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INTRODUCTION

REVIEW OF LITERATURE

NEED/IMPORTANCE OF THE STUDY

STATEMENT OF THE PROBLEM

OBJECTIVES

HYPOTHESES

RESEARCH METHODOLOGY

RESULTS & DISCUSSION

FINDINGS

RECOMMENDATIONS/SUGGESTIONS

CONCLUSIONS

SCOPE FOR FURTHER RESEARCH

ACKNOWLEDGMENTS

REFERENCES

APPENDIX/ANNEXURE

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BOOKS

- Bowersox, Donald J., Closs, David J., (1996), "Logistical Management." Tata McGraw, Hill, New Delhi.
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CONTRIBUTIONS TO BOOKS

- Sharma T., Kwatra, G. (2008) Effectiveness of Social Advertising: A Study of Selected Campaigns, Corporate Social Responsibility, Edited by David Crowther & Nicholas Capaldi, Ashgate Research Companion to Corporate Social Responsibility, Chapter 15, pp 287-303.

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- Schemenner, R.W., Huber, J.C. and Cook, R.L. (1987), "Geographic Differences and the Location of New Manufacturing Facilities," Journal of Urban Economics, Vol. 21, No. 1, pp. 83-104.

CONFERENCE PAPERS

- Garg, Sambhav (2011): "Business Ethics" Paper presented at the Annual International Conference for the All India Management Association, New Delhi, India, 19–22 June.

UNPUBLISHED DISSERTATIONS AND THESES

- Kumar S. (2011): "Customer Value: A Comparative Study of Rural and Urban Customers," Thesis, KurukshetraUniversity, Kurukshetra.

ONLINE RESOURCES

- Always indicate the date that the source was accessed, as online resources are frequently updated or removed.

WEBSITES

- Garg, Bhavet (2011): Towards a New Natural Gas Policy, Political Weekly, Viewed on January 01, 2012 http://epw.in/user/viewabstract.jsp

SAP IMPLEMENTATION FOR PREVENTIVE MAINTENANCE USING BREAKDOWN HISTORY

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ABSTRACT

Maintenance Management is a key function used by industrial systems that deteriorate and wear with usage and age. The primary objective of maintenance management is to increase equipment availability and overall effectiveness. Since the cost of maintenance is very high, modern industry requires not only the theoretical basis to express the experience of operators, but also the identification of proper techniques to optimize the maintenance action. Maintenance Scheduling grows importance as the maintenance cost accounts for a significant portion of the total production cost in capital intensive industries. Scheduling is a crucial component of maintenance management. Effective use of scheduling is a major factor of workforce productivity. The computer aided maintenance system helps both management and maintenance section in working at maximum effectiveness by providing adequate information with minimum effort. The present work was carried out with an objective of computerizing the plant maintenance system and doing analysis for the critical machines which often break down and which in turn affects the factories overall turn over in terms of both production and monetary benefits. The firm was following breakdown maintenance with regular lubrication and simple inspection. Manually the data were recorded, which are characterized by high maintenance costs, unpredictable breakdown, down time and production loss. The computerized preventive maintenance system and analysis was implemented using SAP technology which minimizes breakdown and production loss in terms of breakdown hours.

KEYWORDS

Availability, Mean Time between Failure (MTBF), Mean Time to Repair (MTTR), Preventive Maintenance Program, Reliability.

INTRODUCTION

Maintenance is a combination of all technical, administrative, and managerial actions during the life cycle of an item intended to keep it in or restore it to a state in which it can perform the required function [6]. Until World War II, industry was not highly mechanized. Failure consequences were not vital and had a neglected effect. Therefore, industrial equipment was operated until it failed, i.e., Reactive Maintenance was followed. After World War II, the shortage of industrial manpower and the increase in demand of various products, among other things, led to increased mechanization and maintenance became a task of the maintenance department and was considered as a technical matter, thus the second maintenance approach could be described as a preventive approach. During the 1970's, manufacturing plants became even more automated and complex. Reliability, Availability and Maintainability (RAM), safety, quality, environment, and multi-skilling were considered very important therefore, more integration efforts have been done and maintenance no longer remained an isolated function. Thus, these approaches can be described as a predictive approach. By the beginning of 1980's, many systematic concepts to maintenance have been proposed such as terotechnology, RCM, TPM. Thus, these practices can be described as process oriented "holistic" approach [7].

