SMART BUILDING MAINTENANCE QUALITY SYSTEMS MANAGEMENT OF SUSTAINABILITY

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Abstract

The paper gives a model of the method of handling and controlling the management of building maintenance quality systems in terms of the quality system. The paper includes mechanical and electrical operating instructions, operating warnings, and a maintenance program for devices and machines inside buildings.

Smart Building Maintenance Quality Systems Management and control in the smart building management systems will be opening up unprecedented possibilities in the Building Management System (BMS), otherwise known as a Building Automation System (BAS) which is an automated (computer) control system in buildings that controls and monitors mechanical and electrical equipment for the building such as air conditioning, heating, ventilation, lighting, power systems, fire systems, security systems, Internet of things sensors, energy and gas meters, access control, water management, sewage management, parking management and also services. All this is through the advanced electronic system which is based on the computer installed in the buildings that meet all needs.

There are many problems inside the buildings that are not controlled, either because there is no system or a system that does not work so to make sure that the system inside the buildings works efficiently is to adhere to a quality system and implement a maintenance program for the devices inside the buildings and to preserve the national economy and reduce the losses resulting from all of this is done through the application of the quality system inside the buildings.

The steps of the maintenance process inside the buildings include the following:

1. Maintenance and repair of all devices and machines inside the buildings.

This is to ensure the quality of the devices and machines, maintenance and repair of all devices and machines to ensure their continuity of work without sudden interruption, including the list of devices that are subject to periodic maintenance and the preventive maintenance program, and all of this is recorded in the maintenance file.

2. Calibration and adjusting measuring, checking, and testing equipment to ensure that it performs the required tasks

The paper concluded with recommendations it is necessary to the maintenance of all devices and machines inside buildings that all measuring, then calibrate all examination and testing devices used in the measurements by the planned calibration and control and subjecting them to the quality system for individuals and devices and the existence of a management monitoring maintenance system for smart buildings.

Keywords

Maintenance - Quality Smart Building -: Sustainability

1. Introduction

Over the years, maintenance concepts and procedures have gone through different stages of development in thought and performance, and until recently, the common concept of maintenance was the reaction after the occurrence of the problem which in turn led to large losses, whether financially represented in assets or human in loss of lives [3, 10]. Because of what Egypt owns of real estate assets of public buildings and heritage buildings, and what modern technologies have produced in terms of means, tools, and techniques in the field of maintaining these buildings in general, it was necessary to preserve these assets and ensure their sustainability through optimal operation and maintenance, as the preservation and sustainability of these real estate assets They are among the most important indicators against which to measure the progress and progress of countries[2].

2- A quality strategy maintenance for smart buildings

Quality management of maintenance for smart buildings is based on quality control not only in maintenance operations but in general in the activities of studies, design, and supervision of project implementation. Because The problems in maintenance go back to the beginning of the stages of the project life cycle in studies, design, and supervision of implementation and to expand the perspective of comprehensive maintenance through the integration of roles in the various stages of the project, so we must focus on the requirements of operation and maintenance in the design guidelines and standards and technical specifications for construction and architectural materials, electrical works, mechanical works, security and safety In addition to equipment, supplies, all facilities, selection of systems, characterization of equipment and fixtures, tests and receipts [8]. Therefore, there should be specific joint relationships between designers and operators that must be taken into account in the various stages of design. Information and the exchange of project cycle stages should also be determined according to the requirements of each stage, [1] as illustrated in Figure 1.

And to activate and develop the management of building maintenance quality systems in line with the scientific renaissance in the world, and to be characterized by modern, accurate devices, and to be equipped with modern computers, electronic display devices, audio systems, and surveillance cameras. Also, the presence a system that does not work due to a malfunction of the devices and machines, due to the lack of preventive and periodic maintenance.

This research makes a plan for quality management of maintenance systems of all devices and machines inside buildings and how to implement a quality system in terms of verifying the implementation of maintenance procedures. Building management systems are commonly implemented in large projects involving electrical, and mechanical, The primary function of Heating Ventilation, and Air Conditioning (HVAC) systems is environmental management inside the building by controlling the temperature, carbon dioxide levels, and humidity inside the building. As an essential function in most building management systems, it also controls the heating and cooling and manages the systems that distribute this air throughout the building (eg. via actuating fans or opening/closing valves) so it controls the combination of heating and cooling to up to room temperature.

The secondary function is the detection of the level of carbon dioxide (CO2) which is human-generated then mixing the outside air with waste air to increase the amount of oxygen while at the same time reducing heat/cooling losses.

2.1 Building management systems (BMS)

Building management systems (BMS) are a critical component of energy demand management. BMS represents 40% of a building's energy use, and if the lighting was added the percentage will be around 70%.

In addition, BMS is sometimes linked to access control (gates and door control access that allows entry and exit to the building) or other protection systems such as closed circuit television (CCTV) and motion detectors (Figure 2). Fire alarm systems and elevators are also sometimes linked to the building management system, for example, if a fire is detected, the system can close the valves in the ventilation system to prevent the spread of smoke and send all elevators to the ground floor and stop them to prevent people from using them in the event of a fire Figure 3.

2.2 Optical sensors

The optical sensors (motion detectors) are rays of light that work when the flow of energy is disrupted by something moving in the path of the light beam it will be given an alarm. Photo sensors can be used not only to alert you to intruders with an alarm but also to anyone entering your space with a buzz or a bell (Fig. 4).

2.3Thermal monitoring systems

Infrared night vision thermal camera, Long range rail surveillance camera Integrating the visible camera, near-infrared laser lighting with thermal Camera, multifunction (Fig 5).

