



UNIVERSITY OF NAIROBI

SCHOOL OF THE BUILT ENVIRONMENT

DEPARTMENT OF REAL ESTATE & CONSTRUCTION MANAGEMENT

A STUDY ON THE IMPACT OF MAINTENANCE MANAGEMENT SYSTEMS ON MAINTENANCE CONDITION OF BUILT FACILITIES (CASE STUDY OF PUBLIC UNIVERSITIES IN KENYA)

**A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
MASTER OF ARTS DEGREE IN CONSTRUCTION MANAGEMENT**

BY

DAVID GIDUDI CHOKA

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DECLARATION BY RESEARCHER

I David Gidudi Choka declare that this research proposal is my original work and has not been presented at any other university for examination.

SIGNED:

DAVID G. CHOKA B.A (Building Econs),RQS, CIQSK

DECLARATION BY SUPERVISOR

This research proposal has been submitted for examination with my approval as a University supervisor:

SIGNED:

NICKY NZIOKI B.A (Land Econ),Hons, M.Sc M.I.SK RV

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CHAPTER ONE: INTRODUCTION AND PROBLEM STATEMENT

1.0 INTRODUCTION

Introduction and Background to the problem

Prior to the twentieth century maintenance was considered a necessary evil. Technology was not in an advanced development, there was no alternative for avoiding failure. With advent of technological changes and after the second World's war, maintenance came to be considered as an important function in any organization. The efficiency and effectiveness of the maintenance system plays a pivotal role in the organization's success and survivability.

Maintenance System used can very highly affect maintenance performance. The cost of repairing in preventive mode is on average about three times higher than the cost of repairing in preventive mode and also has less performance than preventive mode. This is because reactive maintenance does not tackle the root level of a problem and always results in repetitive failure.

Many organizations tend to adopt the proactive maintenance philosophies since these approaches are committed to long term improvement of maintenance management. A factor that can bring efficient maintenance management is the operational involvement since one of the main causes of breakdowns comes from abusing operations and a lack of primary care from the operators.

Maintenance works is an important function in organizations with significant investment in physical assets and plays an important role in achieving organizational goals (Tsang, 2002). The most important reason for implementing a maintenance management system is to measure the value created by the maintenance process.

The effectiveness or failure of the maintenance management system may be judged by the maintenance condition of the facilities. It is therefore imperative that the management system adopted meets the predetermined standards from the outset.

This study seeks to analyze management system adopted by public universities in Kenya with the objective of establishing whether they have a bearing on the condition standards of built facilities.

1.2 Problem Statement

All buildings should meet certain safety and health regulations. These regulations ensure that built facilities are well maintained to ensure that they are structurally safe in order to provide a safe environment to live in and ensure that they are not a danger to the health of occupants. Equally the facilities must be in a condition that ensures that they are functionally sound and meet the expectations of users. To achieve this maintenance works must be effectively and efficiently managed. Maintenance management is crucial especially in current times where maintenance budgets are constrained

Maintenance management is an area that has been given very little attention in public institutions of higher learning in Kenya if the number of deteriorating buildings is anything to go by. The current state of buildings or built facilities in Kenyan public universities is a symptom of an inherent problem with the management of maintenance works in these institutions.

Studies by Derek and Syagga have defined described the problem of maintenance of public buildings in developing countries as running down of important national capital assts beyond economic repair. This state of affairs has been a common feature in the maintenance of public buildings in Kenya **(Mwebia, 1988)**

Public universities in Kenya have in the last decade (1998-2008) faced unprecedented challenges due to reduced funding from the government and increase in the number of students after the introduction of Module II programs. The reduced funding from the government consequently results in the universities in monitoring their expenditure levels. This in effect results in reduced budgets in non core service areas. Maintenance is an area where public universities would probably cut down on expenditure. Maintenance management therefore plays a very important role by ensuring limited resources are managed to obtain the best possible outcome for the universities.

According to Seeley, 1987, the ad hoc approach to maintenance may seem attractive but is unlikely to obtain value for money or an efficient maintenance system. It is important for managers in public universities to embrace modern maintenance management systems to ensure that with the little resources available, the built asset portfolio owned by the universities is in good maintenance condition.

In as much as maintenance services do not form a core function, their contribution to the universities' core functions of teaching and research should not be underestimated. The deterioration of buildings due to lack of maintenance can lead to future financial burdens, pose legal and other issues that will affect the delivery of teaching and research. By engaging in a strategic approach to maintenance, universities are bound to benefit from the increase and enhance effective use of Universities' physical assets.

1.3 RESEARCH QUESTIONS

The research seeks to answer the following questions;

- i. Do public universities in Kenya have a maintenance management system and what are the inadequacies of the systems?
- ii. What challenges are faced in implementing a maintenance management system?
- iii. What factors in the maintenance management process contribute to current maintenance condition of built facilities in public universities?
- iv. Does the effectiveness of maintenance management system influence the maintenance condition of built facilities?
- v. What measures can be adopted to improve effectiveness of maintenance management systems of in public universities?

1.8 RESEARCH OBJECTIVES

Stemming from the above research questions, the research intends to meet the following objectives:

- i. To examine the maintenance management system used in public universities and highlight the shortcomings and inadequacies in its implementation
- ii. To establish the impact of the shortcomings in the maintenance management system on the maintenance condition of built facilities at the universities.
- iii. To recommend measures to improve the maintenance management systems in public universities in Kenya.

1.8 HYPOTHESIS

Poor maintenance condition of built facilities in public universities in Kenya is due to ineffective maintenance management systems.

1.9 SCOPE OF STUDY

The study will focus on maintenance of built facilities that contribute directly to the core functions of universities; teaching and research because of limited time and resources. This will focus mainly on lecture halls, libraries and laboratories

The research will cover the maintenance of selected facilities at colleges of the University of Nairobi and Kenyatta University (Main campus)

1.10 JUSTIFICATION FOR THE STUDY

A number of studies on maintenance of institutional buildings in Kenya especially in public universities have concluded that most built facilities are in poor state of repair due to many factors. Few studies have critically studied the maintenance management system in place in these institutions and how much these systems have contributed to the condition of the built facilities. Most of these studies have concentrated on selected aspects of maintenance management such as maintenance policy, maintenance organization and general maintenance.

The study hopes to fill this gap by looking at maintenance from a management systems approach.

The University of Nairobi and Kenyatta University were chosen as the case study given that they are the pioneer fully fledged universities in Kenya. The two universities also have arguably the largest built asset portfolio than any other public universities in Kenya. Some of the buildings are as old as have the respective university been in existence. The large built asset portfolio and ageing building poses unique maintenance challenges for maintenance managers.

The universities also have a relatively better developed maintenance departments and as such are expected to have a better developed maintenance management systems. The two pioneer universities would probably then serve as a benchmark for best practice on maintenance management system in Kenyan public universities.

1.8 RESEARCH METHODOLOGY

1.8.1. Research Design

The research design for the study is exploratory case study. A case study is an in-depth investigation of an individual, group, *institution or phenomenon*.