The maintenance organization is confronted with a wide range of challenges that include quality improvement, reduced lead times, set up time and cost reductions, capacity expansion, managing complex technology and innovation, improving the reliability of systems, and related environmental issues. However, trends suggest that many maintenance organizations are adopting Total Productive Maintenance (TPM), which is aimed at the total participation of plant personnel in maintenance decisions and cost savings. The challenges of intense international competition and market globalization have placed enormous pressure on maintenance system to improve efficiency and reduce operational costs. These challenges have forced maintenance managers to adopt tools, methods, and concepts that could stimulate performance growth and minimize errors, and to utilize resources effectively toward making the organization a "world-class manufacturing" or a "high-performance manufacturing" plant.

Industrial maintenance has two essential objectives which are a high availability of production equipment and low maintenance costs. However, a strong factor militating against the achievement of these objectives is the nature and intensity of equipment failures in plants. Since system failure can lead to costly stoppages of an organization's operation, which may result in low human, material, and equipment utilization, the occurrence of failure must therefore be reduced or eliminated. An organization can have its customers build confidence in it by having uninterrupted flow in operations. Thus, maintenance ensures system sustenance by avoiding factors that can bother effective productivity, such as machine breakdown and its several attendant consequences [1-3 & 8].

The maintenance procedures involve:

- Preventive maintenance—the prevention of equipment breakdowns before they happen. This includes inspections, adjustments, regular service and planned shutdowns.
- Repair work—repairing equipment and troubleshooting malfunctions in an effort to return the equipment to its previous condition. These repairs may be reactive or preventive.
- Improvement work—searching for better materials and improved design changes to facilitate equipment reliability. Repair work is often a part of improvement work.

IMPORTANCE OF THE STUDY

Preventive Maintenance Program consists of actions that improve the condition of system elements for performance optimization and aversion of unintended system failure or collapse. It involves inspection, servicing, repairing or replacing physical components of machineries, plant and equipment by following the prescribed schedule. It is commonly agreed nowadays that preventive maintenance program can be very successful in improving equipment reliability while minimizing maintenance related costs. [5]

Preventive maintenance (PM) refers to any activity, which is performing:

1. To predict the onset of component failure;
2. To detect a failure before it has an impact on the asset function; and
3. To repair or replace the asset before failure occurs.

Availability is the ability of an asset to perform its function as predicted. Availability is usually measured as the mean of time between the failures (MTBF) for each of the system. The maintenance of the centralize availability is a process which could be used to determine any physical asset continuous functioning according to the tasks designed or assigned. The availability engineering is concerned about the prediction and avoidance any failures effectively and at the same time including the cost factors if failure is allowed to happen. Each maintenance personnel must know and understand the machine operations and always tries to improve the availability of the machine. In facing technical problems, competence maintenance personnel could come out with the solution and counter measure so that the problems would not recur. Besides that, they are also responsible to perform the existing maintenance activities and take corrective actions to solve any existing problem. Keeping up with the scheduling has also become an important indicator to control and monitor the maintenance activities. [4]

PROBLEM IDENTIFICATION

The present work was carried out in BHEL, EDN, Bangalore which is an electrical and electronic industry with an objective of computerizing the plant maintenance system and doing analysis for the critical machines which often break down and which in turn affects the factories overall turn over in terms of both production and monetary benefits.

It has been observed that the factory maintenance includes or rather relies on breakdown maintenance for most of the equipments. For some critical equipment manual preventive maintenance was in practice which mainly includes lubrication, greasing, top up of oil levels and servicing, if required and the same was recorded with proper scheduling and planning. Tracking the breakdown history of the machines has been unsuccessful because of inherent problems with data management. Due to this scheduling of preventive maintenance is not carried out properly and completely. This in turn causes breakdowns resulting in large amount of production loss.