2.4 Anti-theft alarm systems

Anti-theft alarm systems, are characterized by extreme sensitivity to detect any unwanted movement in the space of the facility or the house to be secured because the system is equipped with sensors of a high degree of sensitivity, which sound the alarm in the event of detection of infiltration of any kind and contact the security services, agencies and people Who are selected immediately (Fig. 6).

2.5 Electronic Access Control System

Electronic Access Control (EAC) system uses computers to solve the limitations of mechanical locks and keys. Use the search to search on mechanical keys. The system will also list the name of the list, its appearance, if the door is forcibly opened or kept long, after opening it. Road systems and wooden locks can also be controlled (Fig.7).

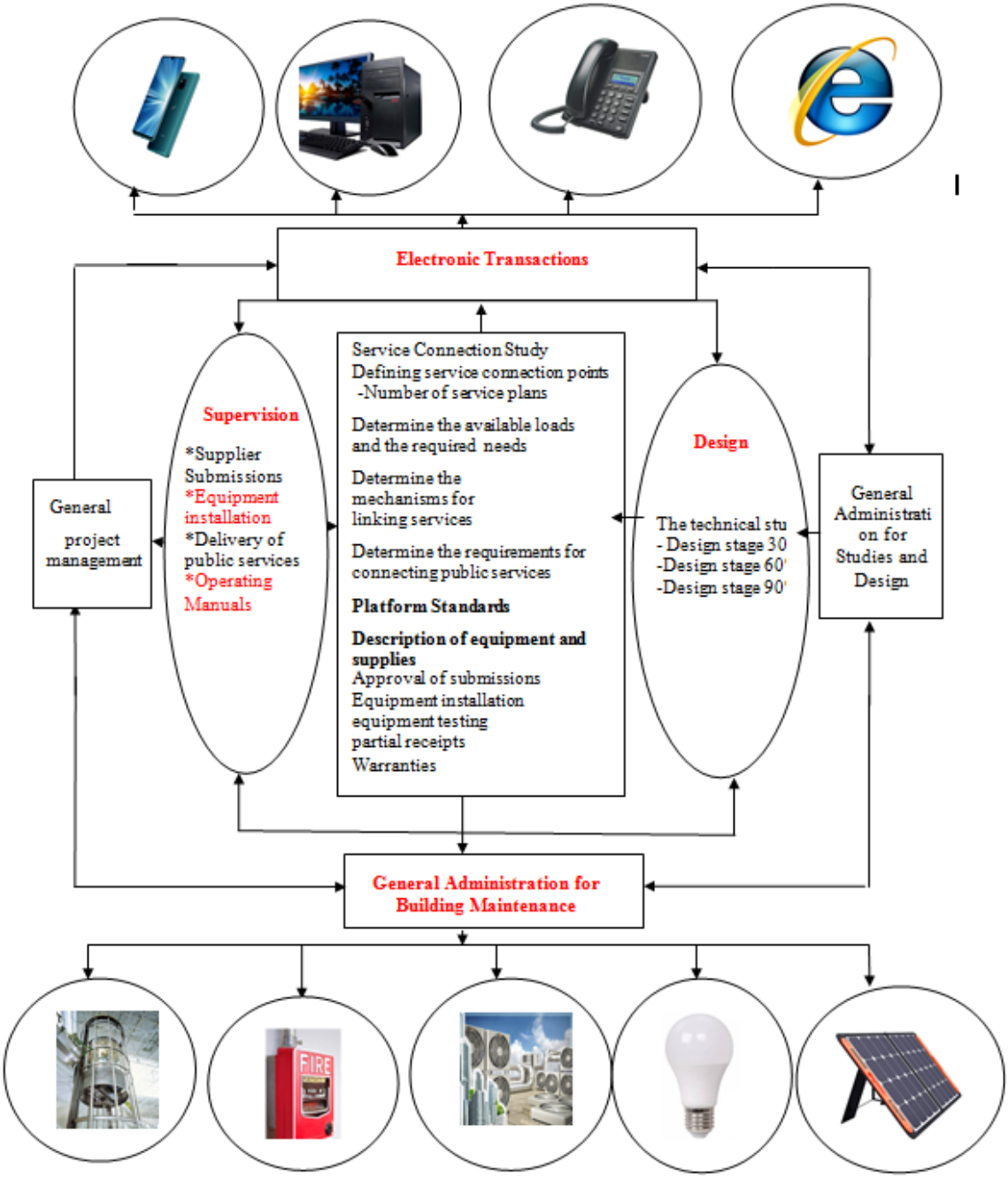

Figure 1: Relationship diagram between designers, supervisors, and operators
Maintenance steps Maintenance steps Maintenance steps