The case study strategy has considerable ability to generate answers to Why?' as well as "What?" and "How?" questions. A case study is selected for **analytic generalization** and **not for statistical generalization. This case study is not a sampling unit**. The researcher's goal is to confirm, challenge or to extend existing theory on maintenance management systems and condition standards of built facilities.

1.8.2 Sampling

The facilities to be assessed will be selected using non-probabilistic sampling techniques such as purposive sampling. This sampling technique allows the researcher to use cases that have required information with respect to the research objectives. The focus is on in-depth analysis of the selected facilities

1.8.3 Data Collection Methods

Since the selected research design is the case study approach, the main research instruments are questionnaires, observation schedules and structured and unstructured interviews. The researcher is a non participant observer; simply observing and recording the phenomena of concern to the study.

1.8.4 Data Analysis

The data to be collected is mainly qualitative in nature as it seeks to make general statements on how themes of data are related.

1.9 SUMMARY

Chapter One outlines the background to the problem, states the research problem, poses research questions, the study objectives, the study hypothesis, scope of study, justification of the case study and the research design.

Chapter Two reviews the relevant literature related to the research problem and to the study as a whole. In the literature review, the variables of main interested are identified and defined. In particular it outlines an exposition on maintenance, maintenance management systems and condition assessment system. Existing theories on maintenance, maintenance management systems, organization of maintenance, maintenance management problems and Condition Standards are also discussed.

Chapter Three outlines the Research methodology. The chapter outlines the Research design for the study. It also explains the procedures of data collection and the research instruments developed. It includes data analysis techniques to be used.

Chapter Four outlines Data Presentation and Analysis

Chapter Five outlines Conclusions and Recommendations from the research findings. There's also a section of areas for furthers areas of research recommended by the researcher

CHAPTER TWO: LITERATURE REVIEW & THEORETICAL FRAMEWORK

2.1 INTRODUCTION

The literature review identified the variables of critical concern to the study. The researcher surveyed and examined existing literature related to the area of research. The primary sources of literature were past research projects, theses, and referred journals, published and unpublished articles on maintenance, maintenance management and maintenance condition assessment. The Literature Review also identified and defined the variables of main interest to the study.

2.2. MAINTENANCE AND TYPES OF MAINTENANCE

2.2.1 Definition of maintenance

Maintenance is defined as *the combination of all technical and administrative actions including supervisory actions, intended to retain an item in or restore it to a state, a state where it can perform a required function (Seeley, 1972)*

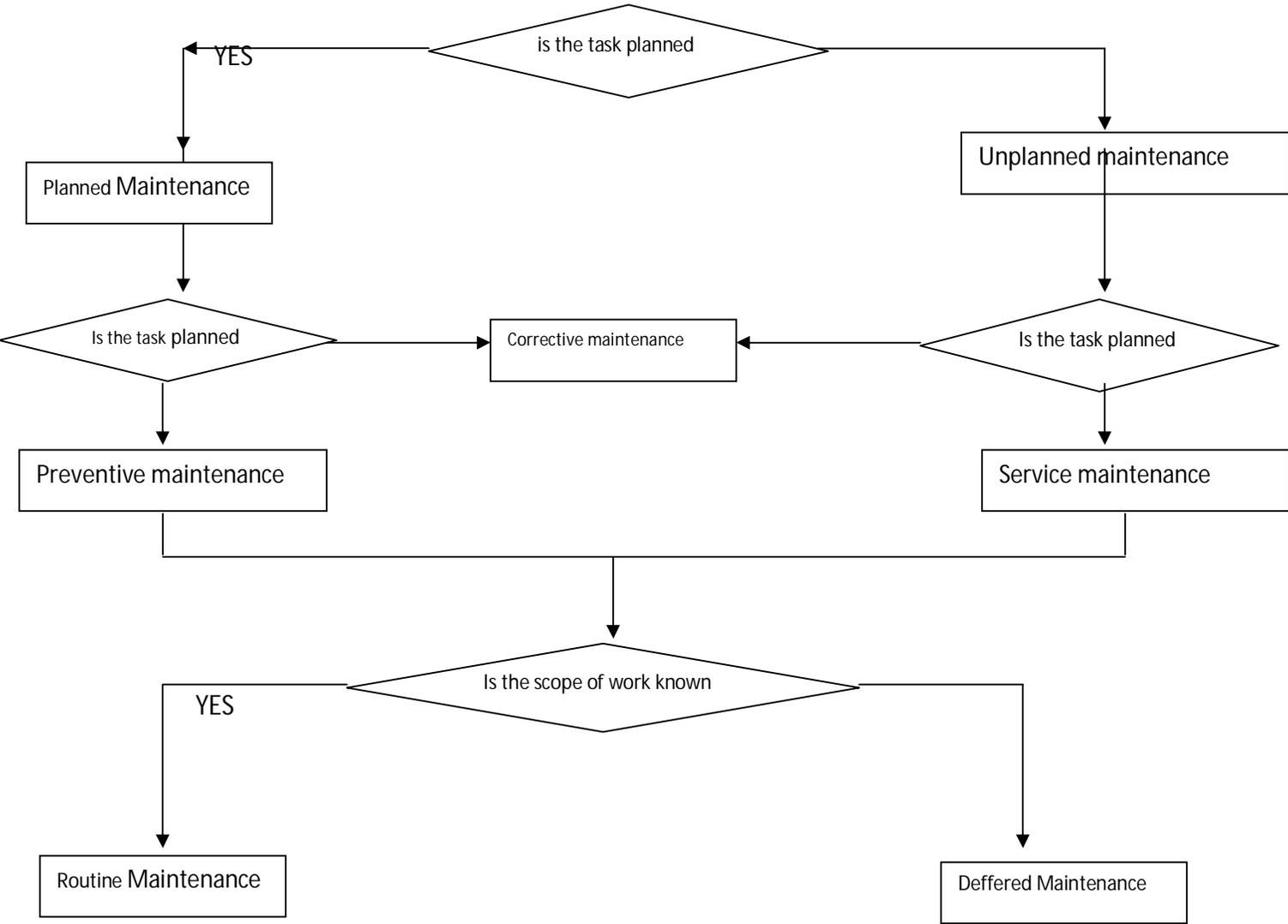
Maintenance is also defined as *the restoring of an item to its original condition to working order. This can be achieved by repair, replacement of parts or total replacement of the item.*

Maintenance is also defined as work undertaken in order to keep or restore every facility i.e. every part of a site, building and contents to an acceptable standard. **(BS 3811 (1964))**

Syagga (1985) in his thesis defines maintenance in its simplest sense to entail the repair or replacement of worn out or damaged parts in order to keep the building in a standard corresponding to its original characteristics and functions. In this case maintenance does not include work necessitated by higher demands or for a change in the pattern of use that could not have been foreseen at the time of initial design.