Hence it was found desirable to have a proper computer aided preventive maintenance and analysis using breakdown history (using SAP) which is capable of handling very large data. Sap can generate maintenance schedule automatically and also keeps records of all the necessary details of maintenance activities, equipment break down history (number of occurrences, date, time, make etc) and also calculate mean time between repair (MTBR), mean time to repair (MTTR).

The main objective of the present work is to develop formats, reports, etc and also to implement the tedious and difficult manual pm and analysis method to easy, user friendly sap technology. This also includes design and development of user friendly software methods for the application of pms. In brief, this includes creating and maintaining pm databases, scheduling of maintenance and also obtaining reports whenever required with results of reduced down time like mean time between repair (MTBR), mean time to repair (MTTR).

In computerizing the maintenance activities, data and procedures, at all levels of an organization. Hence the departments are to be interlinked and integrated to accomplish the maintenance task through sap technology. If in any department, data is changed then it should be reflected in all the departments irrespective of the levels. And authorizations of changing authentic information would be retained with the appropriate responsible personnel. For the maintenance module, most important and critical equipments, or machines are to be listed or identified for analysis and studied depending upon the breakdown history.

IMPLEMENTATION OF COMPUTER AIDED PREVENTIVE MAINTENANCE & ANALYSIS

The computer aided maintenance system helps both management and maintenance section in working at maximum effectiveness by providing adequate information with minimum effort. Record keeping is also made easier because input data can be edited and equipment records can be standardized. The software used in this organization is SAP (an acronym for systems applications and products for data processing) developed in Germany, by the company SAP.

System Application and Products (SAP) technology which is an integrated functional organizational program will be a multi user accessible system to all levels of organization like finance .HRD, production, maintenance etc. Any information at any point of time at any level of organization can be viewed but cannot be altered or manipulated unless authentic authorization is given. But it will be with senior managers of that particular department. This product (package) provides easy access and has user friendly system codes to transact.

When a system failure occurs, the maintenance organization is tasked with accomplishing the necessary repair actions in order to get the system back into operation as soon as possible. The Equipment Maintenance Data to be recorded are:

1. Administrative Data:
- Event report number, report date & individual preparing report.
- Work order number.
- Work area & time of work (month, day, year).
- Activity (organization) identification.

2. System Factors:
- Equipment part number &manufacturer
- Equipment serial number
- System operating time when event occurred
- Segment of mission when event occurred
- Description of event (describe symptoms of failure for unscheduled actions)

3. Maintenance Factors:
- Maintenance requirement (repair, calibration, servicing, etc)
- Description of maintenance tasks
- Maintenance downtime (MDT)
- Active maintenance times
- Maintenance delays (time awaiting spare part, delay for test equipment, work stoppage, awaiting personnel assistance, delay for weather, etc)

4. Logistics factors:
- Start & stop times for each maintenance technicians by skill level Technical manual or maintenance procedure used (procedure number, date)
- Test & support equipment used (item nomenclature, part number, manufacturer, serial number, time usage, operating time on test equipment when used)
- Description of facilities used
- Description of replacement parts (type & quality): Item nomenclature, part number, manufacturer, serial number, &operating time on installed / replaced item, describe disposition.

5. Other information: Failure mode, cause of failure, effects of failure

DEVELOPMENT OF SYSTEMATIC MAINTENANCE PROGRAM

The guidelines for preparing a sound maintenance program which is cost effective and functionally easy and efficient are as follows:

PHASE-1: IDENTIFY EQUIPMENT TO BE MAINTAINED

1. Prepare an equipment list.
2. Assign equipment number
3. Obtain technical literature.
4. Cross check technical literature and equipment specification.
5. Prepare equipment record.

PHASE – II: ESTABLISH CONTROL OF MAINTENANCE

1. Design a master maintenance schedule.
2. Design periodic report for maintenance activities.
3. Design equipment history form.
4. Design equipment maintenance form.