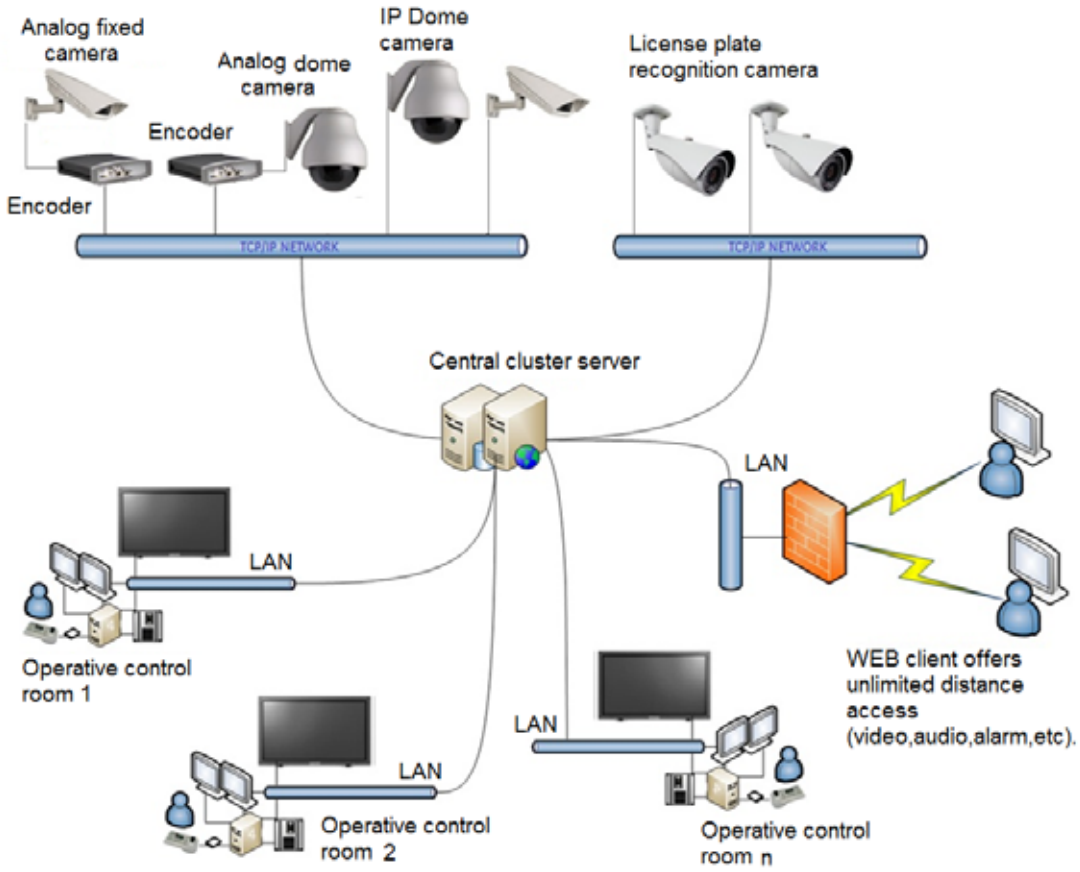

Figure 2: Closed-circuit television (CCTV) Surveillance Systems for Building

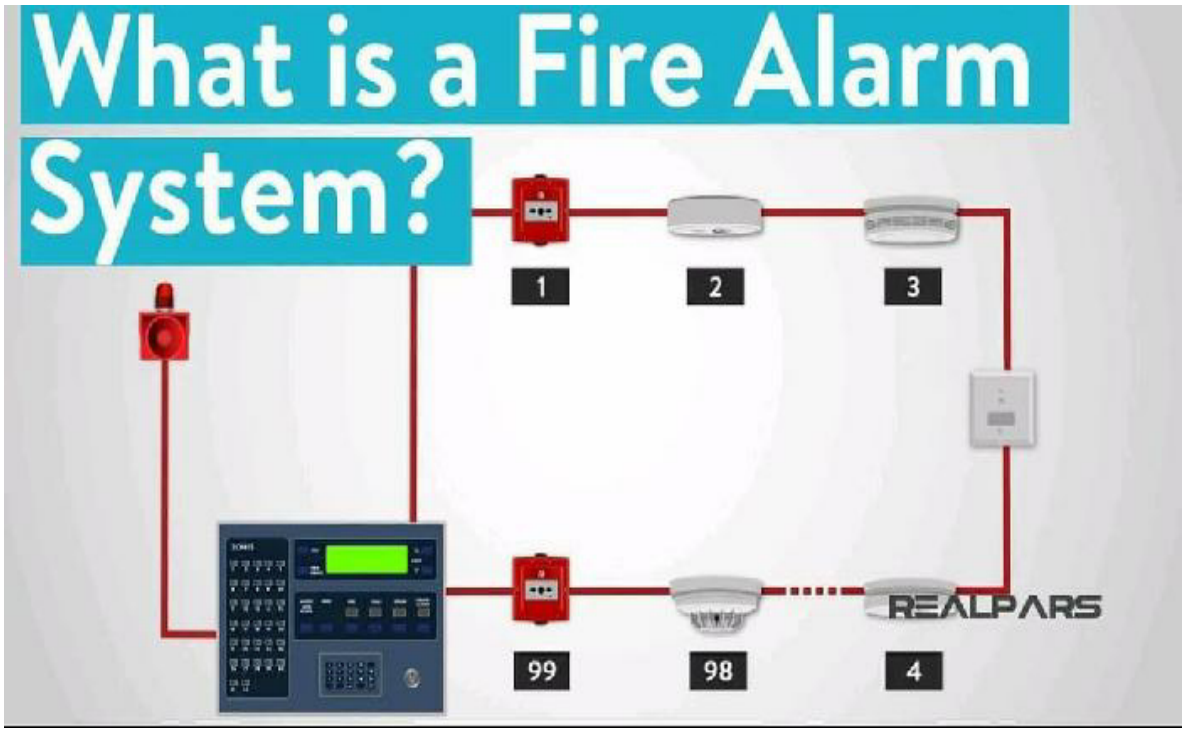

Figure 3: Fire Alarm Systems

Figure 4: Optical sensors

Figure 5: Thermal monitoring systems

Figure 6: Anti-theft alarm systems

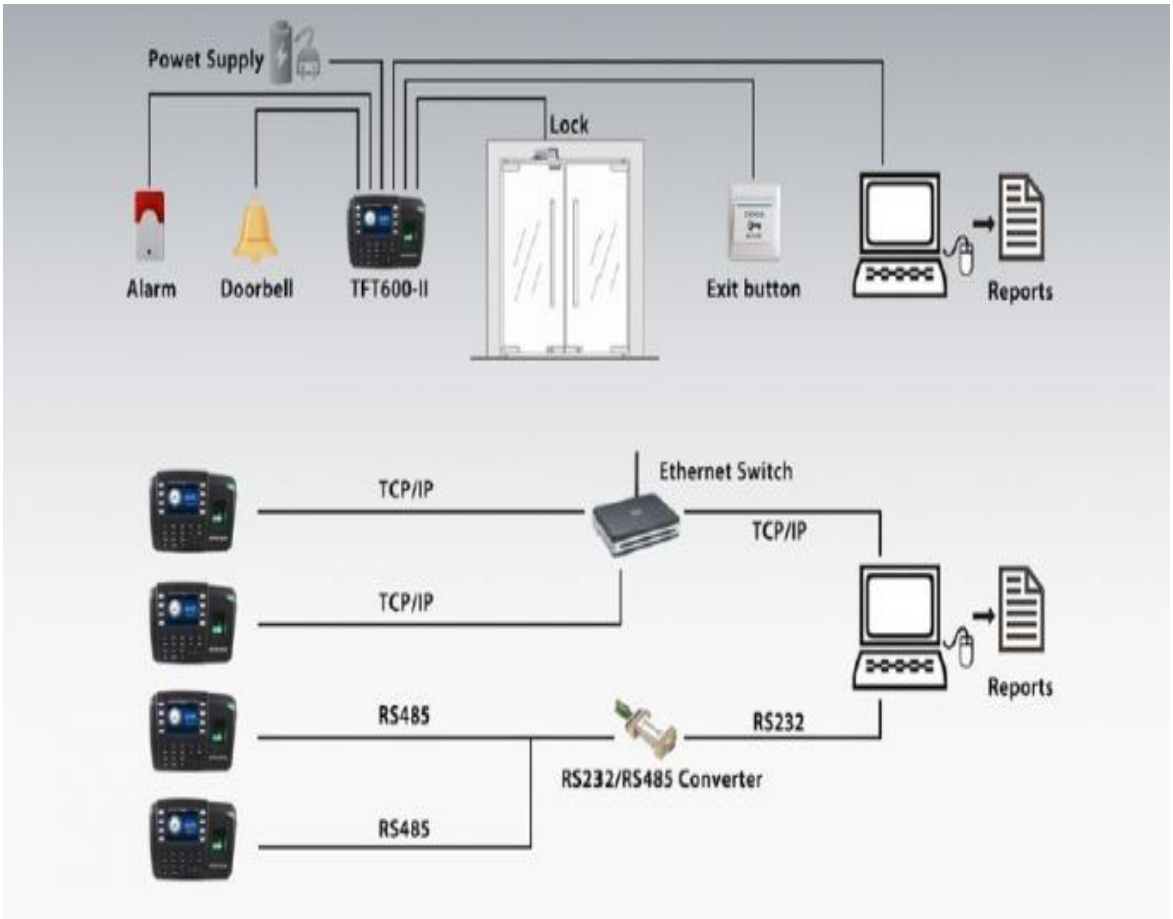

Figure 7: Access Control System

3- Management of operation, maintenance, security, and safety requirements

The principles of operation and maintenance management are applied to all systems and elements of public and heritage buildings. The criterion of efficiency of operation and maintenance management is one of the most important elements of the success of the life cycle of buildings and ensuring its sustainability, compared to the capital invested in the construction and operation of buildings. The application of the principles of operation and maintenance management helps to provide conditions for a stable operation that reduces the expected risks during operation and improves the quality of the internal environment, ensuring the highest levels of security and safety, and providing a healthy, safe and risk-free environment.

Figure (8) shows the general scope and requirements for building management systems, which include:

-Documenting the owner's understanding of the importance of buildings.

-Understand the needs and expectations of stakeholders, users, and participants in operations and maintenance.

-Defining the responsibilities and roles of each party participating in the system, to achieve the success of operations and maintenance.

