30700 LS ATC	
X stroke (mm)	1600
Y stroke (mm)	820
Z stoke (mm)	720

Speed (rpm)

Minimum	30
Maximum	3000

Feed (mm/m)

Minimum	1
Maximum	12000

Control system

Type	Fanuc 6MB
Make	Fanuc JAPAN

Major components

Steel, titanium & light alloys component like flap, truck, slat truck, brackets, bell cranks, beams etc.

II. METHODOLOGY

The work is carried in the following steps

1. ATC is not working

If the ATC is not working changing of tool will take more time this should be operated by operator. The operator work will be depends on his skills.

2. Replacement of bellows

Replacement of bellows should be done because the chips will be block the sliding ways. Due to that the motion of the sliding ways will be strucked and therefore the accuracy of the product will be reduced and also breakdown of machine takes place.

3. Working lamp to be changed

Lamp to be changed, because in working condition the visibility of the tool and coolant not up to the requirement so changing of lamp is necessary.

4. When power failure occurs Z -axis coming down and datum is shifting to Y-axis

Due to misalignment gears in the existing OKK 1 MCV820 CNC

5. Rapid movements switch to be provided.

Rapid movements of switch because to control the programming to procurement action to be taken.

6. Origin option is not available

In OKK 1 MCV 820 machine there is no origin option example drilling of component we need the origin. In this machine we are using in the absolute method for programming when we using in incremental method we need the origin therefore the origin option should be placed in this machine.

7. Change of stabilizer is required.

The change of stabilizer is required, because to avoid the fluctuations of power, if not there is a chance of breakdown of machine.

8. Y axis getting sound while rapidly moving

Because improper connection of cables, and lubrication oil

9. Spindle neutral is not working

For operation the spindle we need a neutral switch because while running in higher rpm or speed suddenly reduce to zero the neutral switch will be operated.

10. MCB Problems. (Master Circuit Breaker)

Due to this the loss of power takes place and there will be cut-off of current.

11. Tool offset not activating.

Tool offset is not activating in our machine because in other machine while programming we can vary the offset and in the machine it should be done in manually so time taken to offset of tool will take more time. So we need as offset option.

12. During "M0", spindle is running in idle.

If not the tool is not running according to the reference point due to this the required model is not occurred.

III. RESULTS AND DISCUSSIONS

3.1 ACTION PLAN OF TPM ON OKK-1 MACHINE

Table 1: Action plan

ACTIVITIES:	PREPARATION FOR TPM
1	Nomination of operators.
2	Nomination Of Maintenance Technicians.
3	Name of responsible shop incharge.
4	Name of responsible maintenance incharge.
5	Meeting about TPM awareness and implementation with operators and maintenance technicians (for awareness among the operators and technicians).
6	Identification and list out of existing and repetitive problems.
7	Action plan for the exiting problem.
8	Action plan for the repetitive problems with root cause analysis.
9	Procurement of general consumable spares required during maintenance.
10	Arrangements of TPM board and stand.
11	Procurement of tags and hooks.
12	Preparations of TPM display board.
13	Preparation of records.
14	Breakdowns register with standard format.
15	History book.
16	Condition monitoring register with standard format.
17	Preparation of check list (daily/weekly/monthly).
18	Identification of required spares with the operational and visual inspection.
19	Tagging of the problem area.
20	Preparation of list of critical and consumable spares.
21	Action plan for procurement of spares and consumables.
22	Review meeting regarding the status of all above work and finalization of date to start TPM.

3.2 DAILY CHECKING ACTIVITIES

1 Check for air leakage.

If the air leakage occurs due to this the pressure going to decrease hence it is unable to clean the chips which all formed on the work piece.

2 Check lubrication oil level and pressure

Due to this movement of the machine parts will going to struck because of improper lubrication the working condition of the machine will comes to improper condition without lubrication oil the friction will occurs due to that the machine will get vibration. Tool holding capacity will decrease due to pressure drop.

3 check for proper lubrication (2)

4 Check sliding protecting cover condition

This protecting cover will oppose the struck and problems occurred in the guide ways due to chip. Due to this chip it will going to effect on operator also.

5 Check hydraulic pressure

The tools will hold due to the hydraulic pressure .without threading due to this the time consumption will less ,because it is automatic process due to this manual operation will be avoid

6 Check for hydraulic oil level and top up (2) and (3)

7 Check for hydraulic oil leakages and rectification

If there is oil leakage due to this oil level will going to reduce. Due to continuous leakage of oil the oil tank become empty. Then definitely problems will occurs in machine.