PHASE-III: DEVELOP PAPER WORKS FOR MAINTENANCE

1. Minimize the number of formats and entries.
2. Develop overall planning for maintenance paper work.
3. Establish functional paper work with crisp and structured formats

PHASE – IV: DOCUMENTATION

1. Equipment data record: It gives details about the machine or equipment, which are critical.
2. Breakdown status: This is required to keep the track of work progress and to maintain a fair workload leveling process. This indicates the no, of notifications (failures) with equipment no, description, breakdown duration, the object part details due to which the machine is not working or down.
3. Comprehensive report: (Breakdown report) this will give the equipments which are down with its down time duration MTTR, MTBR, TBR and TTR. And also the equipments, which are out of factory limitations or specifications as criteria for, further maintenance.

REPORTS USED AND ITS DETAILS

1. Equipment data: This database includes equipment number, equipment name, year of installation of the equipment, manufacturer's details, M/C specifications, etc. all these are fed and stored in the data base which is available in the system of online facility.
2. Equipment history or Breakdown history: This includes equipment name, number, notification no, malfunction start and end, description of the problem, breakdown duplication and planner group.
3. Preventive Maintenance planning schedule: This includes PM planning and scheduling of equipments with schedule start date, completing date, order, plan number and strategy.
4. Analysis: This includes list of equipments reported under breakdown with equipment–name, code, number of breakdowns, Mean Time To Repair, Mean Time Between Repair, Time between repair, time to repair(down time).

The critical Machines are identified for detailed analysis, if their MTBR is <1500hrs. or MTTR > 40 hrs. For the same, analysis report is generated or prepared which highlights equipment number, cause of malfunction or breakdown, damage caused, number of damages and also experts remedy to prevent damage.

METHODOLOGY

The Preventive Maintenance procedure involves:

1. Breakdown is reported through notification from the user/concerned department. (Through ERP online / MSR or through mail)
2. Notification is taken for rectification with malfunction start date and after rectification, the completion date should be mentioned with down time duration.
3. If any material/spares are drawn from the store for any replacements during repair, the maintenance order is created. And the same would be entered in materials management module.
4. After breakdown is rectified the same should be reported with the planner group. These rectifications can be done while during PM Scheduling & planning.

The Maintenance Analysis procedure involves:

1. Prepare a list of critical equipments with cost center, with the help of PM study.
2. Collect & enter breakdown details for all machines, with down time duration and parts / objects failure details.
3. Collect break down data for the listed/selected equipment.
4. Generate Analysis report by calculating or find out MTTR, MTBR using down time.
5. Based on MTTR and MTBF report as shown in Fig. 1, Identify critical equipment using criteria i.e. MTBR < 1500 hrs or MTTR> 40 Hrs for detailed analysis and for further Maintenance.
6. For those equipments, which violates or exceeds the criteria prepare analysis report. This can be done by suggesting remedies or future PM activities to improve MTTR and MTBR, after every breakdown is analyzed. The suggestions or remedies are written after discussing with experts and engineers and also with experienced operators.

RESULTS

The existing system configuration is not optimum in terms of fulfilling the desired objectives, it is necessary to implement a PM for malfunction activity whereby the system can be modified for improvement. From a PM & Analysis (Maintainability) perspective, improvements can be realized through a reduction in;

- The number of maintenance actions required (i.e., improving reliability).
- Maintenance tasks times and maintenance man hour.
- The logistics support resources needed in the accomplishment of maintenance.
- The cost of performing maintenance and so on.

These measures can be impacted in a number of ways, including increasing the standardization of components, improving testability, and system diagnostics, improving the accessibility to critical components, some times retrofitting also. This enhances the system's reliability, functionality and special features required.

CALCULATION OF PERCENTAGE OF DOWN TIME

The factory runs on all 365 days and 24 hours a day. Out of 260 machines, 37 machines are critical based on the breakdown report during the current year. From MTTR & MTBR report shown in Fig. 1,

Total available time =365*24*37=324120 hrs.

Total downtime = 4172.97 hrs.