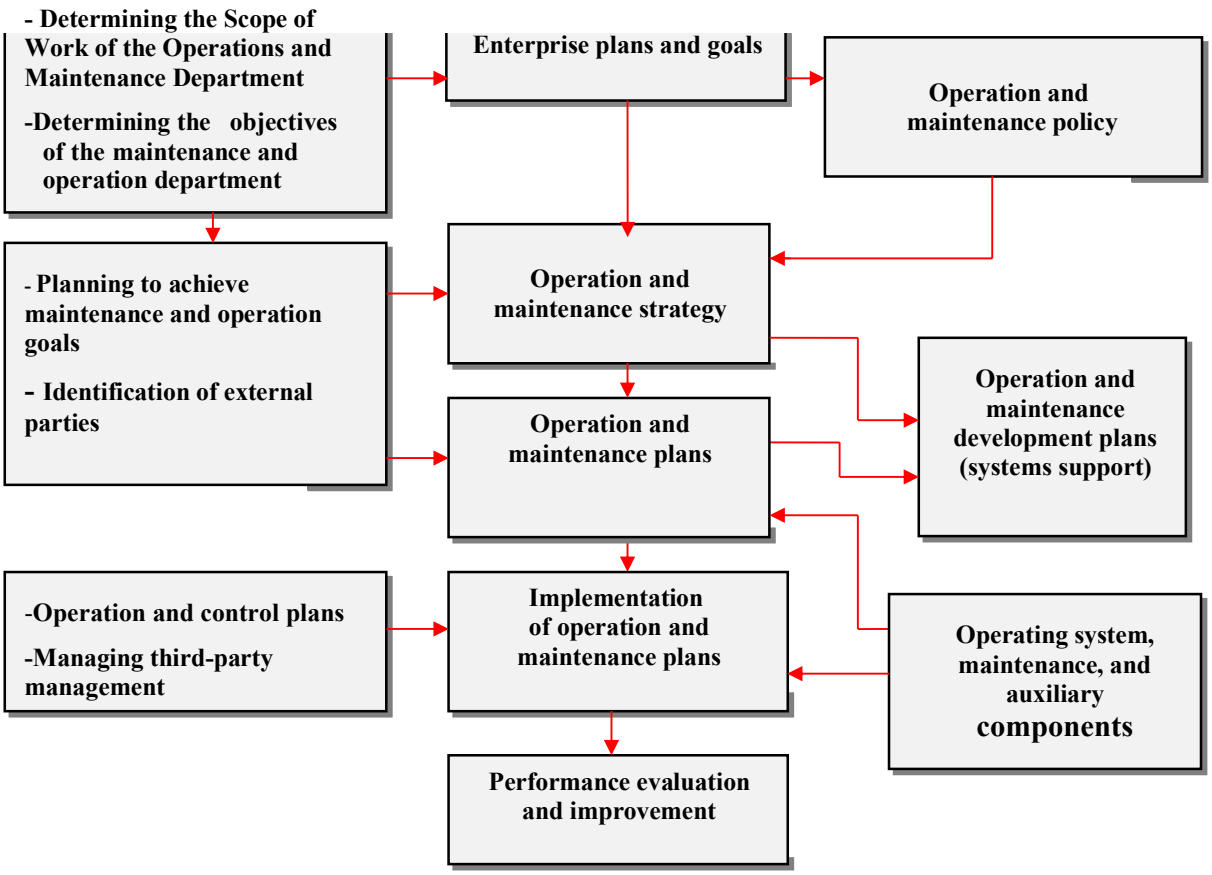

Figure 8: General scope and requirements for operation and maintenance management

3.1 Achieving sustainability through operations and maintenance

Operation and maintenance work must be planned and implemented within the general framework to achieve sustainability in its economic, environmental, and social dimensions. Where targets are set for energy and water consumption, reduce the negative impact on the environment, achieve thermal, visual, and acoustic comfort requirements, prepare and implement an operation and maintenance plan, identify performance indicators related to achieving sustainability goals, monitor the performance of operations and maintenance, and compare actual performance measurement results with the planned targets, and include the following objectives:

-Achieving energy efficiency in buildings.

- Achieving efficiency of using water.

- Achieving efficient consumption of materials and resources and reducing materials and emissions that pollute the environment.

- Achieving air quality in the building (ventilation, thermal, visual, and acoustic comfort).

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3.2 Operation and maintenance information systems

In light of the rapid technological development in information systems and databases and their employment in architectural and engineering design and construction methods, the building owner organization must take advantage of information systems applications in developing operation and maintenance work to document and monitor all strategies, plans, implementation mechanisms, operating results, performance measurement, asset register, accident record, and record Risks, all responsibilities, tasks, documentation and review mechanisms. Computerized Maintenance Management Systems (CMMS) are an effective way to manage assets, schedule maintenance, track work orders, and spare parts, and evaluate the condition of building systems and components.

3-3 Building Information Modeling (BIM) to manage operations and maintenance

Success in the operation and maintenance phase of the building's life requires integration with the previous phases during the design and construction. Most of the owners of buildings and facilities are currently preparing digital models for all building elements and systems using the technology known as Building Information Modeling-BIM. Where all architectural, structural, and electromechanical elements are represented in a 3D digital way (BIM 3D Model). During the construction phase, data on costs and schedules are added to produce a five-dimensional model (BIM 5D Model) that contains all the actual details of implementation (As Built). The building owner can also add information tracking the elements necessary to achieve sustainability to be a six-dimensional model (BIM 6D Model), and add operation and maintenance information to form a seven-dimensional model (BIM 7D Model).

This technology allows documenting information on every element from design to construction and ending with operation and maintenance. This technology helps those responsible for operation and maintenance to link maintenance programs and instructions with building elements in a digital form. These digital systems also contribute to monitoring energy and water consumption, indoor climate quality, and achieving security and safety in the building to achieve sustainability goals and green buildings while achieving the building's economic and operational goals.

The owner of the building or the organization responsible for the operation and maintenance of the building must use computer technologies or building information modeling, as these methods help to manage the operations and maintenance operations with the highest possible efficiency and know the condition of each element in the building accurately and link digital models with simulation applications to achieve goals Rationalizing energy consumption and other applications that contribute to achieving sustainability and the quality of the building's internal climate while rationalizing spending[6]. When preparing a digital building information form for the management of operations and maintenance, it must include the following elements, Figure 9:

