Computerized Maintenance Management System for Thermal Power Plant, Hisar

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Abstract. This paper discusses the development and implementation of Computerized Maintenance Management System (CMMS) for a Thermal Power Plant. CMMS is a computer application which is coded in java and can be used for quick and efficient planning of various maintenance jobs in any industry. The developed computer system is adaptable, inexpensive, time saving and very easy to operate. The motive of this framework is to reduce the cumbersome manual collection of data and inefficiency in data retrieval. This software tool comprises of various modules like Equipment Details, Resources, Work Order, Utilities, and Safety Plans etc. The application developed for Thermal Power Plant, Hisar aims to provide effective maintenance planning and control, proper scheduling and improvement in workforce management.

Keywords. Computerized Management Maintenance System (CMMS), Condition Based Maintenance (CBM), Total Productive Maintenance (TPM), Maintenance Planning, Workforce Management

1. Introduction

In recent years, Haryana has exhibited higher growth as a result of state government policies that promote industrial sector in the state. Hence, demand of electricity is increasing in Hisar region which increases the load on regional power plant namely Rajiv Gandhi Thermal Power Plant (RGTPP). This power plant is one of the coal based power plants of Haryana Power Generation Corporation Limited (HPGCL). The work for a 1200 MW coal-fired power plant was awarded during 2007. This is the first project in the Northern Region to be awarded Mega Project status with attached benefits under the Mega Project policy of Govt. of India. Maintenance personnel of this plant deal with vast variety of technical and financial data for planning and organizing various jobs for effective systematic plant maintenance.

Thermal Power Plants are complex engineering systems which work continuously under uneven load condition without affecting its performance. It fulfils the demand of public and various industries irrespective of the fluctuating demand and changing environmental conditions. To meet these challenging demands continuously, effective maintenance management of the concerned plant is must. Maintenance management is all about maintaining the resources of the plant so that production proceeds effectively and no efforts are wasted on inefficiency. Its prime objectives are cost control, scheduling work, enhancing the safety of manpower and compliance. Maintenance is one of the most important factors for achieving higher plant productivity and good returns on investment and it should
be more responsive and dynamic to varying demands. Effective operation of plant equipment may be assured by adopting some new maintenance practices and strategies such as Condition Based Maintenance (CBM), Total Productive Maintenance (TPM), Reliability Centered Maintenance (RCM) and Computerized Maintenance Management System (CMMS). In fact, CMMS in particular, would facilitate the computer aided planning and control of all maintenance activities. This plant follows Preventive and Breakdown Maintenance which come in action whenever the equipments or machines stop working, standby arrangement becomes functional or plant works at its reduced capacity. Alongside, CBM is also applied for critical equipment such as boilers.

CMMS software maintains a computer database of information about the maintenance activities of an organization for their better planning and control. Concerned plant requires an Enterprise Resource Planning (ERP) system and developed CMMS may work as internal feature for the ERP. It is very helpful in achieving the goal of managing maintenance related data which fulfills the prime motive of this research. It also focuses on reducing the downtime, overall annual maintenance cost, overtime labour and unnecessary maintenance. With the aim of using this CMMS application in RGTPP, Hisar plant, different modules and features were developed.

2. Literature Review
2.1. Kundu et al. (2011) developed CMMS for a Thermal Power Plant Unit. The system provides various information to maintenance personnel regarding various modules such as Equipment details, Task Maintenance list, Task Procedure list, Work Order list, Employee details, Schedule of Maintenance details, Overhaul detail, Critical Issue etc. for better planning, scheduling and organizing maintenance activities.

2.2. Beni (2014) discussed the benefits of implementation of CMMS in Iranian gas industry and used genetic algorithm to optimize the various parameters of maintenance jobs. The developed process and functional models are useful in analyzing other plants with small modifications that can save time.

2.3. Wienker et al. (2015) highlighted out six key reasons for low success rate in implementation of CMMS such as implementation failure, lack of planning in maintenance activities, Inadequate IT Infrastructure, unclear deadlines, Inadequate resources etc. and outlined some essential elements that ensures success while implementing CMMS and utilizing its benefits in planning maintenance activities.

