FACILITY MAINTENANCE AND MANAGEMENT INFORMATION SYSTEM (MIS)

By

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ABSTRACT:

Facilities maintenance managers are required to use modern maintenance systems and methods to control their work activities, account for resources given and to monitor and report maintenance work execution through the full use of various industry based metrics and other management indicators. Due to the scope, complexity and high value of records from facility maintenance centres, the past decades have seen the application of computer technologies to facilities management; and as systems become more powerful, less costly and easier to use it has become very necessary for managers to implement computerized maintenance system. This paper attempt to bridge the functional orientation of Facility Maintenance Management with Management Information System (MIS).

1.1 FACILITY MAINTENANCE
1.1.1 Introduction:

Facility maintenance can be defined as "A combination of any action(s) carried out to retain any facility in or restore it to an acceptable condition".

The actions referred to are those initiations and commissioning of a facility. Once a facility has been commissioned and it is in operation, there must be an organized action to keep the equipment in service or if there is any break down swift action must be taken to restore the equipment or facility to its **"Acceptable Condition"**. [1]

Acceptable condition will include those factors as:
- Efficiency (fuel usage, power output, speed, heat e .t .c).
- Production of good quality product/service.
- Safety of operation.

1.1.2 Objectives of Maintenance:

The main objectives of maintenance are as follows:
- To keep the factory plants, equipment, machines tools e. t. c in an optimum working condition.
- To ensure specified accuracy of product and time schedule of delivery to customers.
- To keep the down time of machines to the minimum thus to have control over the production programme.
- To keep the production cycle within the stipulated range.
- To improve productivity of existing machine tool and to avoid sinking of additional capital.
- To reduce maintenance cost as far as possible thereby leading to a reduction in factory overhead.
- To prolong the useful life of the factory plant and machinery while retaining their acceptable level of accuracy and performance. Thus avoiding or postponing incurring of heavy capital expenditure as a result of their replacement.

1.1.3 Element of Maintenance:

If a good maintenance programme is aimed at achieving the objectives above then we need to know the elements or the important functions of the facility maintenance system which is as follows:
- Inspection or check:
  Is an important function of a maintenance programme, frequency of inspection should be decided very carefully, as too less frequent inspection may cause breakdown since breakdown will not be traced out and rectified immediately while too frequent inspection may result in wastage of machine time or labour productivity.

- Planning and scheduling:
  Every preventive maintenance work should be pre-planned in details on the basis of analysis carried out on the past records of inspection. Thus the schedule programme should be detailed to specify the point requiring attention daily, weekly, monthly, quarterly or even yearly.
- Record and analysis:
  This is the most important element of any maintenance programme as it helps in forecasting any other element of maintenance. The following records are generally maintained during recording:
  (i) Operation manual,
  (ii) Maintenance instruction registers,
  (iii) Spares procurement registers,
  (iv) Inspections register,
  (v) Log books,
  (vi) Defect registers e. t. c.

The record helps the facility maintenance engineers to make decisions.
- Training of maintenance personnel:
For maintenance to succeed a sound training is essential for the maintenance personnel.
- Stock control:
Many a time machines remain idle due to unavailability of parts resulting in attendant loss of production.
This can be easily avoided if proper stock control is done and spare parts and other maintenance material are well stocked.

1.1.4 Advantages of Maintenance:

From the above we can deduce that an efficiently, effectively planned and well-executed facility.
- Reduction in production downtime.
- Lower overtime pay for maintenance personnel.
- Few number of stand-by equipment is needed.
- Reduction in expenditure on repairs.
- Due to well planned spare parts replacement arrangement, only the spare parts needed will remain in stock at any point in time.
- Enhance safety to facility and employee lives is guaranteed.

1.1.5 Consequences of lack of Maintenance:

Facility maintenance involves a commitment of tangible resources like capital, material, men, and energy e. t. c.