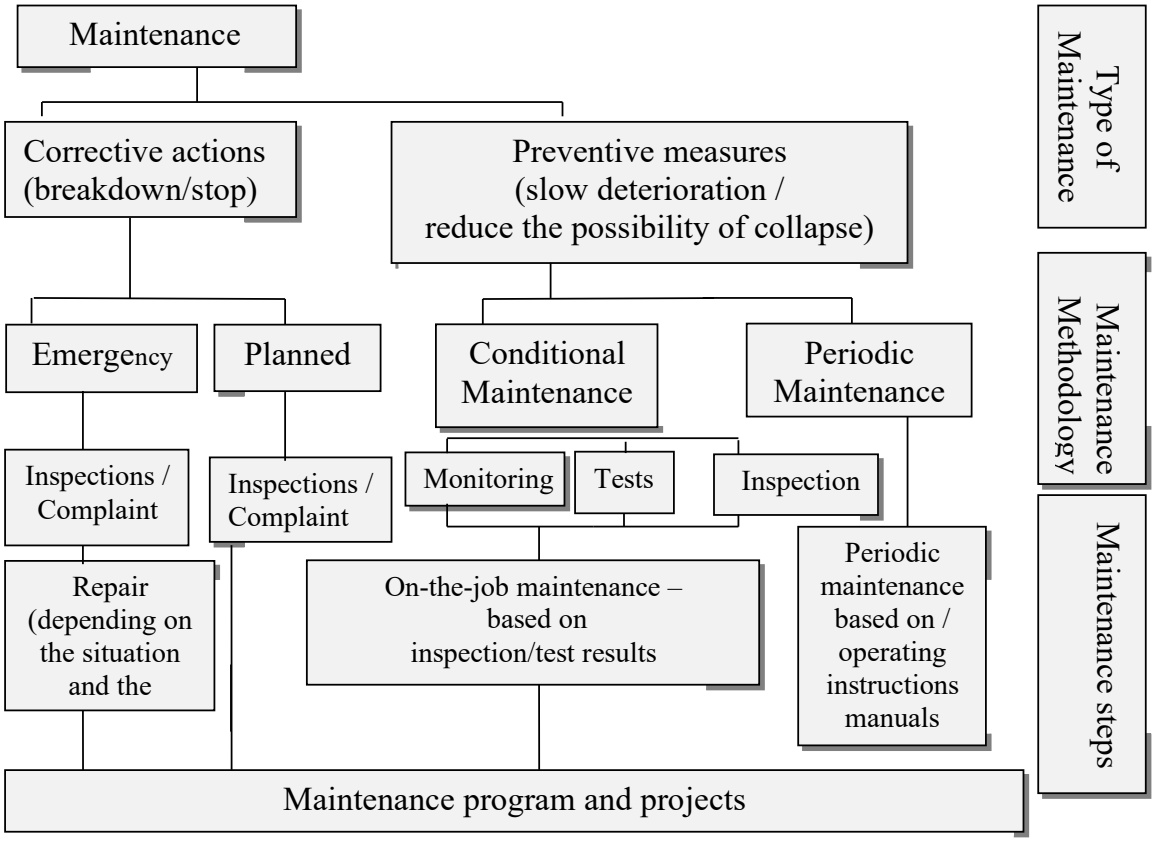

Figure 9: Organizational Structure of Maintenance Procedures

3-4 Preparing the building operation and maintenance manual

The Building Operation and Maintenance Manual is one of the deliverables that a construction contractor makes to a building owner, and is usually part of the initial and final receipt documents. The guide is developed with the start-up of the building and continuously throughout the life of the building. If the construction contractor does not prepare this manual, the owner of the building must assign a specialized consultant or assign the company operating and maintaining the building to prepare a manual for the operation and maintenance of the building. The guide includes basic data on the design and specifications of all building systems and elements, setting performance targets in the operating phase, regular maintenance and correction schedules, and means of assessing the condition and monitoring the performance of building systems and elements, to maximize operational performance, maintaining the building, saving operating expenses, and avoiding damage to the building that reduces the life of the building. The virtual building avoids the high cost of maintenance work and avoids damage to the security and safety of building users, maintenance personnel, and passers-by.

The guide includes information and data about the systems and elements of the building dating back to the design and construction phases. In particular, the electrical and mechanical contractor(s) and suppliers have a primary responsibility to provide information on the building's electromechanical systems and maintenance instructions for each component. The building operation and maintenance manual contain, at a minimum, the following information:

- A description of the elements, systems, and construction works of the building and the technical specifications of each element and system.
- Actual implementation drawings and specifications (As-Built Drawings & Specs)
- Product Data Sheets for all building elements
- Cleaning and maintenance instructions
- Health, safety, and fire prevention instructions from manufacturers and implementers
- Testing and Commissioning Certifications
- Warranties from the original manufacturer or the guarantees provided by the contractor (Warranties and Guarantees)

3-5 Building Management System (BMS)

The primary function of building management systems is to manage the internal environmental conditions within a building, i.e. temperature, in such a way that energy is saved as much as possible. Building Management System (BMS) system based on a computer- installed in buildings that are used to control and monitor mechanical and electrical plants, including heating, ventilation, air conditioning (HVAC), lighting, power systems, fire systems, and security systems.

Effective and well-used BMS systems provide the essential management tool required by building managers to ensure effective energy monitoring and management and user comfort. In addition, it enables building managers to provide the optimum working environment while reducing costs. Effective use of a building management system enables optimum building performance by extending the operating life of equipment and systems by reducing loads and operating hours. Therefore, maintenance and capital costs are reduced, and less built-in energy is consumed through equipment replacement and upgrade.

The BMS will show increases in energy use due to equipment failures or modifications to operating parameters. For example, heating valves open when a building needs cooling. The building management system may also indicate that the air conditioning is started hours before the entire building is occupied due to the activities of security personnel. With this information on hand, the engineering manager may rectify these problems through consulting or engineering solutions.

In the absence of a Building Management System, the impact of such events can be masked by seasonal changes, changes in occupancy levels, or the evolution of technology. A building management system if properly configured with a sufficient number of precisely defined control points is the only way a building manager can be alert for problems that may remain undetected until annual inspections or external audits are conducted.

The BMS is also an essential tool for identifying opportunities to improve energy intensity, for example, improving the size and number of lighting intervals, providing meaningful reports to the Care Environment Committee on issues and opportunities, and enabling fault identification, maintenance planning, and energy-saving upgrade.

3.6 Smart Building

A smart building is one in which basic equipment and assets, such as air handlers, coolers, boilers, lighting, etc., can communicate with other machines. Where there is a detailed management system to control and improve all parts.