2.4. Lopes (2016) presented the case study of requirements specification of a CMMS for a manufacturing company. The adapted system by the maintenance department of the concerned company serves various improvement opportunities such as analysis of failures to reduce its occurrences, access to information in real-time, performance assessment, movement tracking of spare parts and ensure its availability when required.

2.5. Verma et al. (2016) studied, summarized and concluded the research conducted in the field of CMMS since 1996. 16 research papers were reviewed and briefly explained. These research papers constitute method and process of implementation of various CMMS systems in the process as well as manufacturing industries and concluded that with the implementation of CMMS, efficiency of maintenance activities improved with reduced cost and maintenance activities of manufacturing units is performed in a more synchronized and automated manner.

2.6. Yadav et al. (2017) gave a general framework of CMMS for National Thermal Power Plant, Badarpur and designed a system that can record data such as downtimes, details of tools & tackles, equipment information which was not recorded previously. The system offers various advantages and gives maintenance personnel capability to ensure proper recording of data and information.
2.7. Felipe et al. (2018) proposed to establish a computerized maintenance management system for the railway transit. By identifying the causes of the problems, a system was proposed that can reduce the service interruptions effectively and improve the service performance of railway transit by increasing availability of resources with better planning of maintenance activities.

3. CMMS for RGTPP, Hisar

After analyzing different CMMS Software available in market and various modules that can be added, maintenance techniques of the concerned plant were studied and then modules were finalized after discussing them with the plant maintenance team. CMMS software is developed in NetBeans, which is a software development platform that is coded in Java. NetBeans is an open-source integrated development environment (IDE), primarily intended for development with Java, but it also supports other programming languages like PHP, C++ and HTML5. MySQL handles the database components, while PHP or Python represents the dynamic scripting languages. It is often used for web development and internal testing, but may also be used to serve live websites. Netbeans runs along with Wampserver to get the desired output of the CMMS application. Wampserver provides a server platform to connect various computer systems in or out of the plant. The data is maintained and recorded in Wampserver which can be exported as a SQL file. It provides an easy access to all the updates of the plant and for the recording purposes. Proper trial and testing were done on the working of the software, initial bugs were removed and then handed over to the plant maintenance team for reviewing and implementing according to their requirements.

3.1 Proposed CMMS Modules

On detailed plant research and identification of the requirements of this application, two basic pages (Login Page and Home Page) along with fifteen corresponding modules as described below.

Login Page. This ingress page secures the important data by providing access only to authorized personnel with the provision of user ID and Password.

Home Page. Home Page displays name and some information about the organization and consists of all the other modules for navigation within the application.

3.1.1. Equipment Details. Equipment Details stores information of all the equipment in the Maintenance Department. The ‘Equipment details’ tab contains information about the equipments like supplier details, warranty details, manufacturer etc. as shown in figure 1.

3.1.2. Work Request. This module stores information related to the work orders generated along with their current status. It often requests for an immediate action to prevent sudden breakdowns.

3.1.3. Staff Details. Staff Details consists of modules like Employee ID, Employee Name, Email, Contact Number etc. which is used to keep a record of each staff member concerned with Maintenance Department of the plant, shown in figure 2.

3.1.4. Quick Reporting. This module reports about the labour materials, failure codes, completion date and occurrence of the downtime stating the reports that needs to be looked into quickly, shown in figure 4.

3.1.5. Spare Part Details. This module is used to store information related to the spare parts used in the maintenance activities by recording their name, ID, working condition etc. shown in figure 5.

3.1.6. Daily Status. This module contains the day to day information of working employees and the tasks assigned to them. It includes the details about allotment of equipments, time duration for which it is allotted, description of equipment and quantity of equipment available.
3.1.7. **Utilities.** This module stores and provides detailed information on utilities consumption of electricity, oil, diesel, cleaning chemicals; distribution, use, and cost.

3.1.8. **Operating Location.** This module is used to enter and track locations where equipment operates and organize these locations into logical hierarchies.