2.2.2 Classification of Maintenance

Maintenance is classified generally into; *planned* and *unplanned* maintenance, the former being further divided into preventive and corrective maintenance. (Seeley,1976)



Planned Preventive Maintenance is work directed towards the prevention of a failure of a facility, carried out within the expected life of the facility to ensure its continued operation. Planned preventive maintenance is work organized and carried out with forethought, control and use of records to a predetermined plan. It can be divided into;

- ❖ **Scheduled maintenance**- preventive maintenance carried out a predetermined interval.
- ❖ **Condition based maintenance** – preventive maintenance initiated as result of knowledge of the condition of an item.
- ❖ **Preventive running maintenance** – maintenance carried out while the facility is in service.

Planned Corrective Maintenance; is work performed to restore a facility to operation or to an acceptable standard. It is carried out after failure has occurred and is intended to restore an item or facility to a state in which it can perform its intended function

Unplanned Maintenance; is work resulting from unseen breakdown or damage due to external causes. It is based on the policy of waiting until the user lodges a complaint before maintenance action is taken.

According to Seeley, Maintenance work can also been categorized as predictable and avoidable;

Predictable maintenance ;is regular periodic work that may be necessary to retain the performance characteristic of a product as well as that that may be required to replace or repair the product after it has achieved a useful lifespan.

Avoidable maintenance; is the work required to rectify failures caused by incorrect design, incorrect installation or the use of faulty materials

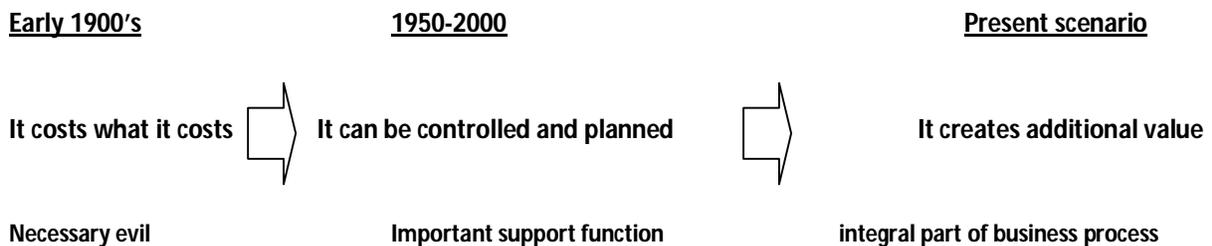
2.2.3 Significance of Maintenance

Maintenance provides a critical support for heavy and capital intensive industry by keeping facilities in a safe operating condition. Today it is accepted that maintenance is a key function in sustaining long term profitability for an organization (Al-Sultan and Duffua, 1995)

Maintenance works as an important support function in business or organizations with significant investment in physical assets and plays an important role in achieving organizational goals (Tsang 2002)

Prior to the early 1900's maintenance was considered a *necessary evil*. There was no alternative for avoiding failure and the general attitude was "*It costs what it costs*",. After Second World War and with technological advances, maintenance was considered a support function. During 1950—1980 with the advent of techniques like preventive maintenance and condition monitoring, the perception was that maintenance *can be controlled and planned*. Today maintenance is considered an integral part of business process and it's perceived as *creating additional value* (**Liyanange and Kumar,2003**)

Fig 1.0 Paradigm Shift in Maintenance perception:



Poor maintenance has an adverse effect on the nation's economy; a badly maintained factor will not encourage productivity; commerce will not flourish in a poor environment; a badly

maintained hospital will have an adverse effect on patients on trained staff and on the nation's health.

The benefits of maintenance can be categorized generally into the social and economic benefits. On the economic front, it is of great significance not only because of the scale of expenditure involved but also its important to ensure that the nation's stock of building as a factor of production is used effectively as possible. The preservation of the value and utility of the stock of buildings is therefore essential to the economic well being of a country.

Socially it is widely accepted that the built environment expresses in physical form the complex social and economic factors which give structure and life to a community. The condition and quality of buildings reflect the public pride and confidence. There's little doubt that a dilapidated and unhealthy building in a decaying environment depress the quality of life and contribute to antisocial behaviours.

Generally the purpose of maintenance is to return or keep buildings or infrastructure in a functioning or operational condition. It protects the capital asset from decay thus from being a liability as a factor of production from being a source of discomfort to users.

A properly maintained building retains both its capital and physical structure values for a longer period than a neglected property. Regular maintenance at a reasonable cost per annum avoids major and costly repairs which would occur after failure has occurred.

2.2.4 Maintenance Process

The maintenance process starts with the maintenance objectives and strategy which are derived from corporate vision goal and objectives based on stakeholders expectations.

Based on the maintenance objectives, maintenance policy, organization, resources and capabilities a maintenance program needs to be developed. The program is broken down into maintenance tasks.

The execution of maintenance tasks is undertaken at specified times and locations as per the maintenance plan. Management must understand the importance of maintenance and match

the plan to the vision, goals and objectives of the organization. The function of managing the maintenance process is maintenance management which forms the crux of this study and is discussed in the next section.

2.3 MAINTENANCE MANAGEMENT PROCESS

2.3.1 Definition of Maintenance Management

Maintenance management *is an orderly and systematic approach to planning, organizing, monitoring and evaluating maintenance activities and their costs.*

Maintenance management has also been defined as the organization of maintenance with an agreed strategy (**Vanier and Lacasse, 1999**)

A good maintenance management system coupled with knowledgeable and capable maintenance staff can prevent health and safety problems and environmental damage; yield longer asset life with fewer breakdowns and result in lower operating costs and a higher quality of life.

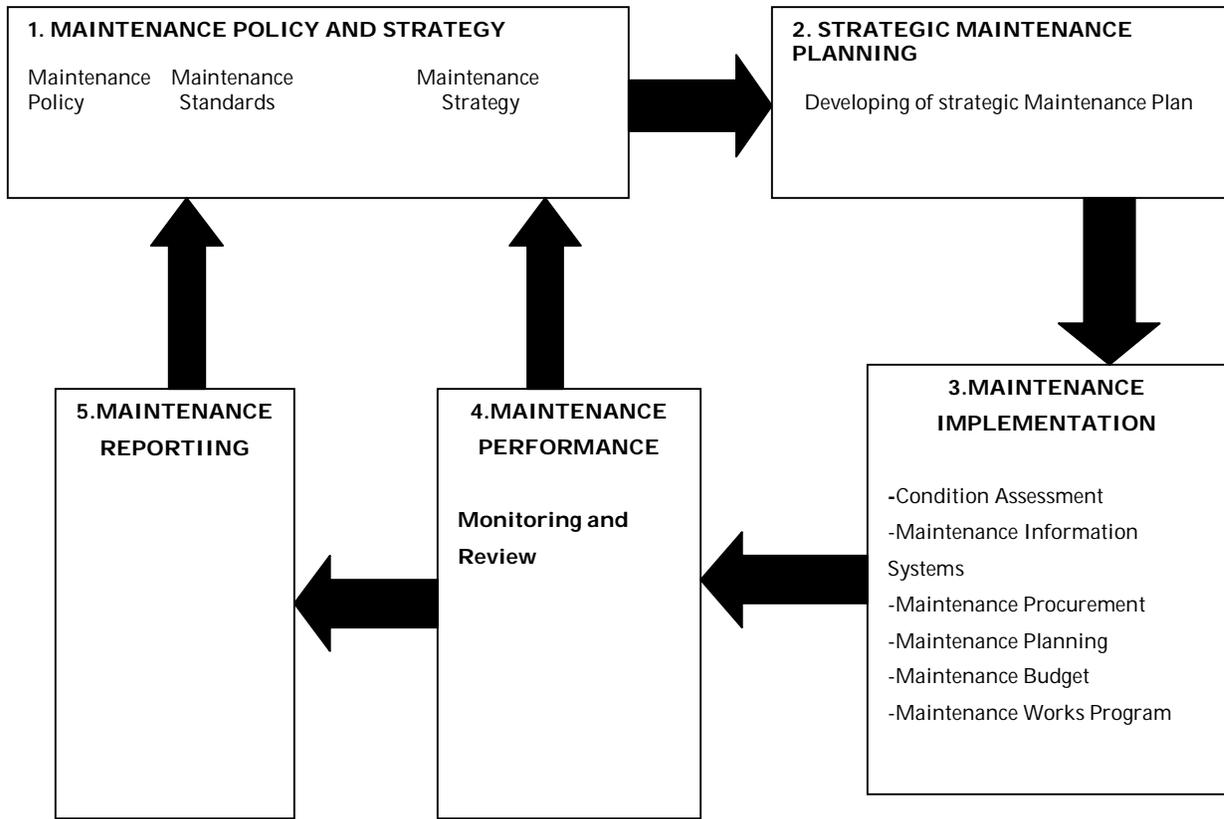
Maintenance management provides a framework for developing maintenance plans, tracking work accomplishment and preparing reports that compare planned and actual performance.