The cost estimate of the above resources is quite involving but failure to maintain facility equipment may be more costly than the actual cost of maintenance; hence the following are the consequences of lack of facility maintenance. [1]
- Excessive machine breakdown with frequent emergency work.
- Shortened life span of facilities.
- Disproportionate investment in spare pares.
- Poor utilization of staff.
- Loss in production output and hence loss of profit.
- Lower quality product/service with attendant loss of good will or reputations with customers.
- Unnecessary damage to facility which may result in the need to invest in a new facility sooner than expected.

1.2 FACILITY MAINTENANCE MANAGEMENT (OMETA CONCEPT)

According to [2] Maintenance Management System documents facility and equipment deficiencies, justifies budget requests for maintenance needs, and provides a sound basis for management decision making.

Maintenance management is a critical component of any facility maintenance program. The management functions bind the distinct parts of the maintenance program into a cohesive entity. A facility maintenance program requires cooperation, dedication, and participation at all levels of employees and cannot succeed without everyone involved understanding the basic principles and supporting the cause; thus a good facility maintenance program should contain five very distinct functions making up the maintenance system: [3]

Operations, Maintenance, Engineering, Training, and Administration (OMETA). A subset of the roles and responsibilities for each of the five well-defined elements of an effective facility maintenance program is presented below:

1.2.1 Operations:

- **Administration** – To ensure effective implementation and control of operation activities.
- **Conduct of Operations** – To ensure efficient, safe, and reliable process operations.
- **Equipment Status Control** – To be cognizant of status of all equipment.
- **Operator Knowledge and Performance** – To ensure that operator knowledge and performance will support safe and reliable plant operation.

1.2.2 Maintenance:

Administration – To ensure effective implementation and control of maintenance activities.

Work Control System – To control the performance of maintenance in an efficient and safe manner such that economical, safe, and reliable plant operation is optimized.

Conduct of Maintenance – To conduct maintenance in a safe and efficient manner.

Preventive Maintenance – To contribute to optimum performance and reliability of plant systems and equipment.

Maintenance Procedures and Documentation – To provide directions, when appropriate, for the performance of work and to ensure that maintenance is performed safely and efficiently.

1.2.3 Engineering Support:

Engineering Support Organization and Administration – To ensure effective implementation and control of technical support.

Equipment Modifications – To ensure proper design, review, control, implementation, and documentation of equipment design changes in a timely manner.

Equipment Performance Monitoring – To perform monitoring activities that optimize equipment reliability and efficiency.

Engineering Support Procedures and Documentation – To ensure that engineer support procedures and documents provide appropriate direction and that they support the efficiency and safe operations of the equipment.

1.2.4 Training:

Administration – To ensure effective implementation and control of training activities.

General Employee Training – To ensure that plant personnel have a basic understanding of their responsibilities and safe work practices and have the knowledge and practical abilities necessary to operate the plant safely and reliably.

Training Facilities and Equipment – To ensure the training facilities, equipment, and materials effectively support training activities.

Operator Training – To develop and improve the knowledge and skills necessary to perform assigned job functions.

Maintenance Training – To develop and improve the knowledge and skills necessary to perform assigned job functions.

1.2.5 Administration:

• **Organization and Administration** – To establish and ensure effective implementation of policies and the planning and control of equipment activities.

• **Management Objectives** – To formulate and utilize formal management objectives to improve equipment performance.

• **Management Assessment** – To monitor and assess station activities to improve all aspects of equipment performance.

• **Personnel Planning and Qualification** – To ensure that positions are filled with highly qualified individuals.

• **Industrial Safety** – To achieve a high degree of personnel and public safety.

