

Preventive Maintenance and Breakdown Reduction of Critical Machines

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Abstract - Manufacturing industries are facing a greater competition in the market because of various factors like technology, standardization, quality, etc. to name a few. This drives companies to work hard on systems of the company to improve and increase both quality and productivity continuously. One of the ways to increase the productivity is to increase the availability of existing machines. More the machine availability more is the scope for increase in productivity keeping other functional aspects of management is rest assured. Total productive maintenance (TPM) aims to increase the availability of existing equipment. TPM can be defined in terms of overall equipment effectiveness (OEE). Availability of machines can be increased by reducing the downtime or breakdowns of the machines. Main objective is to improve the machine performance by finding out the major breakdowns causing production losses to the company and arriving & executing the counter measures by which these problems can be reduced.

In this project, preventive maintenance and a breakdown reduction methodology is adopted to improve the machine performance. Root cause analysis is conducted to find the root cause of breakdowns and some parallel improvement opportunities were also identified for implementation so as to reduce the downtime. The project thus aims to minimize downtime, maximize availability, minimize maintenance cost and maximize profit. The project work concludes that this will help the maintenance department to increase equipment availability. Finally suggestion was given for future work.

Key Words: Preventive Maintenance, Total Productive Maintenance, Overall Equipment Effectiveness, Breakdown Reduction Methodology, Root Cause Analysis, Downtime.

1. INTRODUCTION

[1]Machine maintenance is gaining importance in industry because of the need to increase reliability and to decrease the possibility of production loss due to machine breakdown. Schedule preventive maintenance reduces the regular breakdowns and increases the availability of machine. [2]Maintenance is an activity to ensure that equipment is in a satisfactory condition and reliable. The goal of maintenance is to ensure that equipment is satisfactory. [4]There is an intense need for manufacturing industries to reduce unexpected breakdowns and remain

competitive, and motivating maintenance operations should be integrated into production scheduling models.

Dew (1991) and Sproull (2001) state that identifying and eliminating root causes of any problem is of utmost importance. Root cause analysis is the process of identifying causal factors using a structured approach with techniques designed to provide a focus for identifying and resolving problems. Tools that assist groups and individuals in identifying analysis tools (3).

Maintenance literature is rich with studies concerning the development and implementation of mathematical models for maintenance planning in deteriorating systems. Surveys conducted by authors (4), and an in-depth mathematical analysis by (5), comprehensively document the various approaches to modelling maintenance. Many researchers have developed models to address systems that operate continuously, as well as system that operates intermittently. The latter case assumes the system to age or deteriorate only during the operating periods (6).

This project deals with the identifying the critical machines of an automotive plant based on production, quality, environment and safety criteria. Troubleshooting on critical machines which has the highest breakdown hours and breakdown occurrence, In this project, preventive maintenance and breakdown reduction methodology is adopted to improve the machine performance.

Root cause analysis is conducted to find the root cause of breakdowns and some parallel improvement opportunities were also identified for implementation so as to reduce the downtime. Few points were added in the preventive maintenance checklist. The availability is increased considerably following the breakdown reduction & preventive maintenance methodology. The main objective of the project is to minimize downtime and maximize availability of the machines.

1.1 Methodology of Work

- The initial data collection of the breakdown details of the machine i.e. The data's such as breakdown hours,

breakdown occurrence, MTTR, MTBF are collected & studied.

- Selecting the critical machine i.e., “Shot Blast & Cold Swage” for the analysis.
- Studying the type of failures occurred & frequently repeating failures.
- Following the breakdown reduction methodology.
- Performing root cause analysis to reduce the recurrence of failures.
- Performing “WHY-WHY” analysis.
- Replace the defective parts of the machine.
- Implementing the corrective steps.
- Monitoring and verifying the results

2. ROOT CAUSE ANALYSIS & IMPLEMENTATION

1. Break down Description- Component is not moving

Root cause – Rollers getting jammed

Physical phenomenon –Roller End support bearing jammed

Root Cause from Why-Why Analysis

Problem	Component is not moving
Why?	Roller getting jammed
Why?	Roller end support bearing jammed
Why?	Bearing worn out due to deterioration
Why?	Bearing not replaced periodically

Corrective counter measure –

- Roller bearing is greased during preventive maintenance
- Roller bearing plate is tightened
- Plumber block bearing is replaced



Roller end support bearing is jammed

Plumber block cover plate is loose



Now the cover plate is tightened, greased & plumber block is replaced



Benefits/Results after implementation- Roller end support bearing are free from getting jammed; now the roller is rotating & components are moving.