A smart building aims to provide useful services that help make its users more productive, safer, and at the lowest cost and with the least impact on the environment. A smart building improves and reduces energy use, can operate with clean energy sources, and puts the security of occupants and quality of life first. These priorities not only mean physical safety, such as fire suppression and alarm systems, but also health security - high-quality air and water, and more.

Equipment and systems in a smart building must be connected and able to communicate from one machine to another. For example, a building's chiller can receive weather data from the outside and occupancy information from the inside, so it only operates when needed to maintain the optimum temperature for its occupants.

What makes all of the above work so well? The availability of small, sophisticated, and affordable sensors connected through the BMS allows it to analyze and use the data generated by these sensors to manage and improve operations. Intelligent building systems can use the generated data to monitor performance, track the location of equipment and assets, detect potential operating problems and improve preventive maintenance efforts.

Buildings today are complex chains of structures, systems, and technology. Over time, every component within the building has been developed and improved, allowing us to independently select the lighting, security, HVAC, and systems. Today, we seek to build, work in and live in smart buildings as the right thing to do. Many governments and industry regulators set standards for the construction and management of facilities to meet environmental, safety, and sustainability requirements. Leadership in energy engineering and design (LEED) is an accreditation program approved by building owners and managers to certify compliance with government and subjective requirements [9-4].

3.7 Green building leadership is LEED

LEED (Leadership in Energy and Environmental Design) certification is one of the most widely recognized standards for sustainability, and an excellent way to demonstrate your building's environmental credentials. LEED is the green building rating system for green buildings that are healthy, efficient, energy efficient and cost effective.

LEED Certification Minimum Requirements

Comply with environmental regulations and standards.

-Must meet the threshold of floor area requirements.

-Meet a minimum of building occupancy in terms of the number of users.

-Maintain a reasonable site boundary.

-Be a permanent building.

-Share energy and water usage data.

3-8- Operating instructions and warnings for devices and machines in the building

3-8-1 Mechanical Instructions

Mechanical instructions are one of the main factors in evaluating the efficiency of devices, so the following must be ensured:

-The catalogs of all equipment and machines must be read before operation.

-The water tank must be full for water pumps.

-Check the oil level of the hydraulic pumps.

- The absence of any apparent obstacles hindering the pumps.

-The fuel tank is full and sufficient.

3-8-2 Objectives of sustainable operation and maintenance of the electrical system in buildings and

electrical instructions

3-8-2-1 Objectives of sustainable operation and maintenance of the electrical system in buildings

- Improving the electrical energy efficiency in the building.

- Maintaining the life span.

-Protection from electrocution and electrical fire hazards.

- Using Pro-Diagnostic maintenance and additional diagnostic maintenance before the fault occurs to locate the technical malfunction.

- Using a proactive maintenance system before the damage occurs instead of a reactive maintenance system

after the damage occurs instead of Reactive maintenance.

- Use of automated smart control and monitoring systems throughout the day.

- Using modern maintenance tools, equipment, and systems to reduce maintenance costs and maintain operating

time. i.e. (Reducing the time of preventive maintenance + reducing the number of maintenance workers + reducing the

consumption of spare parts + monitoring the operation of equipment within the limits of the design capacity)[6-7].

3-8-2-2 Electrical Instructions

In this section, you must make sure of the following:

- The presence of an electric current in the operation panel with the appearance of the main supply bulbs.

-All major and minor switches are ON.

-The three phases in the volt switch are intact and all of them read 380 volts between phases and read 220 volts between each phase and the earth.

- All switches to operate the devices are placed on automatic mode.

- If any device stops, the ignition switch is placed in the OFF position.

- When turning on any device manually, the power key is placed in the HAND position.

-When the red indicator light appears, it means that there is an overload so reset is done, which is an internal situation in the control panel until the red indicator light signal disappears, and when it repeats, this device is stopped and the maintenance is informed to detect it to remove the cause.

-When you hear any sound other than the usual sound of operation, The device is turned off and maintenance is reported

- It should be noted that the optimum ampere reading for the operation of all devices separately during normal

operation. In the case of the high ampere, the device is turned off and maintenance is reported

- When the green indicator light appears, it indicates that the devices are working in good condition.

3-8-3 Operation Warnings

All equipment and machinery catalogs must be read before operation.

It is forbidden to operate the pumps without water to prevent damage to the gaskets.

- When servicing any pump, the two sub-clamps are closed for expulsion and withdrawal of the pump for which maintenance is to be carried out while leaving the rest of the other valves open to ensure the continuity of the system's operation.

- Water tanks must be constantly cleaned and purged of all solid materials to not cause damage to the pumps, and to ensure that the main intake valves are not clogged with any suspended materials.

- Pumps need good ventilation.

3-9 Maintenance of systems

1) The procedures for applying mechanical requirements, such as ventilation, cooling, and heating installations, maintenance and operation, and requirements for protection against fire hazards, must be checked according to the standards specified by the manufacturer[5].

2) The following is a statement of the required systems maintenance records, to ensure the availability of a good system for follow-up and documentation as shown in the following table (1):-

Intake fans (Air or draw fumes)	Chilled Water Generating Units (Water Chiller)	Air conditioning, refrigeration and ventilation equipment system	Firefighting and alarm system
Centrifugal pumps	Escalators and electric walkers	Electric elevators	Boilers
Electrical generator		Cooling towers	Chiller

Table (1): Maintenance records of mechanical systems

3-9-1 Steps of the maintenance process

The steps of the maintenance process are summed up in laying the foundations and means that make all devices and equipment inside the buildings in the best operating condition and permanently maintain raising performance and efficiency rates through:-

-Conducting a periodic, continuous, weekly check on all devices, machines, and equipment as included in the preventive maintenance program.

-Establishing a program for early detection of damage and determining the life span of each part of the building's devices and equipment.