The percentage Down Time is the percentage fraction of the total downtime for critical machines w.r.t. the Total available time for critical machines which is found to be 1.287%

The percentage down time is shown in Fig. 2. It is well within the fixed corporate target level and also it is almost same as the previous years. The Total MTTR is shown in Fig. 3. It is found to be within the maximum or fixed corporate target and the mean time to repair is less than the previous year which indicates a reduction in down time.

REPORT GENERATION

Easily understandable reports and equipment data fields are developed to have a user-friendly tables, which is easy to understand and can be accessed by all concerned personnel. Any modifications or updating of the data regarding any equipment can be made by looking at the screen, which in turn will be changed in the concerned data of the equipment.

Database is also created for equipment profile, equipment history, and maintenance reports like object part details, cause code details etc. and the equipment reports that can be produced are:

1. Equipment history report: This allows the detailing of any work performed on any specified equipment.

FIG. 1: MTTR AND MTBR REPORT

	List of Equipment Reported Breakdown 2009-10						
		Equipment	Actual Breakdown	Mean Time to Repair	Mean Time Between Repair	Time Between Repair	Time To Repair
1	10000517	Exhaust - Lacquering Booth	2	4	7,141.00	14,282	8
2	16923003	INJECTION MOULDING MACHINE HMT	10	42.18	858.32	8583.17	421.83
3	25111023	16 TON POWER PRESS	3	35.26	3085.03	9255.08	105.78
4	25113002	63 TON POWER PRESS	2	39.13	6035.74	12071.48	78.27
5	25161002	CNC TURRET PUNCH PRESS	12	23.23	584.52	7014.22	278.78
6	25247001	CNC PRESS BRAKE	8	9.18	1079.48	8635.85	73.40
7	26246001	POWER SHEARING MACHINE-STAR	2	147.25	2767.50	5535.00	294.50
8	26246002	POWER SHEARING MACHINE-AMETEEP	7	8.67	1145.97	8021.78	60.72
9	31128004	CENTRE LATHE	1	5.50	7603.50	7603.50	5.50
10	31131001	CENTRE LATHE	1	1.00	8542.93	8542.93	1.00
11	31131002	CENTRE LATHE	1	50.75	16428.25	16428.25	50.75
12	31212001	CAPSTAN LATHE	5	23.85	3583.01	17915.07	119.23
13	32123001	RADIAL DRILLING MACHINE	1	0.57	8320.93	8320.93	0.57
14	32133002	RADIAL DRILLING MACHINE	3	8.21	1975.74	5927.23	24.62
15	32133003	RADIAL DRILLING MACHINE	1	237.02	8257.32	8257.32	237.02
16	34114002	HORIZONTAL MILLING MACHINE	1	7.25	8754.75	8754.75	7.25
17	34114005	HORIZONTAL MILLING MACHINE	1	7.70	7130.30	7130.30	7.70
18	34114006	HORIZONTAL MILLING MACHINE	8	41.60	927.65	7421.18	332.82
19	34234001	VERTICAL MILLING MACHINE	1	4.72	3887.45	3887.45	4.72
20	34234002	VER.MILLING M/C (CNC RETROFIT)	5	132.24	1711.06	8555.28	661.22
21	34234003	VERTICAL MILLINING MACHINE	1	0.27	2477.73	2477.73	0.27
22	34234004	VERTICAL MILLING MACHINE	2	39.08	4260.43	8520.85	78.15
23	37432001	CIRCULAR SAW (NON-METAL)	1	3.78	13041.22	13041.22	3.78
24	41134004	SURFACE GRINDING MACHINE	2	10.87	3384.63	6769.27	21.73
25	42231002	CYLINDRICAL GRINDING MACHINE	1	17.97	10610.38	10610.38	17.97
26	44420001	BAND SAW MACHINE	9	14.68	1348.21	12133.87	132.13
27	53111007	SPOT WELDING M/C (PORTABLE)	2	1.63	6225.40	12450.80	3.25
28	53121010	SPOT WELDER	6	17.90	2450.05	14700.30	107.40
29	55111002	SOLDER MELTING POT	3	206.78	1504.56	4513.67	620.33
30	73865103	PCB IN-CIRCUIT TESTER (Genrad)	3	21.67	1274.33	3823.00	65.00
31	81121001	5 TON EOT CRANE	1	7.38	7192.12	7192.12	7.38
32	81122001	5 Tonne EOT Crane - Century Fab.	1	19.75	2377.92	2377.92	19.75
33	81122003	10 TON EOT CRANE -Century Fab Tech P Ltd	2	130.88	5251.75	10503.50	261.75
34	81131001	0.5 Tonne Jib Crane - Hi-Tech Engineers	1	31.25	59864.50	59864.50	31.25
35	81134001	5 TON JIB CRANE WITH MOTORISED TROLLY	1	4.00	10121.75	10121.75	4.00
36	81321002	CAGE LIFT	1	1.75	15398.00	15398.00	1.75
37	81731001	BELT CONVEYOR	3	7.80	6108.78	18326.35	23.40
		Total	115	36.29	3434.50	394968.00	4172.97
	Identified machines (if MTBR < 1500 hrs or MTTR >40 hrs) for Detailed analysis						