2.3.2 Maintenance Management Process

A Maintenance management process assists organizations in establishing a framework for maintenance works. Its objective is to achieve consistency in planning, implementation and reporting of building maintenance.

It must be emphasized that the establishment of condition standards is fundamental to the maintenance management process. The development of condition standards provides a statement of the desired condition standard to which assets should be maintained to enable an organization service delivery to be achieved effectively. Figure 2 illustrates the maintenance management process which acts as a guideline for organizations in maintenance management.

Figure 2: Maintenance Management Process



Outputs from the maintenance management process include; Maintenance management plan, maintenance plan and the maintenance management system.

Maintenance policy

Maintenance policy refers to a formalized set of rules and guidelines to achieve good maintenance practices. Maintenance policy has also been described as a written document that provides a management framework to ensure building assets are maintained appropriately to support the organization’s strategic objectives. It is realized that maintenance activities may not achieve the desired outcomes without a defined maintenance policy

(Hackman & Scott)

Lee (1976) defines maintenance policy as the ground rules for allocation of resources between the alternative types of maintenance actions that are available to management.

According to **Seeley,1987** the benefits of a maintenance policy is the ability to formulate a long term maintenance strategy and prepare budgetary forecasts

In Kenya, Maintenance policies are ineffective, unclear or lacking. Despite the recommendation for the formulation of a comprehensive national maintenance policy no effort has been made to articulate a proper maintenance policy (**Kirera, 1995**)

A study by **Chepkorir, 2001** on the University of Nairobi halls of residence established that there was a lack of laid down policies on maintenance of buildings. These policies are supposed to give guidance on the way maintenance work should be carried out.

Maintenance standards form a major benchmark towards effective and efficient execution of maintenance work as it provides a basis for control which is the rule for an effective organization. The concept of maintenance standards therefore an important aspect on maintenance management (**Mwobobia 1996**)

Maintenance strategy

Maintenance strategy is a long term plan covering all aspects of maintenance management which sets direction for maintenance. Maintenance strategy describes the systems and procedures to be used to plan and manage maintenance work. It also specifies the types of maintenance to be carried out.

Strategic maintenance planning

Strategic maintenance planning is a structured process undertaken to ascertain the immediate, medium and long-term maintenance requirements of an organizations built asset portfolio. Strategic maintenance planning involves a review and analysis of the organization's building portfolio, corporate and service delivery objectives and the building maintenance environment.

2.3.4 ORGANISATION OF MAINTENANCE MANAGEMENT

Different authors have viewed good maintenance management differently. According to Syagga, a measure of good maintenance is whereby a defect is remedied when it occurs. Yahya's criterion is based on the frequency of maintenance works.

Whatever the standard or criteria adopted, good maintenance management will be influenced by the organization structure in place. Organization structure is simply the various duties or functions are arranged in hierarchical manner from top management to lower levels of operations.

According to **Shake, 1995** the main factors that determine types of maintenance management structure to be set up is the principal function of the parent body. Maintenance departments operate within established organization structure and for this reason tend to be organized on the same way as the parent organization.

In setting up any organization structure for maintenance management top management should look into the following factors;

Firstly, the volume of maintenance work load to determine the staff, time required for inspections, estimating requirements, preparation of drawings and technical documents programming and control functions

Secondly the nature and complexity of maintenance work load and whether predominantly building or engineering will determine the desirable qualifications of the maintenance supervisory staff

Thirdly, the geographical over which work load is spread. The location and dispersal of maintenance work will influence the traveling time and hence the number of supervisors required for maintaining effective control.

Fourthly, the timing of the work and in particular the need for certain works to be habitually undertaken outside normal working hours may demand some duplication of supervisory staff to ensure continuous control

Sixthly, the method of executing the work by direct labor or by contract

2.3.5 Organisational Structure for Maintenance

In the larger organizations especially the public sector maintenance management structure tends to require elaborate administration.

In addition to the top management in the strategic apex and the people who do the basic maintenance works in the operating core. As it grows larger, the organization may also find that it needs two kinds of staff. First are the analyst who design the system concerned with the formal planning and control of work they form the techno-structure. Secondly the support staff providing indirect services to the rest of the organization

Most maintenance departments in the public sector find they have to justify their action to outsiders because external control encourages bureaucratization and centralisation

2.4 MAINTENANCE MANAGEMENT PROBLEMS

Planned preventive maintenance is essential for proper conservation of buildings. In the long run such practice is more economical than breakdown maintenance. Even so, preventive maintenance is grossly neglected in most public maintenance agencies and “maintenance by crisis” remains the prevailing norm. **(Shake, 1995)**

Shake, 1995 gives the following reasons for this state of affairs;

Lack of qualified and experienced staff coupled with little appraisal to guide staff on what standards are expected of them.

Many authorities or organizations lack norms of productivity of specific maintenance operations or on timing of maintenance. Few have realistic maintenance standards or updated tools for costing individual maintenance tasks. Efforts at realistic programming of maintenance therefore rarely succeed.

Budget demands are usually based on ad hoc estimates often repetitions of last years actual, in the absence of adequate planning and programming, maintenance effort is often focused on where complaints are loudest rather than where maintenance needs are greatest

Lack of maintenance plan often is accompanied by the absence of simple systems to direct staff such as work order systems. They also pay little attention too accumulating records of maintenance performed or analyzing them to identify work and equipment performance.