8 Check coolant level and concentration

Coolant will acts as a very important in the machine. Because which is used to reduce the heat occurred in machine parts. Concentration is mixture of coolant and water. With the ratio of 1:40 to check this concentration the "HAND HELD REFRACTOMETER" is used.

9 Check for coolant leakage

Already this problem is more in OKK machine by this problem the heat of the machine tool is continuously increasing and reaches in danger zone.

10 Check proper oil flow to gear train

If proper oil flow is there means the motion of gear train will be good, otherwise it will effect on gear train. There is a chance of struck in motion of the gear train

11 Inspect spindle noise in different rpm

Speed of the spindle is very important in machine because due to high speed the noise will occurs and so we shows maintain the required speed

12 Inspect the clamping and declamping pressure

The clamping and declamping of machine tool is very important during the running of machine if the sudden declamping occur means it is very dangerous and its effects on machine. The clamping and declamping should be proper manner.

13 Inspect noise in axis movements

Actually this noise in commonly occurred in Y axis because of movement of bed in vertical direction this is major problem due to this there is a chances of breakdown the tool.

14 Inspect spindle run out and Z axis drop with dial indicator

The motion of the Z axis must be checked before the working condition.

15 Check functionality of work lamp

For invisibility of work piece the work lamp must be required during the working condition. Because of initially preparation like tool adjustment.

16 Inspect cable damage

If there is cable damage there is a chance of shock circuit and supply of program to the monitor to check.

17 Cleaning of panel AC fans

To cool the circuit inside the machine the AC fans will required.

18 Check the panel AC fan working condition

We should check the condition of AC fans because it reduces the shock circuit occurred inside the machine due to the heat of machine.

3.3 OVERALL EQUIPMENT EFFECTIVENESS FOR THE MACHINE AFTER INTRODUCING TPM

Table 2:

MONTH	MACHINE AVAILABLE (HOURS)	MACHINE BREAKDOWN (HOURS)	TARGET (%)	AVAILABILITY (%)
FEB	525	25	99.9	95.2
MAR	515	15	99.9	97.08
APR	510	10	99.9	98

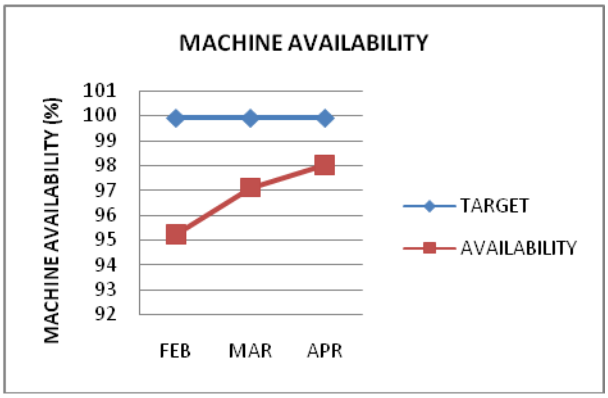


Figure1: Machine Availability

Table 3: Quality of the machine after TPM

Sl. No	Month	Total Output Achieved (Hrs)	Lost In (Hrs)	Acceptance Quality (%)
1	FEB	500	15	97
2	MAR	500	12	97.6
3	APR	500	10	98