3.1.9. **Inventory Control.** This module includes the details regarding the quantity of material ordered, stock available, date of reordering, cost of order etc.

3.1.10. **Purchasing Ledger.** This module contains the purchasing details of Maintenance Department and the various fields of this module are Item purchased, Receipt number, Transportation Cost, Total Cost, and Vendors Contact etc.

3.1.11. **Safety Plans.** Safety Plans is related to the issues for particular safety equipment and fatal accidents that can be recorded in this module. This keeps a check over the personal protective equipments (PPE) that are needed in some particular departments.

3.1.12. **Tools.** Tools module is required to store information regarding the tools that are required at various maintenance activities in a plant as shown in figure 3.

3.1.13. **Condition Monitoring.** This module stores the condition of equipments so that spotting of the upcoming failure can be done. It gives detail about the shift timing, section of the task, monitoring of the equipments, shown in figure 6.

3.1.14. **Action.** This module gives the detail about the actions of the tasks done in the plant like the Time Taken, Feedback, Task Date and Remarks.

3.1.15. **Permit.** Permit module comprises of the details about the permission, taken before starting the work such as power supply, operation time and location of work etc. from Control Room.

**Figure 1.** Equipment Details

**Figure 2.** Staff Details

**Figure 3.** Tools

**Figure 4.** Quick Reporting
3.2. Cost Estimation for Implementation of “CMMS”

The cost for implementation of ‘RGTPP CMMS’ at RGTPP, Hisar has been estimated considering the Software Development cost, other software packages required to run the developed software and infrastructure requirements etc. The cost details are shown in Table 1 given below:

| No. | ITEM                                      | Qty. | Rate (Approx.) in Rs. | Annual Cost in Rs. |
|-----|-------------------------------------------|------|-----------------------|--------------------|
| 1   | Microsoft Visual Studio.NET Package       | 1    | 35,000/-              | 35,000/-           |
| 2   | Infrastructure Cost                       |      |                       |                    |
|     | 1) Computers with all accessories         | 4    | 60,000*4 = 240,000/- | 240,000/-          |
|     | 2) Printer                                | 2    | 16,000*2 = 32,000/-  | 32,000/-           |
| 3   | Additional work force required            |      |                       |                    |
|     | 1) Computer Operator                      | 1    | 18,000/- (Per month)  | 216,000/-          |
|     | 2) Data Collector                         | 1    | 15,000/- (Per month)  | 180,000/-          |
| 4   | Programming Cost                          | 24 Hrs | 1000/hr * 24 = 24,000/- | 24,000/-          |
|     | Grand Cost of Implementation              |      | 364,000/-             | 727,000/-          |

4. Conclusions and Future Scope

After considering the requirements of the concerned plant, a Computerized Maintenance Management System (CMMS) has been proposed. It provides a systematic way of collecting and preserving information that can be easily utilized by the maintenance personnel for better planning, organizing, scheduling and controlling the maintenance activities. It also improves the efficiency and develops the database for quick and easy retrieval of maintenance related information.
The following specific conclusions can be drawn from this study:

- Proper utilization of CMMS in the plant improves the reliability of equipments, which is essential for its optimization. CMMS improves the quality and efficiency, with better decision making outputs.
- CMMS provides an effective maintenance management of process plant facilities throughout their working loop with improved plant efficiency.
- It leads to reduction in downtime, total annual maintenance cost, number of failures of machines. This provides day-to-day maintenance schedule to the maintenance personnel, so as to predict maintenance budget and maintenance policy using CMMS software.

Effectiveness of any plant mainly depends upon availability and maintainability of the machines or equipments during their operations. Hence, in future the applications of CMMS can also be beneficial in any industry such as Sugar, Beverages, Cement, Chemical, Aerospace, Defence, Automotive, Communications, Consumer, Health, Manufacturing and Fertilizer Industries where the management of a huge quantity of maintenance data and information is required. While implementing CMMS in any plant, most of the focus should be given to the successful installation of the hardware and software associated with the new system. Hence, the major benefits of the CMMS can be utilized and effective plant operation can also be achieved.

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