1.3 MANAGEMENT INFORMATION SYSTEM (MIS)

1.3.1 Management:

To manage is to forecast and plan, to organize, to command, to coordinate and to control. It is a practice not a science and it's about making decisions which usually involves:

- The work of the organization
- People in the organization
- Structure of the organization
- Systems of the organization

1.3.2 What is Management Information System(MIS):

There is no universally accepted definition of an MIS and those that exist reflect the emphasis and prejudices of the particular writer. The term MIS has become almost synonymous with computer based data processing,..., system analysis , file design, and other various other technical facets of computer based systems.[4]

Management Information System can also refer o any information systems which deals with the control of so-called 'routine', 'structured', 'day-to-day' operations of an organization using relevant information technology tools .[5] It is a system using formalized procedures to provide management at all levels in all functions with appropriate information based on data from internal and external sources ,to enable them to make timely and effective decisions for planning, directing and controlling the activities for which they are responsible.[4] We can thus conclude that Management Information System (MIS) is an integrated, computer based , user machine that provides information for supporting operations and decision making functions of management.[6]

It should however be noted that emphasis is on the uses/functions to which information is put and that no mention is made of the means by which the information is processed. This is because it is the end use of information that is important and not the intermediate processing stage. [4]

Management Information System can be classified into 3:

- Organizational level:
  Here the management information system supports managers at different levels of an organization. e.g. Operation Management System, Tactical/Middle Level Management System which support middle level managers and Executive Information System (EIS) which support senior level management of an organization.
- Support provided:
  Management information system can also be classified according to the support they provide to management.
- Functional orientation :
  This MIS support operations and management of different functions within an organization. Information system in this classification may include:
  Financial Management Information System, Human Resource Management Information System, Marketing Management Information System, Maintenance Management Information System and so on .

This paper however attempts to bridge the functional orientation of facility maintenance management with Management Information Systems (MIS).

A good combination of management information system and a comprehensive facility maintenance management will ultimately result in what can be called the computerized maintenance management information system (CMMIS).

1.3.3 Computerized Maintenance Management Information System (CMMIS):

A computerized maintenance management information system (CMMIS) is a type of management software that performs functions in support of management and tracking of Operation and maintenance activities. CMMIS systems automate most of the logistical functions performed by maintenance staff and management. CMMIS systems come with many options and have many advantages over manual maintenance tracking systems.

Depending on the complexity of the system chosen, typical CMMIS functions may include the following: [3]
- Work order generation, prioritization, and tracking by equipment/component.
- Historical tracking of all work orders generated which become sortable by equipment, date, person responding, etc.
- Tracking of scheduled and unscheduled maintenance activities.
- Storing of maintenance procedures as well as all warranty information by component.
- Storing of all technical documentation or procedures by component.
- Real-time reports of ongoing work activity.
- Calendar- or run-time-based preventive maintenance work order generation.
- Capital and labor cost tracking by component as well as shortest, median, and longest times to close a work order by component.
- Complete parts and materials inventory control with automated reorder capability.
- PDA interface to streamline input and work order generation.
- Outside service call/dispatch capabilities.

The U.S Fish and Wildlife Service in the year 2000 initiated integration of facility management information using application software known as the Facility Management Information System (FacMIS). FacMis was created as a "modern, corporate system that links existing Service databases so as to provide one-stop shopping and cross-functional queries of facility data." FacMIS integrates Environmental and Facility Compliance, Federal Financial System, Refuge Management Information System, Fisheries Management Information System, Budget Allocation System, Bridge Safety, Dam Safety, Real and Personal Property Inventories, Seismic Safety, Quarters, and Leased Space databases to enable data search and completion of queries on all facility related data. The Maintenance Management System is a primary component of the FacMIS data integration effort. [2]
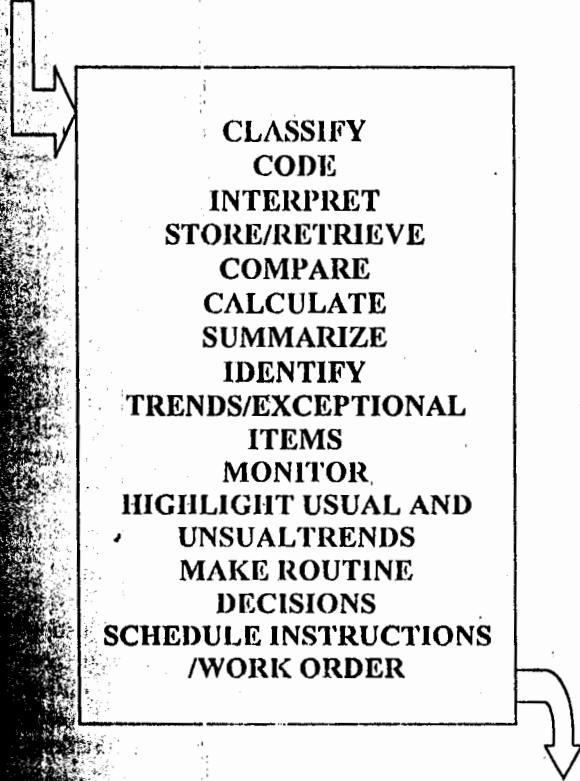
In addressing various issues related to CMMIS, the crucial need for reliable and adequate data is stressed. Moreover, what is needed is a careful approach to database design. The approach to database design in CMMIS can either be by "function" or by other classification system such as the "Organizational approach" to facility maintenance. [8]