A typical reason for delays in response time to even crisis emergency request is that materials, parts and tools are out of stock. This is a sign of fundamental low productivity of maintenance staff operators and poor quality of maintenance arising from poor procedure of stores and stock control. A study by Abdul, 1993 found out that delays in response to maintenance request and long procedures in the execution of maintenance work at the results mainly from poor stock control.

Maintenance management spends little time in monitoring the progress of work, evaluating performance and establishing targets for their work with no framework for evaluation. Staff and management wander through their tasks without direction or goal.

The introduction of maintenance manuals that lay down maintenance procedures in a step by step manner can help ease the work of operations and supervisory personnel, improving productivity and reducing complain response time.

Specification for maintenance works, outlining material requirements and maintenance procedures are essential for effective control whether work is executed by in-house staff or through outsourcing.

Maintenance problems in most organizations are often as a result of institutional inadequacies. Selection of maintenance staff is seldom based on required aptitude or skill. In service training is seldom organized for maintenance staff.

At operational level there's a general death of multi-trade skill, a typical maintenance requirement. A poor working morale is also common because of lack of staff incentives. Poor condition of many building assets and services create a high incidence of failures and problems fostering the crisis atmosphere. The cycle could be broken if management would be improved,

maintenance approach shifted to planned preventive action and work stabilized with an effective and efficient service delivery operation.

2.5 MAINTENANCE MANAGEMENT SYSTEMS

“A Maintenance Management System (**MMS**) is a reporting system designed to track daily maintenance activities. Maintenance management systems are used to plan, organize, schedule, control and evaluate maintenance activities using standardized procedures. The system tracks labour, material, equipment and contract costs”. (Maintenance Management Systems, Technical information Document, October 2000)

The basic components of maintenance management systems developed include:

- The development of performance standards
- The determination of workload
- Budgeting
- Scheduling of activities within the budgeted program to utilize resources in the most efficient manner
- The establishment of management information system which provides the basic knowledge required by managers for decision making

Depending on the application and design, Maintenance Management Systems may have various formats and procedures but the basic principles are;

1. **Asset inventory;** is a list of physical features of capital assets that require maintenance. The types of data to be kept vary with maintenance activity and the task required. A maintenance plan begins with the inventory of facilities and information on their conditions. Inventory and condition data provides maintenance managers needed to plan maintenance work.
2. **A task statement;** is a detailed list of generic maintenance tasks performed for a particular type of asset in conducting preventive or routine maintenance. Frequency

refers to how often the maintenance tasks are performed. Task times indicate how long it will take to do such an amount of work. Each task statement relates to a specific appropriate for an asset. To prepare a set of tasks applicable to a particular assets one should review the physical features of an asset and maintenance manual to determine the maintenance tasks, task times and frequencies required.

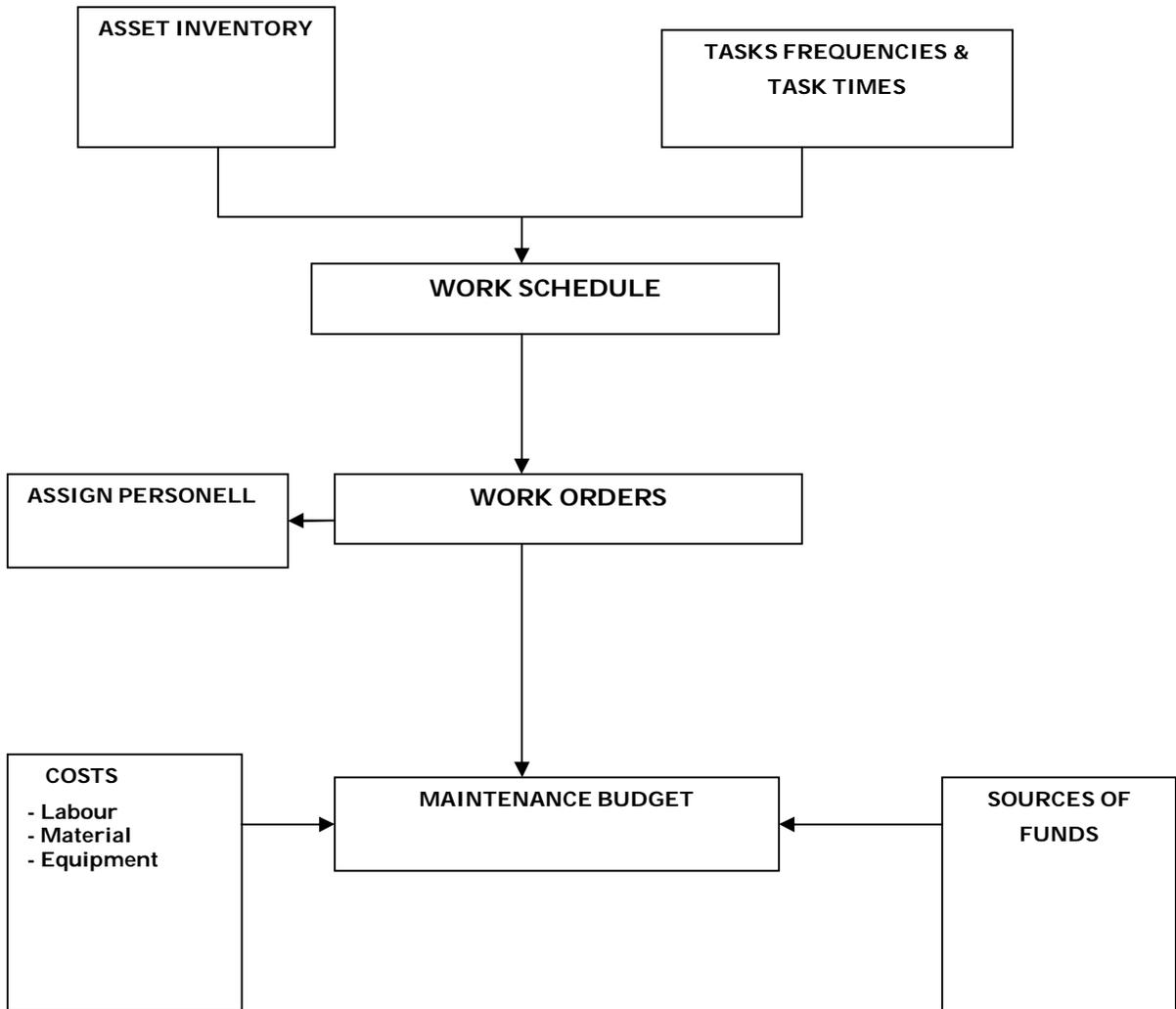
3. **Work Schedule;** is a list of maintenance tasks to be done for the whole year for each asset. It can be used to identify work loads. It serves as a basis of preparing and issuing scheduled work order for preparing the maintenance budget.

4. **Work Orders** provide information on what, where and how long and by whom maintenance work is to be carried out. A Work order system is a standard way of processing maintenance work and provides uniformity in planning maintenance work. Work Orders are prepared from inventory data and task statements.

5. **Maintenance Budget** is a cost projection based on the costs of labor, equipment, material and other items required to do all the work identified in the work schedule. After the costs have been are calculated for the work order, the process is repeated for the remaining work orders to get the total cost required to maintain the asset.