2. Break down Description- Table tilting is not working

Root cause – Limit switches not working

Physical phenomenon – Limit switch cable got cut

Root Cause from Why-Why Analysis

Problem	Table tilting is not working
Why?	Table tilting Limit switches all 3 no's not working
Why?	Limit switch cable got cut
Why?	Cable to be checked & rejoined
Why?	Cable to be replaced on Time Based Maintenance

Corrective counter measure –

- Table tilting Limit switches all 3 no's not working
- Cable to be checked & replaced.

Table tilting is not working, cable got cut



Cable is replaced, Limit switches all 3 no's now working



Table tilting is now working



Benefits/Results after implementation- After cable replacement, limit switches all 3 no's now working hence the table tilting problem is eliminated, & cold swage operation is further proceeded.

3. RESULTS AND DISCUSSION

3.1 Process Parameters of Disa Shot Blast Machine before the Implementation of Counter Measures

1. Total downtime of Disa Shot blast machine in the period **Oct-2015** to **Jan-2016** = **138** hours
2. Total available time for Disa Shot blast machine in the period **Oct-2015** to **Jan-2016** = **2288** hours (22hours×26 Days, 26Days×4Months = 572×4=2288) Excluding Sundays, holidays, & lunch time.

3. Total number of breakdowns in the period **Oct-2015** to **Jan-2016**= **39**

$$\text{Availability} = \frac{\text{Totalavailablehours} - \text{Totalbreakdownhours}}{\text{Totalavailablehours}}$$

$$\text{Availability} = \frac{2288-138}{2288} = 0.9396$$

$$\text{Availability} = \mathbf{93.96\%}$$

$$\text{Loss of availability} = 1 - 0.9396 = 0.0604$$

$$= \mathbf{6.04\%}$$

$$\text{MTBF} = \frac{\text{totalavailablehours} - \text{breakdownhours}}{\text{no.ofbreakdown}}$$

$$= \frac{2288-138}{39} = 55.12$$

$$= \mathbf{55.12 \text{ hours}}$$

$$\text{MTTR} = \frac{\text{totalbreakdownhours}}{\text{no.ofbreakdowns}}$$

$$= \frac{138}{39} = 3.53$$

$$= \mathbf{3.53 \text{ hours}}$$

3.1.1 Process Parameters of Disa Shot Blast Machine after the Implementation of Counter Measures

1. Total downtime of Disa Shot blast machine in the period **Feb-2016** to **Apr-2016** = **48** hours
2. Total available time for Disa Shot blast machine in the period **Feb-2016** to **Apr-2016** = **1716** hours (22hours×26 Days, 26Days×3Months = 572×3=1716) Excluding Sundays, holidays, & lunch time.
3. Total number of breakdowns in the period **Feb-2016** to **Apr-2016**= **18**

$$\text{Availability} = \frac{\text{Totalavailablehours} - \text{Totalbreakdownhours}}{\text{Totalavailablehours}}$$

$$\text{Availability} = \frac{1716-48}{1716} = 0.9720$$

$$\text{Availability} = \mathbf{97.20\%}$$

➤ Loss of availability = 1- 0.9720 = 0.028

$$= \underline{2.8\%}$$

➤ $MTBF = \frac{\text{totalavailablehours} - \text{breakdownhours}}{\text{no.ofbreakdown}}$

$$= \frac{1716-48}{18}$$

$$= \underline{92.66 \text{ hours}}$$

➤ $MTTR = \frac{\text{totalbreakdownhours}}{\text{no.ofbreakdowns}}$

$$= \frac{48}{18}$$

$$= \underline{2.66 \text{ hours}}$$

Table 1: Comparison of results before and after implementation of counter measures of a Disa Shot Blast Machine

Availa bility before imple mentat ion (%)	Availa bility after imple menta tion (%)	MTBF before imple mentatio n (hours)	MTBF after imple mentatio n (hours)	MTTR before imple mentatio n (hours)	MTTR after imple mentatio n (hours)
93.96	97.20	55.12	92.66	3.53	2.66