Facilities Maintenance Managers are expected to discuss with software developers to develop a suitable CMMIS for the organization or get competent vendors.

Managers should however evaluate their maintenance management data requirements and establish their electronic data needs prior to acquiring CMMIS or modifying an existing one. Maintenance mangers should acquire only what is required to accomplish the Organization maintenance goals. Of course, once a CMMIS is acquired, resources must be dedicated to initially populate the systems (modules) and to continually keep them up to date. The data once entered into the CMMIS must be utilized for day-to-day operations and management of the organization's maintenance program to be cost effective. Periodic review of the CMMS data should be made to keep the system abreast of current requirements, deleting unnecessary data entries and adding new ones as required.

A good CMMIS should be able to carry out the following operations as seen from the model figure below based on its functional inputs to produce relevant outputs that will meet the organizational goal and requirements.

TYPICAL INPUTS

CLASSIFY
CODE
INTERPRET
STORE/RETRIEVE
COMPARE
CALCULATE
SUMMARIZE
IDENTIFY
TRENDS/EXCEPTIONAL
ITEMS
MONITOR
HIGHLIGHT USUAL AND
UNSUALTRENDS
MAKE ROUTINE
DECISIONS
SCHEDULE INSTRUCTIONS
/WORK ORDER

TYPICAL OUTPUTS

FIGURE 1: A TYPICAL MANAGEMENT INFORMATION SYSTEM.

1.3.4 CMMIS Functions:

As seen from [8] all NASA's maintenance Center's CMMIS must support the major functions discussed in the following paragraphs as they apply to facilities maintenance. Information entered in the functional areas of the CMMIS is critical for the day-to-day maintenance operations, management of the Center's maintenance program, for providing data to support the budget process, and for providing historical information critical for use in performance-based contracting.

1.3.4.1 Manage Facilities and Equipment:

This function contains the facilities maintenance processes and procedures to be utilized in managing the facilities maintenance workload. In addition to the automation of the administrative processing associated with maintenance management, the major advantage of having a CMMIS is the capability to process a large amount of data in order to identify trends that would not be readily apparent by reviewing individual work orders. The following paragraphs highlight files/modules which are a part of most CMMIS's and that are used in managing maintenance programs.

- **Facility/Equipment Inventory:** These data files/modules contain a detailed inventory of all facilities and maintainable collateral equipment subject to the facilities maintenance management system (and could include other information if needed for planning, space management, or accounting purposes). For facilities, they include information such as identifier, size, cost, date acquired, category codes, uses, location, users, material condition codes, and other similar information. For equipment, they include nomenclature, manufacturer, part number, cost, serial number, date acquired, size, location, identifiers to major system or use, warranty, specific facilities maintenance requirements, life expectancy, and similar information. Current and reliable data will enhance analysis and budget preparation and may be needed in developing customer charges in the organization's Cost Accounting system.
- **Work Input, Control and Scheduling:** This data file/module contains information on work requested by customers, work generated internally, and work status as it proceeds from requirement identification to work completion or request disapproval.