-The importance of informing the competent authority about the existence of machines or devices that need spare parts the maintenance company submitted an offer for the required spare parts and this offer is examined technically and financially before being approved by the competent authority.

-Always ensure the correctness and safety of maintenance and repair.

-Attention to achieving industrial security in all devices, machines, and equipment.

-Submitting a detailed weekly report on maintenance work.

3-9-2 Program for repair and maintenance of machines, machines, and equipment

Maintenance work for all parts of the machine/equipment is as follows: -

3-9-2-1 Inspection of electrical parts and accessories

- The electrical circuit (connections - cables) is detected if the electric current is connected or not.
- On and off switches are detected.
- The control circuit is detected (conductor-overload switch.....)
- The inspection shall review the entire above before operation.

3-9-2-2 Inspection of mechanical parts and accessories (mechanical actuator connectors

Rotating mechanical parts and their accessories (ball bearings, belts, oil pumps, taps, pump gaskets, etc.....) are detected.

3-9-2-3 Inspection of the oil pump

a) Oil tank b) oil lines or oil hoses

c) Valves (exits and inlets) d) filters (exits - inlets)

e) Inspection of pressure control parts

f) The oil itself is detected and the degree of viscosity is determined using a viscometer

3-9-2-4 Inspection of the auxiliary parts and accessories

Checking (pressure gauges - current and voltage meters - temperature gauge - temperature sensor).

4- Maintenance and repair of equipment and machinery in the building

The purpose of maintenance is to ensure the quality of the devices and machines, and maintenance and repair of all devices and machines to ensure their continuity of work without sudden interruption. This is for all devices and machines in the building.

4-1 Responsibilities

a. Head of the maintenance unit. b. General supervisor of maintenance.

4-2 Forms

a. List of building equipment b. Preventive and periodic maintenance program

c. Maintenance record d Examination report of device and machines

e- Request to replace a spare part f. Weekly report

g. Installation report. h. Varieties of reflux

4-3 Maintenance work instructions

All catalogs of devices and machines.

4-4 Steps off maintenance

a. The general supervisor of maintenance works identifies and codes the devices and machines that are subject to the building's preventive maintenance program.

b. The head of the maintenance unit ensures that a maintenance log is prepared for a machine or device, and the data and specifications of the device are recorded.

c- The head of the maintenance unit reviews and approves the maintenance program at the beginning of the year on the planned dates based on:

* Specifications of the machine. *Maintenance instructions in catalogs

* Machine life history of the machine is included in the maintenance record.

* Experience with maintenance personnel. * Devices menu

According to the maintenance program, the maintenance team undertakes the maintenance work, under the supervision and follow-up of the building maintenance supervisor.

e. After completing the maintenance work on the machine or equipment, the unit technician completes an inspection report, then signs it and presents it to the general supervisor of maintenance work, who confirms that all required maintenance items are completed with work instructions and then approves the inspection report.

f. The general supervisor ensures that the maintenance program is implemented.

g. The administrative supervisor of the building updates the data in the maintenance record for a machine or equipment that has been periodically maintained.

h. If new spare parts are needed to complete the maintenance work, the maintenance technician shall obtain the approval of the maintenance manager to replace the spare parts, which contains the estimated price of the piece.

i. The technician, the user of each device or machine, reports sudden malfunctions on the form. The technician of the maintenance unit checks the equipment and completes the form prepared for this, and submits it to the general supervisor of maintenance, who in turn directs the maintenance procedure. Spare parts are installed and making an installation report.

j. The general supervisor of maintenance works analyzes the technically and financially submitted quotations, inspects the devices, and prepares the technical examination and the parts returned with the maintenance unit.

K - Weekly reports are prepared and compiled periodically by the general supervisor of maintenance work. This report is submitted to the maintenance manager through meetings (reviews of the senior management of the work system) and includes:

* Develop visions for the development of devices and machines for future needs.

* Sudden malfunctions and their causes.

* Extent of adherence to the maintenance plan.

* The condition of the devices and machines and the extent of the need for the replacement process.

* Resources and additional costs to implement the maintenance and repair plan.

* The most important problems and obstacles facing the maintenance work.

M- Putting files on the computer for maintenance work, which the computer operator performs, and doing a BACK-UP for these files.

5- Calibration work and adjust measuring, inspection, and testing equipment

5- 1Purpose

It is to ensure that all measuring, inspection, and testing devices used in the building can be relied upon and that their measurements and indications are relied upon by the planned calibration and control.

5-2 Scope of application

All measuring, inspection, and testing devices in the building.

5-3 Calibration Responsibilities

a. Head of the calibration unit in the building. B. The general supervisor of calibration work in the building.

5-4 Forms

a. A statement of the list of devices that are subject to calibration b. Calibrated device tracking card

5-5 Work Instructions

Hardware Catalogs.

5-6 Calibration

The calibration supervisor performs the calibration of the building's equipment on the planned dates according to the periodical.

The calibration supervisor also records the data of the devices and machines and records the actual calibration date and the upcoming calibration. The device follow-up card and the issuance of (the calibration certificate), which is approved by the head of the calibration unit, and a copy of it is kept with the maintenance and calibration supervisor, and the original is kept with the head of the calibration unit.

6- Conclusion

Based on the study, the following can be concluded:

1. There must be the management of quality systems for the maintenance of smart buildings.

2. Operating instructions for building machinery and equipment must be clear and periodic training should be carried out.

3. Adoption of the maintenance program and applied monitoring to maintain the building's machinery and equipment.

4. Checking the quality system periodically and applying it well.

5. All building equipment and machinery must be calibrated.

6. There should be positive, multiple, sudden and continuous periodic administrative control.

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