Figure 3.0 below illustrates the basic principles of a maintenance management system;

Figure 3: Components of a Maintenance Management System



(Source: Maintenance Management Systems <http://www.Publications.gc.ca/collections/collections/p25-5-5-2-2000E.pdf>)

Rapp and George, (1998) maintain that good maintenance management systems are essential for economically viable and operationally safe buildings. A lot of work is required to set up a successful maintenance management system. The maintenance manager must also monitor the progress of the work periodically depending on the nature of the situation and the potential impacts of breakdowns.

The maintenance manager must continuously review the maintenance budget and not wait until the end of the year. Any variance in costs for a particular asset should be identified and its cause determined and alternative solutions should be developed or actions taken to reduce time and costs. These steps will help improve the efficiency and effectiveness of the maintenance system

2.5.2 Objectives of a Maintenance Management System

The primary objectives of a Maintenance Management System include the following;

- Optimise the use of available funds , personnel, facilities and equipment through effective maintenance management methods.
- Provide accurate data for maintenance decision making
- Systematically identify maintenance needs or deficiencies
- Determine backlog maintenance
- Prioritize maintenance works
- Preparation of maintenance budget reports using systematic standardized procedures
- Monitor and document corrective actions expenditure and accomplishments
- Conduct comprehensive condition assessments

2.5.2 Best Practice Criteria for Effective Maintenance Management Systems

Having an effective maintenance management system in place is critical to ensure that maintenance expenditure is kept to a minimum. The development of an efficient maintenance management system is not an easy task and maintenance managers are often faced with the task of determining what is best-practice, in their search for an effective maintenance management system. **(Nkado et al 2006)**

Recent research has identified recognition by business managers that the standards of property and facilities management affect the organization as a whole in terms in terms of cost efficiency, service delivery and performance as well as protecting this substantial property asset. **(Housley, 1996)**

A study by (Nkado, R. 2006) on maintenance management systems in South African educational institutions an effective maintenance management system consists of the following main elements;

- Clearly formulated maintenance budget based on the maintenance plan
- Open and effective communication at all levels of the organization
- Computerization of maintenance management system
- Maintenance staff with the right qualification and experience at both top management and operational level
- Training of staff on maintenance technology
- Maintenance plan and a sound maintenance policy
- Setting maintenance standards
- Maintenance information Management- recording maintenance works and maintenance reports
- Flexible organization structure
- Regular Maintenance Inspections
- Life cycle costing at the design stage

A Maintenance Management System (MMS) is necessary for the optimal use of maintenance resources such as funds, personnel, facilities and equipment using standardized procedures.

To ensure that a Maintenance management system functions properly, several other subsystems are necessary. These subsystems include maintenance planning and scheduling, budgeting, inventory control system, work order system and maintenance information system. These components are not exhaustive but are considered more critical in the proper functioning of a maintenance management system.

2.5 MAINTENANCE CONDITION STANDARDS

2.5.1 INTRODUCTION

Building performance can be measured in many ways, the most common being condition. A building's condition gives a measure of the effectiveness of current maintenance programmes because it determines the remaining useful life of components or systems and compares it with the full economic life expected, given good maintenance **(Abbot et al, 2007)**.

Condition however changes over time as the physical and operational environments impact on the building and regular, accurate and consistent assessment are therefore required to update current information provide for maintenance works done subsequent to the previous condition assessments and capture any significant changes in condition before they can impact on the performance of the building.

The condition of building asset relates to the physical state of repair and influences the physical and functional performance of the asset. The required standard of maintenance should depend on how much the failure to achieve the standard will affect the objectives of the parent organization or the users of the building or facility and how sensitive the users are to failure **(Chepkorir, 2002)**

Maintenance can only be effectively managed if the maintenance demand is properly quantified and this demand is governed by the need to define the gap between current condition and the desired condition **(Then, 1995)**. The desired condition or condition standard should be clearly defined. **(Abbot, 2007)**

Lee (1987) outlines three ways in which Maintenance standards can be expressed;

Firstly *in physical terms*; whereby an element could be left to deteriorate up to a predetermined point before remedial action is taken. Presumably deterioration beyond this point would be detrimental to the users. Some buildings have been designed to specific performances. These specifications can be used to express standards. These are called condition controlled maintenance.

Secondly; where studies have been carried out to determine their useful life of elements a frequency based maintenance system could be used so that times when to repair or replace are fixed in advance.

Thirdly; financial criteria which may take the form of a variable sum related to the cost of some primary functions or replacement value or fixed sum based on historical costs or analysis of anticipated benefits.

2.5.2 DEVELOPING CONDITION STANDARDS

The establishment of condition standards for building assets is fundamental to the maintenance management process. Condition Standards provide a clear statement of the level to which assets must be maintained. Specifically condition standards;

- Are the starting point of departmental maintenance strategies and plans
- Are benchmarks against which building condition assessments results are evaluated (thus identifying the extent of any gap between desired and actual building condition)
- Facilitate the analysis of actual condition over time
- Are important factors in the development of maintenance budgets and annual works programs
- Ensure that during condition assessments, maintenance activities bring s the assets to the specified condition.

Prior to developing building condition standards there's need for an organization to determine the service requirements of built facilities to meet service delivery requirements. Through this process, organizations will be able to determine the relative importance and required performance of each building asset to meet service delivery and organisation's objectives.

The benefits in establishing building condition standards include;

- Ensuring that building assets are not under or over maintained
- Ensuring maintenance funding is used effectively
- Providing direction to maintenance service provider regarding expectations and the level of maintenance required for each building asset

- Enabling comparison of the actual condition of building asset against a desired condition standard and the identification of maintenance works required to bridge the gap.

The factors to be considered in the development of desired building condition standards include;

- The aesthetics of the building including the general appearance, colour, surface, integrity.
- The physical integrity of the building including water-tightness and structural stability that is required.
- Compliance with statutory requirements.

The functional performance and reliability of the services required including the operational performance of systems, design compliance and acceptability of defects.

The standards developed for the condition of the building asset must adequately reflect the asset performance required to meet service delivery demands.

The steps involved are summarized as follows;

- Determine service delivery requirements
- Classify building assets in terms of;
 - a) Criticality of their function to meeting core services of the organization
 - b) Functionality-how well the facility fits within the operation of the business and the design of the space of current use
- Establish condition standards and assign ratings.

Prior to developing building condition standards there is need to determine the relative importance and required performance of each building asset to meet service delivery and organizations objectives

The actual facility condition will be compared against the desired maintenance standard. This is done through condition assessment. Any variance from the standard will form the basis for maintenance planning.

Each facility will be allocated a maintenance grading to identify the maintenance standard that is required for the particular asset. Maintenance standards, conditioning, auditing and frequency of servicing/maintenance will vary depending on the importance of the facility in achieving core organizational needs and strategic priorities.

2.5.3 Assigning Condition Ratings

After identifying the requirements for each building asset, an organization or maintenance department must decide how they will assign condition standard ratings. The approach to determine these ratings must be outlined in the maintenance policy. Once determined, condition ratings form the basis regarding the level to which buildings must be maintained.