It includes information on customer, cost estimate, funding, scheduling for execution, and execution status for each work order. This data provides the ability to track facilities projects, requests for facilities maintenance and Service Requests.

- **Reliability Centered Maintenance:** This data file/module contains information on facilities and equipment criticality codes, maintenance requirements and schedules. It contains data for equipment and facilities maintenance actions required, predictive testing test points, diagnostic aids, references to or excerpts from maintenance manuals and equipment drawings, schedules, frequency, materials, safety requirements, and related procedures. Linked with the inventory, the combined data files can be used to create several schedules and work orders/task descriptions for maintenance technicians and mechanics.
- **Correlation of Maintenance Data:** Much benefit can be realized by correlation of various metrics, trends databases. An important function of a CMMIS is to automate that correlation as new input is made, with limits that alarm for follow-up action.
- **Continuous Inspection:** This data file/module contains information for the continuous inspection program. It should include facilities maintenance standards, facility condition inspection schedules, and inspection and test procedures. Linked with the inventory, it can be used to create the inspection orders and work sheets used by inspectors.
- **Facility/Equipment History:** These data files/module contain summaries of the maintenance histories of the facilities and collateral equipment. They contain summaries of repairs, rehabilitation, modifications, additions, construction, and other work affecting the configuration or condition of the item. They include completed and canceled work orders. These files also include the current material condition assessment of each item, derived from the continuous inspection program. The maintenance history records can be used to support proactive maintenance techniques such as root-cause failure analysis and reliability engineering.

1.3.4.2   Provide Utilities Services:

Utilities services are essential to a maintenance Center in that no operations would be possible without the power, steam, water, and related services they provide. Utilities also represent a major cost of operations. Computer support, both in terms of direct control of system components and analyses to identify losses in efficiency, is vital to energy conservation efforts as well as to effective system maintenance and management for optimal reliability and cost efficiency. The utilities data file/module contains detailed information on utilities consumption, distribution, use, metering, allocation to users, and cost. It could include modeling capability and linkage to utility control systems.

1.3.4.3   Assist in Formulating and Administering Contracts:

Contracts provide the majority of a maintenance Center's facilities support services. In many cases this extends to both recurring facilities maintenance efforts and one-time, specific facilities maintenance projects. Computerized support for contract preparation and administration in support of the Contracting Officer is essential for a well managed facilities maintenance program. This data file/module contains information on contracts supporting the broad spectrum of facilities maintenance management as required by the Contracting Officer, Contracting Officer's Technical Representative (COTR), and Quality Assurance Evaluators (QAE). With other database files, it provides a picture of each contractor's past performance, current loading, and planned work. It could include information on specifications, Government furnished property, quality assurance, payment processing, delivery orders issued, schedules, and related matters. It should cover both contracts for specific facilities maintenance requirements and support services contracts.

1.3.4.4   Develop Budgets and Perform Cost Analyses:

Management is largely the process of allocating and directing resources to accomplish an organization's goals. The functions listed above focus on facilities maintenance work and work methods. The budget and cost analysis functions obtain and track resources.

in an environment of competition for limited resources to perform an ever-expanding workload, managers need sophisticated tools and techniques to account for resources, demonstrate efficient use of resources, and prepare persuasive requests for future resource allocations. Computer support to perform in-depth analyses of requirements is essential to meet this end.

1.3.4.5 Additional Database Functions:

The functions discussed above were typically found in NASA centre CMMIS(s); although very comprehensive, a typical CMMIS functions may not be limited to those discussed above or may not have to meet all the functions. The CMMIS however could also perform additional database functions like [8].

