A Study on Development and Implementation of a Computerized Maintenance Management Information System for a Process Industry

C.G. Ramachandra, T.R. Srinivas, T.S. Shruthi

Abstract—In this information age, data has become one of the most important resources to organizations. The effective and efficient management of large quantities of data is a common problem found in many industries. Modern computers offer the capability to maintain accurate records, update them instantly with the most recent information and do accurate calculating for more rapidly than human can. Maintenance management should be effective so that there should not be any loss of production because of maintenance. To make the maintenance system effective, it is essential to keep track of all the information related to maintenance. The objective of maintenance management is to provide timely and accurate information to the required personal. This paper studies manual maintenance system in detail which involves manual job of computation. Obviously this system is prone to delay in getting the information at the right time and proposes a computerized maintenance management information system for a process industry. This information system is designated to assist management in monitoring and controlling maintenance activities. The result of computerized maintenance management system is proper recording of data/information. Generate reports which helps in day to day decision making and in long term planning, reduction in down time, reduction in maintenance cost, increased productivity, reduced inventory costs etc.

Index Terms—Development; Implementation; Maintenance Management; Information System.

I. INTRODUCTION

Economy and quality are the prime factors, essentially required to be practiced and adopted by an organization not only to compete in the market, but primarily for survival and growth. Economy speaks about how best the resources like men, material and machines are mobilized and utilized to suit existing environment and prevailing organizational culture. Quality focuses on the performance and reliability of a product in comparison with the existing industry standards. The best economic and quality product is the one which is perceived and demanded by the society. On Indian scenario many of the organizations fail to produce economic and quality goods as a result of poor utilization of resources due to various reasons. This will hamper the growth of that organization and bear an adverse effect on national economy. The best economic and quality product is the one which is perceived and demanded by the society. On Indian scenario many of the organizations fail to produce economic and quality goods as a result of poor utilization of resources due to various reasons. This will hamper the growth of that organization and bear an adverse effect on national economy. Effective maintenance management is very useful. At present the maintenance cost in carrying out a job is not known regarding breakdown maintenance is very useful. At present the maintenance cost in carrying out a job is not known which can help in cost reduction. By developing a system the effective use of manpower can also be made. So that the performance can be monitored and controlled. A key component of providing economic and effective engineering services to any industry is the provision for the control of an effective Maintenance Management Information System. Modern computers offer the capability to maintain accurate records, update them instantly with the most recent information and do accurate calculating for more rapidly than human can. Some of the usages of computerized maintenance management information system in different fields are according to Zhaohui Li, Youzhong AI, Huixuan SHI [11]. Maintenance is fundamental for the safe and stable operation of hydro power plants. And it’s also the most cost intensive activity. Optimal maintenance is a reliability centered maintenance strategy with considering all facility condition, hydraulic resources and electricity market. HOMIS (Optimal Maintenance Information System for Hydro power plants) is an information platform to implement this strategy. HOMIS is vertically organized to equipment level (condition monitoring and analysis), group level (long term memory and diagnosis), plant level (technique decisions on maintenance), enterprise level (management decisions on maintenance), and remote level (remote monitoring, analysis and consultation). HOMIS horizontally integrates with the control system (such as SCADA, the speed governor and the voltage regulator) and the Management Information System (MIS). This system has been successfully put into service in Gezhouba Hydro Power.
Plant in China. F. Chris Sautter, Patrick W. Jemison, Christopher M. Goes, Jerod M. Wooten [12] states that in the Condition Based Maintenance environment, health or condition is a function of an individual component, not families of components. In order to understand how a component degrades to a level where maintenance has to be performed, it is essential that the health and condition of that component can be understood by its individual ID. Likewise, the maintenance actions that are driven by its condition must be understood at both the fleet and local levels. In order to achieve that level of understanding, effective metrics must be generated using the data that comes from a task-based; Unique Identification enabled Maintenance Management Information System. To achieve this goal will require transformation, not modernization, of today’s MMIS within the Department of Defense. According to Rosina Surovi Khan [13] with the advent of ever evolving technology, it becomes necessary to manage IT information efficiently, and managing it the right way cuts down maintenance costs. A variety of IT-maintenance software products exist in the market which can be used to manage IT equipment efficiently. But often these IT-maintenance software products do not always fulfill all the IT requirements of an organization. For example, most of the IT-maintenance software products available in the market manage hardware and software assets quite well but fail to capture non-pc data such as telephone system and office material and also lack the ability to support heterogeneous networking in MAC environment. In such cases, developing a good interface to a database where IT information are stored often helps to provide good overviews, good updates and low maintenance costs. This paper is just about such a system that the author worked on. The system is called the Asset and Maintenance Management System (AMMS)