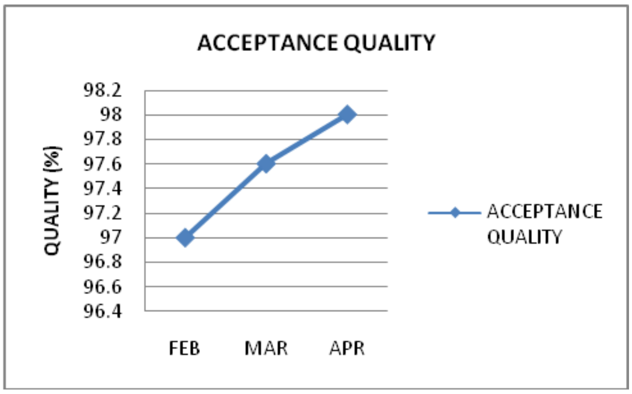


Figure 2: quality acceptance

Table 4: Norms achieved after TPM

SL.NO.	MONTH	NORMS	ACHIEVED
1	FEB	0.7	0.65
2	MAR	0.7	0.59
3	APR	0.7	0.55

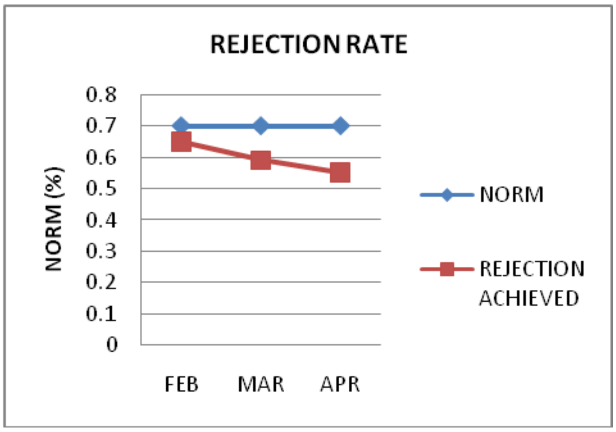


Figure 3: rejection rate

3.4 DETERMINATION OF OVERALL EQUIPMENT EFFECTIVENESS AFTER TPM

Table 5: OEE after TPM

Sl. No	Month	Availability (%)	Performance (%)	Quality (%)	OEE (%)
1	FEB	95.2	88.7	97	81.9
2	MAR	97.8	89.9	97.6	85.8
3	APR	98.6	91.2	98	88.1

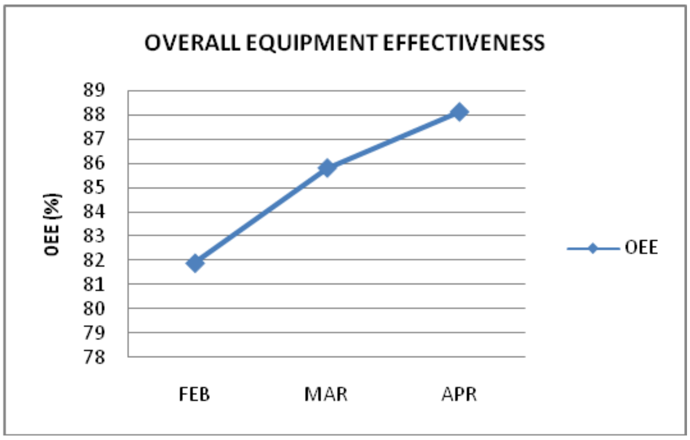


Figure 4: OEE after TPM

- $\text{OEE} = \text{Availability} \times \text{Performance Efficiency} \times \text{Quality}$
- $\text{Availability} = \frac{\text{MTBF}-\text{MTTR}}{\text{MTBF}}$

$$\text{Availability} = \frac{515-15}{515}$$

Hence,

Availability=95.2%

- $\text{Performance} = \frac{\text{obtained value}}{\text{required value}}$

Performance=88.7%

- $\text{Quality} = \frac{\text{total acceptable components}}{\text{total components required}} \times 100$