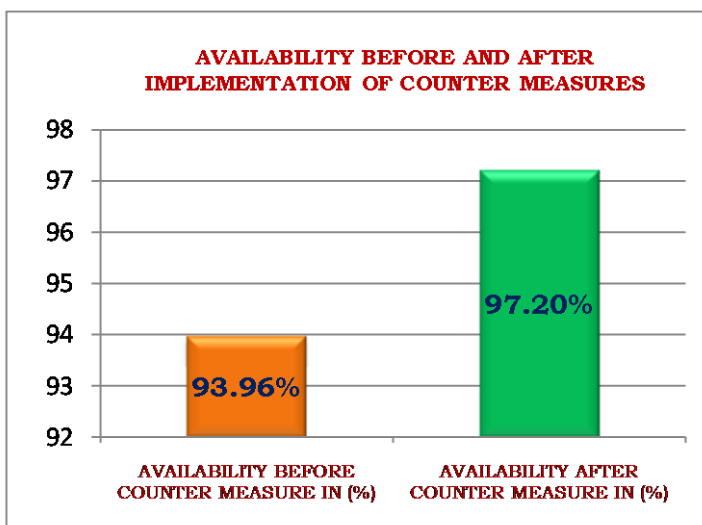


Fig.1 Graph Showing Comparison of Availability before and after implementation of counter measures

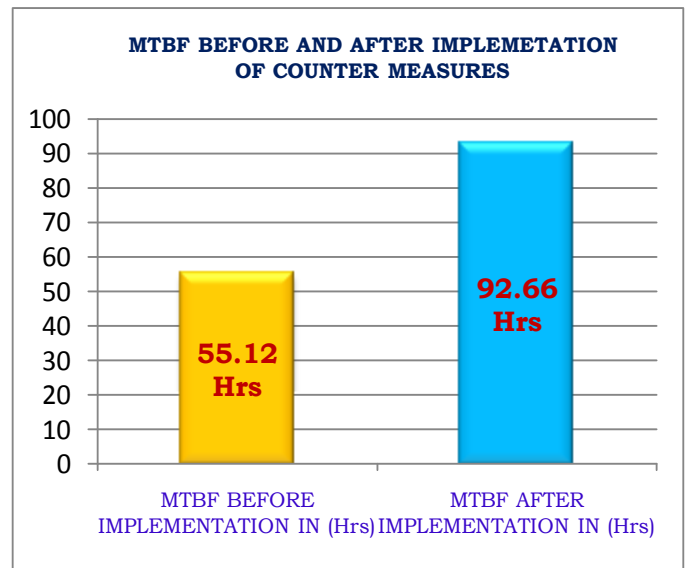


Fig.2 Graph Showing Comparison of MTBF before and after implementation of counter measures

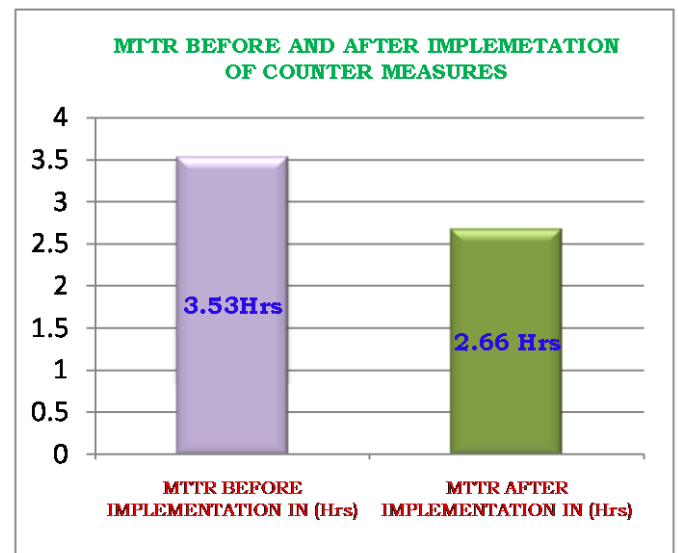


Fig.3 Graph Showing Comparison of MTTR before and after implementation of counter measures