A. Causes of Poor Maintenance

- Increased down time.
- Poor efficiency.
- Deterioration of Equipment.
- Poor Quality of Product.
- Higher labour cost.
- Loss of material in process.
- High production cost.
- Increased hazards.

B. Benefits of Maintenance

Systematic maintenance procedures offer tremendous possibilities for saving in money, material

- Reduction in down time.
- Reduction losses of material in process.
- Increased life of the equipment.
- Reduction in overtime.
- Optimum spares inventory.
- Timely replacement of spares and machines.
- Maintenance of product quality.
- Proper running of the equipment.
- Optimum operational cost of the machines.

II. TYPES OF MAINTENANCE

Maintenance can be defined as a set of actions which are carried out to replace, repair and service an identifiable set of manufacturing components, so that the plant continuous to operate at a specified level of availability for a specified time. The main objective of Maintenance is to maximize the availability of machinery and equipments for production. Preserve the values of the plant, machinery or equipment by minimizing wear and deterioration. Accomplish the above goals most economically on a long term basis. By systematic maintenance it is possible to achieve substantial savings in money, material and manpower as every effort is directed towards avoiding catastrophic failures

A. Breakdown Maintenance

In this the equipment is attended to only after it breakdown. Despite the numerous disadvantages this type of system may be suitable in certain conditions such as the equipment is non critical and standbys are available or plant capacity exceeds market demand.

B. Scheduled Maintenance

Analysis of routine maintenance like cleaning, greasing etc, which will keep the equipments in a good running condition and in a state of operational readiness.

C. Preventive Maintenance

The objective of preventive maintenance is organizing maintenance before the needs being developed, would minimize the possibility of anticipated breakdowns. It is the cooperative effort directed towards the upkeep and repair of equipment. Effort should be directed to prevent breakdowns or if breakdown occurs, to return the equipment to service in minimum time.

D. Predictive Maintenance

While the equipment is in actual operating conditions a study of performance of the equipment would reveal whether unexpected deterioration is taking place in it and what be frequencies of scheduled maintenance should be to reduce such deterioration.

E. Corrective Maintenance

A study of failure of equipment in service may warrant a change in design, material or working conditions of the equipment and corrective steps should be taken thereafter.

F. Design-Out Maintenance

While designing and developing the equipment objective is set to provide no maintenance or higher maintainability which would reduce the maintenance effort in the life time

III. MAINTENANCE MANAGEMENT

Maintenance management can be defined as managing the maintenance activities. Maintenance management can be considered as the direction and organization of resources in order to control the availability and performance of industrial
plant to some specified level. Maintenance activities are a major cost factor in most industries, affecting both return on capital and production throughout. Maintenance management is the art and science of executing the maintenance activities in an efficient way. The objective of the maintenance management system is to streamline the vast maintenance information system to improve the productivity of an industrial plant. A good maintenance management system makes equipment and facilities available. The fundamental steps of maintenance management program are shown in figure-1

**D. Schedule**

Schedule involves three factors.

a) Priority: Priority codes based on established criteria or on the importance of the equipment and the kind of work to be performed may be used.

b) Job Assignment: May be on a first come basis or may reflect skill requirements and time estimates as part of a manpower scheduling plan.

**E. Perform Work**

This step involves craft man working from little or no instructions or from detailed procedure.

**F. Record Data**

The data recording may vary from simply listing the actual hours to keeping comprehensive records of material charges, equipment identification, work assigned and performed and other pertinent data.

**G. Accounts for Costs**

It is important to know where and what the money being spent for.