Quality = 97%

- $\textbf{OEE} = 0.952 \times 0.887 \times 0.97$

Hence,

OEE = 81.9%

3.5 COMPARISSION OF MACHINE AVAILABILITY

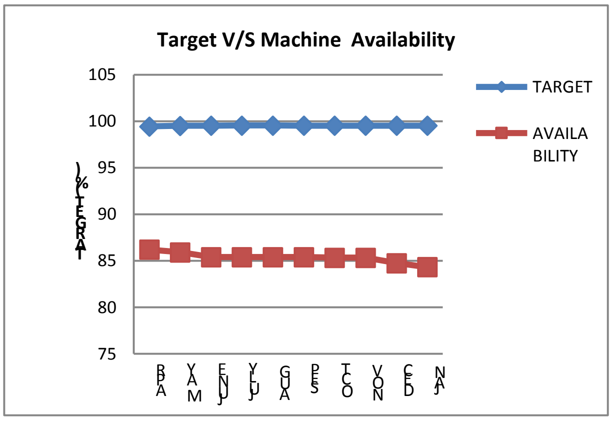


Figure 6: machine availability before TPM

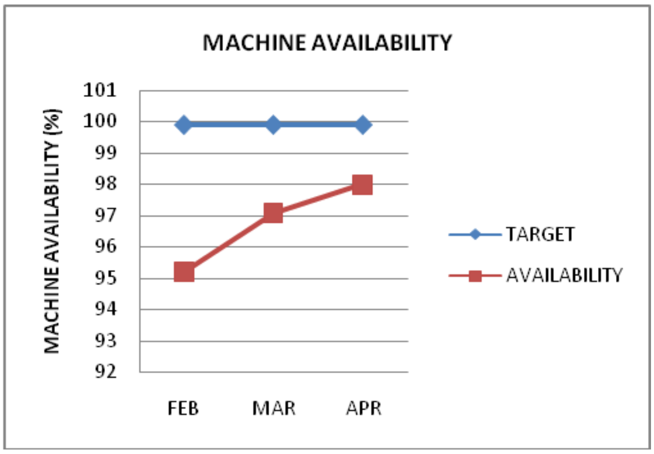
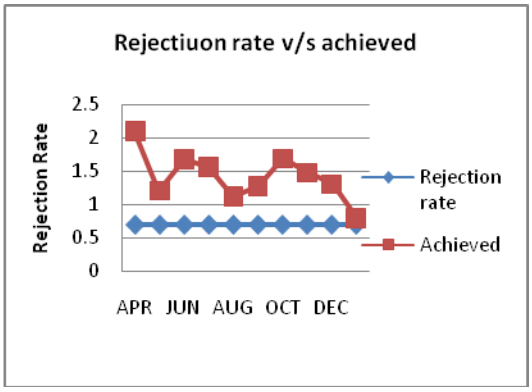


Figure 7: machine availability after TPM

In the above graphs the machine utilization before implementing TPM in OKK-1 MCV 820 was 87.5% from the period of 10 months that is April 2013 to Jan 2014 and after the implementation of TPM in OKK-1 MCV 820 the machine utilization is 96.5% in the period of February and March. The machine utilization increased after implementing TPM by 9%. And the availability and the performance of OKK-1 is increased.

Before TPM



AFTER TPM

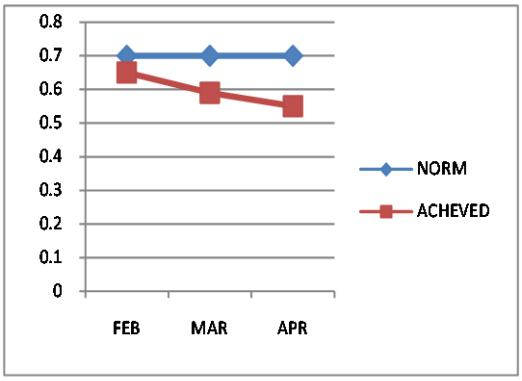


Figure 8: Comparison of rejection rate before and after TPM

In the above graphs before implementing TPM on OKK-1 MCV 820, the average rejection rate in the period of 10 months that is April 2013 to January 2014 is 1.423% and after implementing TPM on OKK-1 MCV 820 the average rejection rate 0.62% in the period of February and march. And the target norms is 0.7%, the rejection rate reduced in OKK-1 MCV 820 after implementing TPM.

IV. CONCLUSION

A manufacturing facility has been studied and analyzed to study TPM implementation methodology, calculations of OEE, difficulties in implementation, the roadmap followed and key benefits as a result of TPM implementation. In the case study firm, there have been attempts by management and the maintenance workers to involve the production people in basic maintenance work. But success has been limited for reasons discussed earlier, with negative effects. The study reveals that successful implementation of TPM requires top management support and commitment, a greater sense of ownership and responsibility from operators, co- operation and involvement of both operators and maintenance workers and an attitude change from "not my job" to "this is what I can do to help" The study shows how TPM significantly contribute to improve the productivity, quality, safety and morale of workforce. In case company, if there was any practice of TPM and team working between the maintenance and production people, this practice only existed informally, based upon personal relationship rather than taking it as TPM initiative. The study reveals the need for a more proactive approach to maintenance management and greater integration between maintenance and production departments. In the case company, the driving force came mainly from the maintenance department, which was keen to transfer some of basic maintenance tasks to their production fellows. But production operators resisted towards these changes as they have productivity pressure from middle management and they treat it as an additional workload. The study shows that implementing TPM is by no means an easy task without strong backup from the top management.

Before implementing TPM on the OKK-1 MCV 820 the Availability, Performance, Quality of the products and the machine was less and we calculated the Overall Equipment Effectiveness (OEE) of the OKK-1 MCV 820, the OEE in the periods of 10 months that is April 2013 to January 2014 was found that 65.73% because of the problems in OKK-1 MCV 820 the overall equipment effectiveness of the machine was less.

We introduced total productive maintenance (TPM) on the OKK-1 MCV 820.After implementing total productive maintenance on OKK-1 MCV 820 the availability, performance, quality of the products and the machine is increased. The overall equipment effectiveness after implementing TPM is found that 81.90% in the period of February and March 2014 and the OEE is increased by 12.17% after implementing total productive maintenance.

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