3.2 Process Parameters of BFW Cold Swage Machine before the Implementation of Counter Measures

1. Total downtime of BFW Cold Swage machine in the period **Oct-2015 to Jan-2016** = 134 hours
2. Total available time for BFW Cold Swage machine in the period **Oct-2015 to Jan-2016** = 2288 hours (22hours×26 Days, 26Days×4Months = 572×4=2288) Excluding Sundays, holidays, & lunch time.
3. Total number of breakdowns in the period **Oct-2015 to Jan-2016**= 34

$$\text{Availability} = \frac{\text{Totalavailablehours} - \text{Totalbreakdownhours}}{\text{Totalavailablehours}}$$

$$\text{Availability} = \frac{2288-134}{2288} = 0.9414$$

$$\text{Availability} = \mathbf{94.14\%}$$

$$\text{Loss of availability} = 1 - 0.9414 = 0.0586$$

$$= \mathbf{5.86\%}$$

$$\text{MTBF} = \frac{\text{totalavailablehours} - \text{breakdownhours}}{\text{no.ofbreakdown}}$$

$$= \frac{2288-134}{34} = 63.35$$

$$= \mathbf{63.35 \text{ hours}}$$

$$\text{MTTR} = \frac{\text{totalbreakdownhours}}{\text{no.ofbreakdowns}}$$

$$= \frac{134}{34} = 3.94$$

$$= \mathbf{3.94 \text{ hours}}$$

Availa bility before imple mentation (%)	Availa bility after imple mentation (%)	MTBF before imple mentation (hours)	MTBF after imple mentation (hours)	MTTR before imple mentation (hours)	MTTR after imple mentation (hours)
94.14	97.31	63.35	98.23	3.94	2.70

$$\text{MTBF} = \frac{\text{totalavailablehours} - \text{breakdownhours}}{\text{no.ofbreakdown}}$$

$$= \frac{1716-46}{17}$$

$$= \mathbf{98.23 \text{ hours}}$$

$$\text{MTTR} = \frac{\text{totalbreakdownhours}}{\text{no.ofbreakdowns}}$$

$$= \frac{46}{17}$$

$$= \mathbf{2.70 \text{ hours}}$$

3.2.1 Process Parameters of BFW Cold Swage Machine after the Implementation of Counter Measures

1. Total downtime of BFW Cold Swage machine in the period Feb-2016 to Apr-2016 = **46 hours**
2. Total available time for BFW Cold Swage machine in the period Feb-2016 to Apr-2016 = **1716 hours** (22hours×26 Days, 26Days×3Months = 572×3=1716) Excluding Sundays, holidays, & lunch time.
3. Total number of breakdowns in the period Feb-2016 to Apr-2016= **17**

$$\text{Availability} = \frac{\text{Totalavailablehours} - \text{Totalbreakdownhours}}{\text{Totalavailablehours}}$$

$$\text{Availability} = \frac{1716-46}{1716} = 0.9731$$

$$\text{Availability} = \mathbf{97.31\%}$$

$$\text{Loss of availability} = 1 - 0.9731 = 0.0269$$

$$= \mathbf{2.69\%}$$

Table 2: Comparison of results before and after implementation of counter measures of BFW Cold Swage Machine

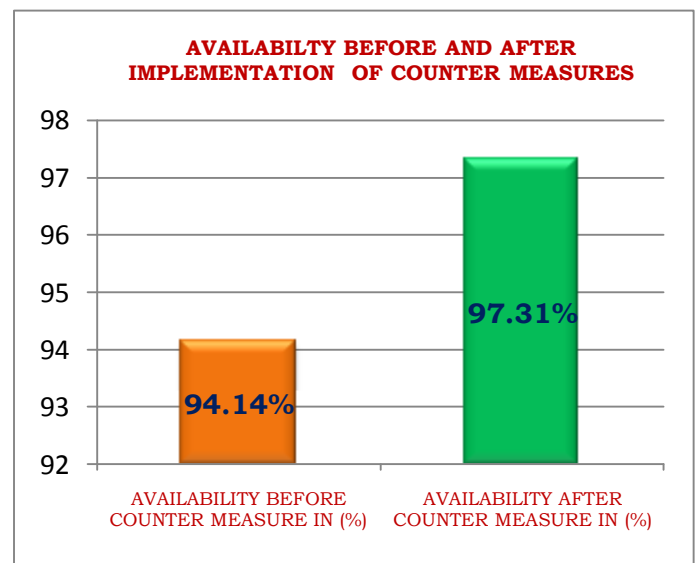


Fig.4 Graph Showing Comparison of Availability before and after implementation of counter measures