**H. Develop Management Information**

It involves providing facts on current work, including cost, accumulated data, equipment identification, productivity, and budgets and scheduling.

**I. Update Equipment History**

History records may vary from little or no data online upgrading of all equipment, showing use, downtime and maintenance labor and material costs on each piece of equipment.

**J. Management Control Reports**

As Management Information is developed, control reports, covering expenditures, performance, backlog, equipment data etc., can be generated regularly to summarize the results of the maintenance function. Some key problems pertaining to maintenance management are

- Man power requirements.
- Employee production.
- Machine productivity.
- Planning for material and tools availability.
- Lack of history records.
- Incomplete material control records.
- Lack of preventive maintenance that causes high unscheduled downtime.

**IV. ABOUT THE COMPANY**

The tyre manufacturing is a process industry and it involves different types of machines at every stage of process. To achieve the production target machines should be always available for production. Thus it needs a program which keeps up the health of machine and also ensures maximum availability and reliability. To monitor the program, information is required, also to prolong the life of machines, some schedules have to be developed for inspecting the machine parts at regular intervals and take necessary actions.
At present the maintenance problems and the work done are recorded every day in log book. It indicates the nature of the problems breakdown time, machine handed over time, manpower engage. At the end of the day a format is prepared showing downtime of all machines. From this production loss percentage will be calculated. The drawback of the present system is as follows

A. Availability of Past Data
With this system if anybody wants to find the number of times a particular machine has failed or details of work performed on a machine, he has to refer to old log book. This job is laborious and time consuming. Some time it is difficult to get the relevant data.

B. Relevant Information
To carry out major jobs, information’s regarding spares, tools and special arrangements required should be available. Not having these information leads to loss of time, energy and increases maintenance cost. In a hurry to finish the job early, satisfactory work may not be carried out.

C. Maintenance Cost
At present it is not known, what is the maintenance cost involved in carrying out each job, so we do not know whether the work is done economically or not. But having a clear picture of cost involved in each job. Comparison can be made with similar past jobs. This can help in cost reduction.

D. Complexity of Work
On an average 75nos of breakdowns are attended in each shift. This means 225 numbers of breakdowns in a day. There are about 320 people are working in maintenance department. The number is so large, that a proper planning and organizing is required for effective use of manpower so that their performance can be monitored and controlled.

V. SCOPE OF THE STUDY
The present maintenance management system in the industry involves manual job of computation. Obviously this system is prone to delay in getting the information at the right time. Besides this is coupled with inevitable errors such as arithmetical, clerical and so on. The production target for every year is increasing. To achieve this target machine to be always available for production. The priority is now to reduce the breakdown hours. Hence there is a need to develop a system which aims to minimize down time while providing for the most effective use of facilities and man power in order to secure desired results at the lowest possible cost. The detailed study of manual system is carried out with an objective of designing and develop the computerized maintenance management information system to make good use of the machines, to reduce the breakdowns and increase the production. The information obtained by this system will help the manager and the maintenance engineer in developing a maintenance program. It will create a better maintenance organization, proper control, effective planning and scheduling to face any situations. The objective of maintenance Management Information System is to provide timely and accurate information that will assist management in planning, organizing, budgeting, directing and controlling the maintenance activity of the plant. The Advantages of a computerized Maintenance Management Information System are as follows

A. Standardization
A fundamental system is installed for all facilities.

B. The Development of a Database
Computers provide a complete description of each piece of important equipment. It will become obvious that much of clerical effort invested in fully identifying the equipment and components requiring maintenance can be applied to other facilities.

C. Spinoff of benefits by Developing Explicit Procedure for Maintenance Personnel
Printouts and procedures developed for one plant serve as an excellent jumping off point for other facilities. Detailed instructions also allow less skilled personnel to perform the task.

D. Analytical Capabilities
To be able to review and compare experience and performance between facilities by use of modern computers has considerable value not only for the plant engineering management but also for the engineers who are essential to the success of any system. It is the intent to make the computer a tool for those responsible for overseeing the work and achieving the business oriented objectives of the system, increasing the efficiency of the facilities at a reduced cost.