- **Reports and Metrics:** This provides information which can be used to produce results/performance-oriented reports and metrics. This will ensure that the organization can analyze and evaluate performance and overall maintenance management at that Center.
- **Job Estimating:** This data file may contain shop or flat rate guides, estimating tables, work performance (time and motion) standards such as engineered performance standards, labor and material rates, and local cost and time factors in computer-usable form. Sources include commercial services, Government-developed standards, developed Facilities Engineering Job Estimating (FEJE) software, and local experience.
- **Tools/Material:** Tools and material data files typically contain the inventory of centrally managed tools and material for use in support of facilities maintenance. The material data file aids in assigning material to work orders, supports the preparation of material requisitions, tracks the receipt of material on order, and documents related information. Also, these data files record accountability data for shop tools and equipment.
- **Environment:** This data file contains environmental information, including permits, licenses, the history of violations and citations, potential hazards, environmental compliance and related actions underway and tracking of work or materials of special environmental interest.

- **Space Management/Planning:** This data file typically contains user name and user data for each facility, space within the facility, or other asset managed. It may include other information for use in managing the space such as configuration, utilities services, finishes, furnishings, environment, communications, assigned function or task, and accounting information.
- **Facility Graphic Documentation:** Computer Aided Design and Drafting (CADD), Geographic Information Systems (GIS), and similar systems such as Automated Mapping/Facility Management permits the digitized storage of graphic data on individual facilities such as drawings, photos, and other pictorial information. GIS offers a three-dimensional definition of a facility plus associated databases that together are a powerful facilities engineering tool. For example, a GIS for a street network could include data on underground utilities showing each utility (water, gas, electricity, sewage, and storm drainage), parking, traffic volume, pavement condition, and landscaping each in a separate plane. GIS technology fully integrates graphics and text.

1.3.5 CMMIS Peripheral Systems

There are peripheral systems that can be integrated into the CMMIS to enhance facilities maintenance operations. These systems can be more efficient, reduce paper work and provide more accurate and complete records in accomplishing maintenance tasks. The selection of a system should be based on the specific maintenance requirements, a cost study and resource availability. The following are some systems that could be considered.

- **Bar Coding Systems:** There are a number of bar coding systems available that can be employed in a Center's facilities maintenance program. The systems vary from the simple identification of an equipment item to sophisticated systems that permit input and downloading of data. Systems are available that permit bar code tags to include such things as the equipment items history and its preventive maintenance program. These tags are updated along with the CMMIS as changes take place, thereby providing current status at all times.

Systems include software that must be integrated into the Center's CMMIS and handheld bar code readers (terminals) with high contrast Liquid Crystal Displays (LCD) and a keyboard system to be used by the technician performing the work. The system may include a beeper subsystem that confirms scanner and keyboard entries, and alerts the operator of error conditions.

- **Handheld Computers:** This is another CMMIS peripheral system that is available for use in a Center's maintenance program. This is a wireless system where information flows to and from the maintenance Center's CMMIS. The system could be used to eliminate paper-based work orders; particularly those for small service requests, and small repair jobs. This would reduce the workload on the work control center and the technicians. With this system the technician receives work orders, work order changes, and updates electronically. The technician reports work start electronically and when work is completed the completion report and comments are provided electronically. Because information flows wireless to and from the CMMIS, the work control center sees the exact status of every assigned work order from assignment through work start to completion. At the end of a technician's shift the handheld computer is dropped off for use by the next shift. [9]

1.4   CONCLUSION

A proper harmonization of facility maintenance and management information systems will ultimately produce the computerized maintenance management information system (CMMIS). The following can therefore be considered as the benefits of implementing a computerized maintenance management information system (CMMIS) over manual maintenance program: [3]

- Detection of impending problems before a failure occurs resulting in fewer failures and customer complaints.
- Achieving a higher level of planned maintenance activities that enables a more efficient use of staff resources.
- Affecting inventory control and enabling better spare parts forecasting to eliminate shortages and minimize existing inventory.

- Maintaining optimal equipment performance that reduces downtime and results in longer equipment life.

However one of the greatest benefits of the CMMIS is the elimination of paperwork and manual tracking activities, thus enabling the maintenance staff to become more productive. The functionality of a CMMIS lies in its ability to collect and store information in an easily retrievable format. A CMMIS does not make decisions; rather it provides the maintenance manager with the best information to affect the operational efficiency of a facility. [3]

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