Any proposals for disposals, refurbishment and any future changes to service delivery will impact on the settings of standards and should be considered when assigning standards. In particular, the life cycle of the asset needs due consideration. Where assets are meeting the end of their economic life, the condition standards are not set too high and causing assets to be over maintained.

Standards can be assigned to buildings as:

- **Overall assets;** Amenity Blocks, Halls of Residence: Lecture Theater
- **Element/Element Grouping;** Substructures, superstructure; Finishes; Services
- **Sub-Elements:** Floor Finishes, Wall Finishes, Sanitary Fittings

The criticality of asset portfolio, the relative importance of the building and the criticality of the elements and sub-elements will dictate how building conditions should be assigned. In the case of the less complex and critical built assets, building condition standards may generally be assigned for the overall asset or element grouping.

As the more complex, critical and strategically important assets will generally have specific performance requirements that will need to be specified in detail. Where an organization has a mixture of asset classifications different methods of assigning standards may also be required for the various asset classifications.

Ratings should be used in the condition assessment to identify gaps between the desired and actual condition of buildings. On the basis of the assessment maintenance works required to return the buildings to desired standards can be determined. Appropriate detailed and well documented standard ratings provide a clear statement of an organization's expectation regarding the maintenance of their portfolio.

Where condition standards are specified at overall building level, detailed descriptions of what is meant by the ratings should be articulated in terms of condition standards of key elements most critical to delivery of services. This is because more complex and critical building elements will generally have specific performance requirements and these elements may need to be maintained above the required standards required of the overall building.

2.5.4 Review of Condition Ratings

It's important that assigned building condition standards are reviewed regularly to ensure buildings do not become over or under rated due to changes in service delivery requirements over time that the standards reflect the true needs of the asset and that resources are used efficiently. The review should be undertaken prior to the establishment of the annual condition assessment program so that any changes may be taken into consideration and incorporated in service delivery arrangements.

2.5.5 Risks Involved in Condition Ratings

The application of building condition standards has the following inherent risks:

- Establishing standards that are too detailed and impractical or costly to practice
- Deterioration and loss of value of the asset to the point where the organisation's service delivery is ineffective and inefficient if the standard is set too low and

- An increase in maintenance cost if the standard set is too high

Internationally there seems to be a tendency to favour a five point rating scale for condition standards. A five point rating system has been developed and refined through experience and sustained research and development (**Abbot, 2007**)

The Department of Public Works, Queensland Government, Australia (**1999**) also proposes a five point rating scale in its Maintenance Management Framework Guidelines for Condition Standard Rating.

Table 1.0 : Condition Standard Ratings

RATING	CONDITION STANDARD	PERFORMANCE STANDARD
5	<u>BEST</u> Asset to be in best possible condition. Only minimal deterioration will be tolerated	Highly sensitive functions with critical results (e.g hospital operating theater) or high profile public building
4	<u>GOOD</u> Asset to be in good operational and aesthetical condition, benchmark against industry for that class of asset.	Operations requiring good public presentation and high quality working environments e.g health facilities, modern multistory CBD building
3	<u>REASONABLE</u> Asset to be in reasonable condition fully meeting operational requirements	Functionally focused asset at utility level
2	<u>MINIMUM</u> Condition needs tom meet minimum operational requirements only	Functions are ancillary only with no critical operational role or asset has limited life
1	<u>HOLDING</u> Condition can be allowed to deteriorate or marginally maintained at minimum cost to comply with statutory requirements	Functions have ceased; the asset is dormant or on hold pending disposal, demolition

2.6 CONDITION ASSESSMENT SYSTEM

The current condition of the fabric, elements or building and the maintenance work required, to restore the fabric, elements or building to the desired condition, primarily determine the cost and timing of maintenance works **(Then,1995)** . Without this information cost effective planning and management of building maintenance are impossible.

Buildings are complicated three-dimensional configuration of a diverse range of fabrics and materials, which deteriorate at different rates depending on use applications and environmental conditions. Because the deterioration of fabric and materials is varying and ongoing process information on the conditions of these fabrics and materials tend to age rapidly and regular accurate and consistent assessment are therefore essential to effective building maintenance management.

The type and extent of maintenance work required to restore the fabric, element or building to the desired condition (standard) should form an integral part of the condition assessment exercise.

“Effective building maintenance requires the correct diagnosis of defects and implementation of the correct remedial measures, all based on sound technical knowledge, otherwise there can be additional waste of materials, labour and money since the work will in all probability have to be done again. Observing and rectifying a defect at an early stage is likely to reduce repair costs” **(Seeley, 1987)**

Table 2.0 sets out the commonly used condition ratings for describing the current/existing condition of a building or built facility. The condition rating is also referred to as condition index

Table 2: Condition Assessment Ratings/Condition Index

RATING	CONDITION	DESCRIPTION
5	<u>AS NEW/VERY GOOD</u>	The fabric, element or building is either new or has recently been maintained: does not exhibit any signs of deterioration
4	<u>MINOR REPAIRS/GOOD</u>	The fabric element or building exhibits superficial wear and tear, minor defects, minor signs of deterioration to surface finishes and requires maintenance/servicing. It can be reinstated with routine scheduled or unscheduled maintenance
3	<u>SERIOUS REPAIRS/FAIR</u>	Significant sections or elements require repair usually by a specialist, The fabric element or building has been subjected to abnormal use or abuse and its poor state of repair is beginning to affect surrounding elements. Backlog maintenance work exists
2	<u>CRITICAL REPAIRS/BAD</u>	Substantial sections or elements have deteriorated badly, suffered structural damage and require critical repairs, upgrading or replacement. There is a serious risk of imminent failure. The state of repair has a substantial impact on surrounding elements or creates a potential health or safety risk
1	<u>CONDEMN /REPLACE/VERY BAD</u>	The fabric element or building has failed, is not operational or deteriorated to the extent that it does not justify repairs but should rather be condemned or replaced. The condition of the element actively contributes to the degradation of surrounding elements or creates a safety, health or life risk.

Condition assessment generally comprises;

- Physical inspection of a building to assess the actual condition of the building and its individual elements or services in comparison to the specified condition standard.
- Identification of maintenance works required to bring the condition of the building and its services up to, maintain at the specified condition standard.
- Ranking of maintenance works in order of priority
- Determination of actions by assessor to mitigate any immediate risk until remedial works or other actions are taken to address problems

Frequency of Condition Assessments

The frequency of condition assessment is usually determined by the maintenance department or organization depending on the nature of the building and its elements or services. The more critical and complex an asset is, the more likely it is that condition assessment will be required more often.

The following should also be taken into account when determining assessment intervals;

- Intensity and extent of use of the facility by occupants and other members of public
- Exposure to harsh environmental conditions
- Age of the building and its components
- Costs, risks and benefits of assessment interval adopted
- Likelihood of possibility of health and safety or other environmental issues occurring

Development of condition standards for facilities is the benchmark for the maintenance management process. Establish of condition standard is vital in the design of a maintenance management system as it provides a point of reference during condition assessment process to determine the maintenance needs of the facilities.