E. Historical Data
A completer historical record of cost data and repair frequencies is available and easily accessible by using computers. This information aids management in making economical decisions such as repair or replace.

VI. DESIGN AND DEVELOPMENT OF PROPOSED SYSTEM
Computers offers unmatched speed, performing repetitive tasks, releasing us for more critical, creative activities. It performs tasks repeatedly without error, avoiding the fatigue that affects humans. Formulation of ideas of maintenance, its day to day standings, final monthly or yearly analysis etc., are the targets of the maintenance department. Maintenance requires large amount of information to be stored. An extensive report of system is also very essential. This package is designed and developed using any data base management system (DBMS). The system has been divided into four menus namely

A. Equipment Menu.
B. Work Order Process Menu.
C. Preventive Maintenance Menu.
D. Spare Details.

### Main Menu

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Work Order Process</th>
<th>Preventive Maintenance</th>
<th>Spares Details</th>
</tr>
</thead>
</table>

### A. Equipment Menu

It is like a identity card for a machine. It gives the information like:
- Department.
- Name of the machine.
- Manufacturer’s name and address.
- Suppliers name and address.
- Equipment drawing and catalogue number.
- Cost of the machine.
- Data of purchase, installation, commission.
- Machine dimensions.
- Details of drives.
- Details of services.
- Other specification if any.

This menu will have following sub-menus like Add Record, Edit Record, and Delete Record.

### Work Order Maintenance menu

Work Order Maintenance menu gives the basic input data to the maintenance system. In the event of any breakdown the shop production supervisor fill up this form and hands it over to shift engineer. This form gives the following details like work order number, department, data and time of breakdown, equipment code number, equipment name, nature of work, priority, job details. Activity and Case Details, this form will be filled by the engineer who has attended the job. This form gives the details of work carried out against the work order. It gives the following details like work order number, equipment code number, equipment name, work started date and time, work completed date and time, functional unit code and its name, job detail, number of persons engaged, spare parts used. After the completion of the work the equipment will be handed over to production and acknowledgement is taken by production supervisor. Both work order maintenance and activity and case details serves as the input data.

### B. Work Order Process Menu

It is used to enter the day to day breakdown details of all the machines’. This menu will have following sub-menus like Work Order Input, Equipment History Record and Work Order Reports.

### Work Order Report

In this report all the work orders are recorded as and when it comes every day. It records the machine work order number, machine code, name of the machine nature of work, problems reported, action taken, machine downtime whether completed or pending. Work order status report is generated at the end of every day. It shows which are the pending breakdowns and the reasons. It helps managers to take necessary decisions in solving problems.

### Preventive Maintenance Menu

PM program are periodic inspection of plant assets and equipment to upkeep the plant to avoid such conditions or to adjust or repair them while still they are minor. The pm is divided into two sub menus namely Daily lubrication list and PM Inspection list.

<table>
<thead>
<tr>
<th>Main Menu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>Daily Lubrication List</td>
</tr>
<tr>
<td>Pm Inspection List</td>
</tr>
<tr>
<td>Exit To Main Menu</td>
</tr>
</tbody>
</table>
1. Daily Lubrication List: It gives the different locations in a machine to be lubricated. It also indicated the number of points and the lubricant to be used in each location. These points are lubricated in all the three shifts.

2. PM Inspection List: It has different schedules like Daily, Weekly, Monthly, half yearly and yearly. The activities to be carried out in each schedule is recorded. After checking the points, the remark has to be written by the person stating whether it was satisfactory or needs repair.

The benefits of PM program are

- Less machine down time.
- Less large scale repairs and reduction in respective breakdowns.
- Lower maintenance cost.
- Better quality control.
- Prolonged machine life.
- Better spare parts control, leading to minimum inventory.

A. Spare Details

When there is a machine break down because of a failure of a machine part, this part has to be replaced with a spare. The proper control of spares is necessary to lessen the maintenance cost. Improper control of spare parts results in excessive costs. Not having enough material in hand results in production loss. Having enough material in hand results in production loss. Having too many spare also builds up the inventory cost, more storage space and danger of obsolescence of spares. Hence it is necessary to have required level of spares to keep machine running at lower inventory costs.