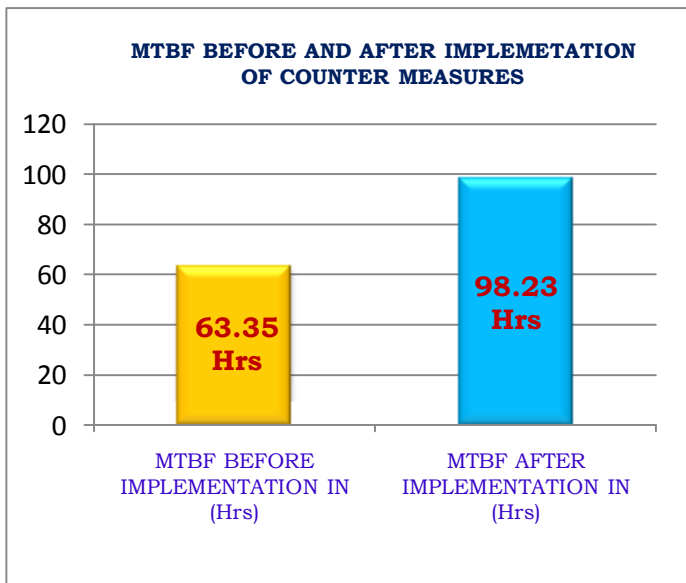


Fig.5 Graph Showing Comparison of MTBF before and after implementation of counter measures

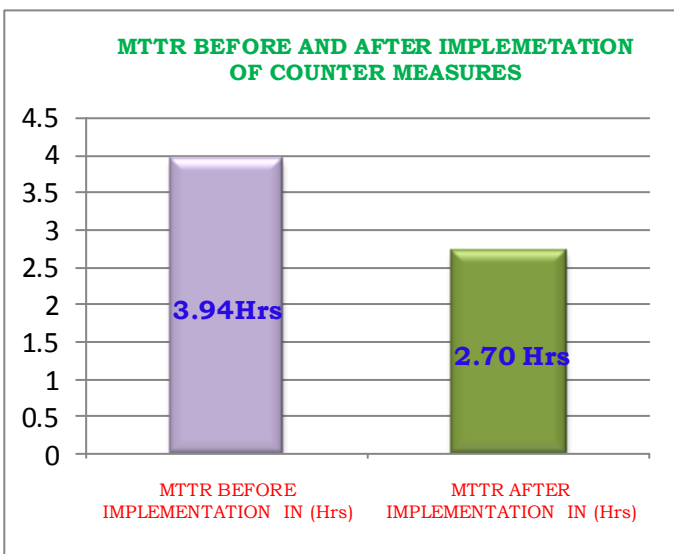


Fig.6 Graph Showing Comparison of MTTR before and after implementation of counter measures

4. CONCLUSION

The use of root cause analysis helped to identify the correct causes of failures by which the suitable countermeasures are developed and implemented. The process measurable such as Availability, MTBF, and MTTR are calculated before and after the implementation of counter measures. Continuous monitoring of processes is done after the implementation of counter measures and following conclusions are drawn:

The Breakdowns such as Rollers problem, Spout unit problem, Impeller problem in Disa Shot Blast Machine is completely eliminated.

- The availability of Disa Shot Blast Machine is increased from 93.96% to **97.20%**.
- The MTBF of Disa Shot Blast machine is increased from 55.12 hours to **92.66** hours.
- The MTTR of Disa Shot Blast machine is decreased from 3.53 hours to **2.66** hours.
- The Effectiveness of preventive maintenance of Disa Shot Blast machine is improved.

The Breakdowns such as Table tilting problem, Deep Pressmark on job, Proximity Sensors problem in BFW Cold Swage Machine is completely eliminated.

- The availability of BFW Cold Swage Machine is increased from 94.14% to **97.31%**.
- The MTBF of BFW Cold Swage Machine is increased from 63.35 hours to **98.23** hours.
- The MTTR of BFW Cold Swage Machine is decreased from 3.94 hours to **2.70** hours.
- The Effectiveness of preventive maintenance of BFW Cold Swage Machine is improved.

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