FIG. 2: CHART FOR PERCENTAGE DOWNTIME

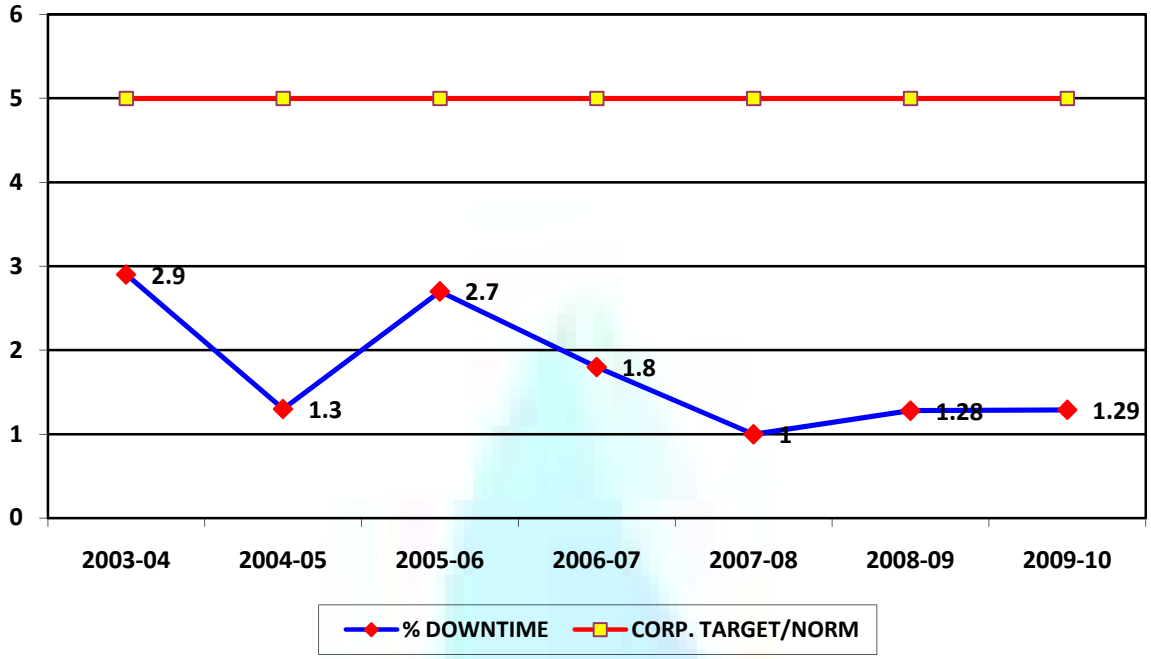
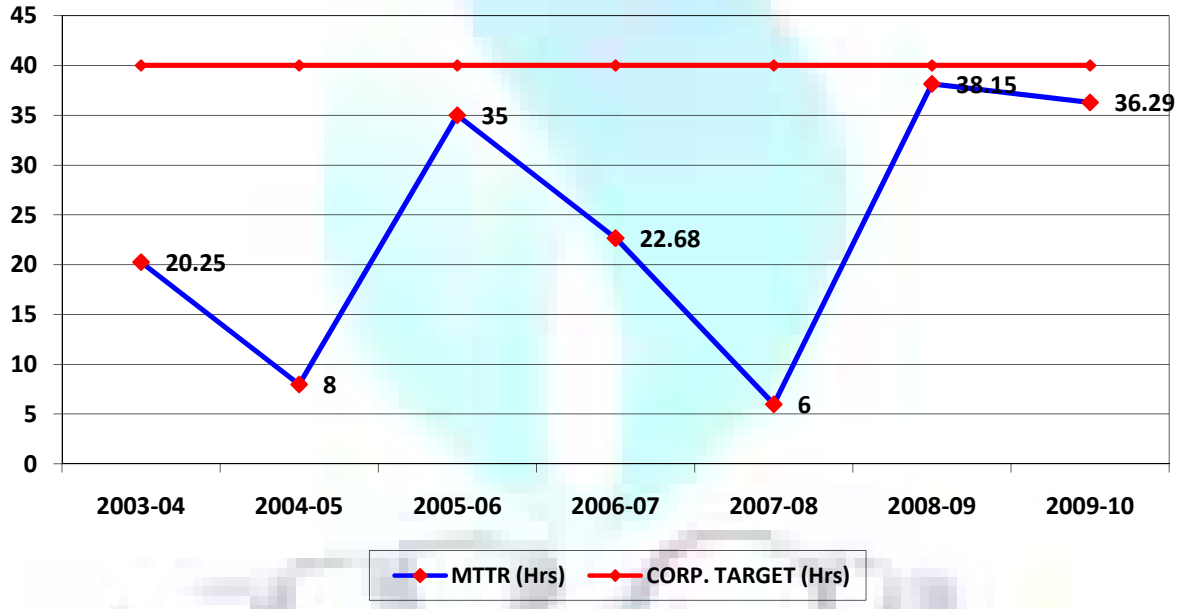