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Work Order Process</th>
<th>Preventive Maintenance</th>
<th>Spares Details</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance Of Spare Detail</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spares Detail List</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exit To Main Menu</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Spares Code Structure: There are 8 digits used for a spare part number.
   - AABB CCCD
   - AAFirst two digits - Major Class
   - BBSecond two Digits - Sub Class
   - CCC Third three digits - Sequential number
   - D Last digits - Make Code (1 for imported, 2 for Indian) The spares details is divided into two sub menus namely Maintenance of spares detail, Spares detail list.

VII. IMPLEMENTATION

The system developed has been run on a test data related to maintenance of 4 roll calendar. It can be implemented in phased manner side by side with the existing manual system until the system becomes familiar to the users. The menu driven system is designed in such a way that the user can easily operate by selecting proper menus and sub menus, feed the input and get the required information. The advantage and effectiveness of Computerized Aided Maintenance Management Information System depends to a larger extent on the proper utilization of the system. It is necessary to review the system periodically and identify the improvements required and incorporate them for further benefit. The said project provides the necessary formats. One should keep in mind the user requirements and mode of operation i.e. system should be user friendly. In management of almost all operational activity, the information forms a major input and as such for effective implementation of futuristic information system in overall system, it is essential to modify the existing management. Maintenance Management Information System is a part of total Management Information System. In today’s world of ever increasing complexities of business as well as management for every organization to survive and grow, must have an efficient and effective Management Information System.

VIII. CONCLUSION

The computer aided maintenance management information system has been developed keeping in mind the user requirement as the primary concern. This information system is designated to assist management in monitoring and controlling maintenance activities. This information system is designated to assist management in monitoring and controlling maintenance activities. The result of this information system is

- Proper recording of data/information.
- Generate a report which helps in day to day decision making and in long term planning.
- Reduction in down time.
- Reduction in maintenance cost.
- Increased productivity.
- Reduced inventory costs.
- Less paper work and fast access of information.

This system is basically an information processing tool. It cannot make decisions. One must use the information generated for better decision making.

IX. ACKNOWLEDGMENT

We are thankful to the Management, Principal, Mechanical Department HOD and Staff of Srinivas Institute of Technology, Mangalore for their support and encouragement.

REFERENCES


AUTHOR’S PROFILE

Ramachandra C G is working in Srinivas Institute of Technology as Associate Professor in the department of Mechanical Engineering. Presently he is pursuing Ph.D degree from Visvesvaraya Technological University. He received the M-Tech degree in Mechanical Engineering from Sri Jayachamarajendra college of Engineering, Mysore under Visvesvaraya Technological University in 2002 and B.E degree in Mechanical Engineering from P.E.S College of Engineering, Mandya under Mysore University in 1998. He has presented 8 national conference and 8 international conference papers in various fields. He has published 8 international journal and 3 national journal paper in various fields. He is an active member of ISTE and IEI. He has done the project in the area of condition monitoring, maintenance management information system etc. His area of interest is Maintenance Engineering, Management Information System, Condition Monitoring and Production Engineering.

Dr. Srinivas T R is working in Sri Jayachamarajendra college of Engineering as Professor in the department of Industrial and Production Engineering. He received the Ph.D degree from Mysore University in 2000, M-Tech degree in Mechanical Engineering from Indian Institute of Technology, Chennai in 1990 and B.E degree in Mechanical Engineering from Sri Jayachamarajendra college of Engineering, Mysore under Mysore University in 1984. He has presented 12 national conference and 18 international conference papers in various fields. He has published 15 international journal and 10 national journal paper in various fields. He is an active member of ISTE and IEI. He has done the project in the area of Total Quality Management, Total Productive Maintenance etc. His area of interest is Total Quality Management, Management Information System and Total Productive Maintenance.

Shruthi S studying 5th semester Industrial and Production Engineering in Sri Jayachamarajendra college of Engineering, Mysore. She had presented 1 national conference and 2 international conference papers in various fields. She has done the project in the area of Total Quality Management. Her area of interest is Total Quality Management, Lean Manufacturing, Management Information System and Work Study.