FIG. 3: CHART FOR MEAN TIME TO REPAIR (MTTR)



1. MTBF / MTTR Report: This report calculates the mean time between failure and the mean time to repair for a piece of equipment or even for the component of the equipment. This information can be useful to set frequencies for PM programmes and planning production schedules.
2. Periodic equipment wise Maintenance cost report: In order of highest to lowest.
3. Equipment down time report: In order to highest to lowest.

CONCLUSIONS

The Computer Aided Preventive Maintenance and analysis using breakdown history is designed to help the management in planning routine inspection to minimize down time, breakdowns and also to reduce the expenditure of the plant. It reduces clerical work like listing electrical equipments, number of failures and its causes, remedies and also indicates or reminds about preset scheduling dates for Preventive Maintenance.

The SAP implementation of PM helps to analyze the availability and maintainability of the plant facility like equipments or machines in order to reduce the down time and also repair time by identifying redundant problems. It also assists the maintenance department in carrying out the maintenance of machines in an organized manner. The main purpose of implementing the software is to:

- Reduce the paper work.
- Provide back history instantaneously.
- Have detailed history of breakdown of or parts, materials, its problems causes and remedies.
- Easy to operate and uses friendly i.e. any layman can understand and operate easily.
- Reports of equipment data, equipment location, preventive maintenance instructions and scheduling can be taken.
- Correct and suggest the appropriate PM tasks and also to analyze properly using connect down time with failure analysis terminology.

The present work helps to know the equipment details, its damages and causes with appropriate remedies, which will be discussed with experts and experienced operators. Reports of analysis depicts down time reduction year-to-year, if proper maintenance or corrective action is taken care. It makes or guides any layman to perform the PM tasks and also to operate the SAP software with least knowledge of maintenance. The software has security features, which allow only authorized personnel to easily operate, understand and work without any difficulty. Since SAP software technology has different modules like maintenance finance, HR, marketing, production sales etc. This will be accessed at all levels of the organizations but cannot be altered by any other module/ user department unless and until it is been authorized.

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