If a condition standard is not set for particular building or facility there's a likelihood of over or under maintaining the building/facility. It is prudent for maintenance managers to set such standards, which will form a yardstick of evaluating effectiveness of their maintenance strategies. A comparison between the desired condition and actual condition of a building would provide a basis for making decisions on the maintenance of the building

Condition Assessment forms a crucial facet of a maintenance management system. The overall result of a systematic and objective condition assessment is that adequate and reliable information is made available for effective maintenance planning scheduling and implementation.

The condition of a building could be a pointer of an ineffective maintenance management system especially where there are no condition standards set for the facilities from the onset.

SUMMARY

This chapter is a review of literature on the existing theories relevant to the research problem. The chapter begins with an overview of maintenance and its significance. Here the maintenance problem is also explored in depth.

The chapter also outlines the process involved in maintenance management to gain a better understanding of what is involved in maintenance management of built facilities.

The researcher then explores what constitutes a maintenance management system and highlights the basic components of such a system. An overview is also given on best practice criteria for an effective maintenance management system from previous research.

The Chapter concludes on the aspect of condition assessment and development of building condition standards. A critique on condition standards, condition ratings and condition assessment is done in the final section of this chapter.

The aim of the literature review was to identify and define variables critical to study. The next chapter covers the Research methodology used by the researcher in organizing the study and answering the research questions posed at the onset.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter outlines the how the researcher seeks to find answers to the research questions emanating from the research problem. In this the researcher operationalises the variables of the study. The proposed research instruments used in the collection of data are also outlined in this chapter. Techniques that are used in the analysis of the data collected by the researcher are also outlined in this chapter.

3.2 RESEARCH DESIGN

A research design *is the plan and structure of investigation so conceived so as to obtain answers to research questions.* The research strategy used in the study to answer the research questions is exploratory case study. The case study strategy has considerable ability to generate answers to 'Why?' as well as 'What' and 'How' questions.

Case study research method is an in-depth study of one or a few of events or cases in order to understand the phenomenon being studied. The case study approach places more emphasis on full analysis of a limited number of events or conditions and their interrelationships. It is also preferable in examining contemporary events but where the relevant behaviours cannot be manipulated. The case study approach allows the researcher to retain the holistic and meaningful characteristics of real life events such as individual life cycles, organizational and managerial processes.

It's important to note that *a case study is selected for **analytic generalization** and **not for statistical generalization**. A case study is not a sampling unit. (Yin,1984).* Analytic generalization can be used whether the case study involves one or several cases. A case study like an experiment does not represent a sample and is generalisable to theoretical propositions and not to populations or universe. The researcher's goal is to confirm, challenge or to extend existing theory.

In reference to this study the researcher studies the selected public universities in Kenya extensively in order to have an in-depth understanding of their maintenance management system and how it impacts on the maintenance condition of built facilities

3.3 SAMPLING

Sample frame/ unit of analysis

The sample frame for this study includes all buildings in the institutions

Sampling in the study was especially for selecting facilities for condition assessment. The population consists of buildings at Kenyatta University, University of Nairobi and Egerton University. The targeted buildings are lecture halls, libraries and laboratories.

Sampling Technique

The researcher employed both probabilistic and non-probabilistic sampling techniques. Purposeful sampling was employed in narrowing the sample frame to only educational facilities and random sampling to select the actual buildings to be analyzed.

Non probabilistic sampling techniques are useful for qualitative studies and especially for case studies where the aim is analytic generalization rather than statistical generalization. The sampling technique selected for this study is purposive sampling. This sampling technique allows the researcher to use cases that have required information with respect to the research objectives.

3.4 DATA COLLECTION

3.4 Data Collection Methods

The researcher collected data from the population using the following instruments: interview schedules, structured questionnaires and physical observation of buildings. The researcher also photographed the buildings sampled for the study.

3.4.1 Primary Data Collection

a) Structured and unstructured interviews

Structured interviews targeted maintenance managers. The researcher targets the senior managers at maintenance departments. The purpose was to evaluate the organizations maintenance management system.

Unstructured interviews will identify preliminary issues which will assist the researcher formulate a good idea of what variables need further in-depth investigation. These interviews could result in identification of several critical factors relating to the problem.

Structured interviews will further pursue issues touching on the research problem raised by the unstructured interviews.

b) Observational Surveys

The observational surveys will mainly focus on the condition assessment of the sampled buildings. The researcher will have predetermined aspects of maintenance condition which will form the basis of the observation schedule to be used. The purpose of observation schedule is to record the status of the buildings as they are in their natural setting. The researcher will therefore be a non participant observer; simply observing and recording the phenomena of concern to the study.

c). Questionnaires

The researcher proposes use of questionnaires which will be self- administered to respondents which will considerably reduce the time and cost involved. The questionnaire will be constructed in a manner that covers the areas relating to the main study objectives so that the information obtained conforms to these objectives and assists in a better understanding the research problem.

3.4.2 Secondary data

Secondary data was collected from analysis of related and relevant literature and records **from** the maintenance departments and internet sources on the World Wide Web.

3.5 BACKGROUND OF CASE STUDIES

CASE STUDY I: KENYATTA UNIVERSITY



(Kenyatta University Administration Block Source: University website www.ku.ac.ke)

Kenyatta University is situated about 23 kilometres from the city of Nairobi on the Nairobi-Thika dual carriageway on 1,100 acres of land. The long journey to University status started in 1965 when the British Government handed over the Templer Barracks to the Kenya Government. These were converted into an institution of higher learning known as Kenyatta College. Initially, Kenyatta College was divided into two sections, the Secondary Education Division (SED) and the Teacher Education Division (TED). Following an Act of Parliament of 1970, Kenyatta College became a constituent College of the University of Nairobi. Consequently, the name changed from Kenyatta College to Kenyatta University College. It admitted its first batch of 200 students in 1972 to pursue studies leading to the award of the Bachelor of Education degree of the University of Nairobi.

The University status was achieved on August 23, 1985, when the Kenyatta University Act received Presidential assent making the Institution a full - fledged University. The Act became operational on September 1, 1985 and the new University was inaugurated on December 17, 1985. Kenyatta University immediately started establishing new Faculties and constituent

colleges. In this pursuit, Jomo Kenyatta College of Agriculture and Technology (JKUAT) became a constituent College of Kenyatta University in 1988 before becoming a full – fledged university.

Campuses and Constituent Colleges

- Kahawa(Main Campus)
- Ruiru Campus
- Parkland Campus
- Kitui Campus
- Mombasa Campus
- Pwani University College

CASE STUDY II: UNIVERSITY OF NAIROBI

LOCATION

The University is situated in Nairobi, a fast growing city with a population of over 3.5 million. The city center has an area of over 700 square kilometers and stands at an altitude of 1,675 meters above sea level. It is 140 kilometers south of the equator and some 480 kilometres west of the Indian Ocean

ESTABLISHMENT

The University of Nairobi, a body corporate established by an Act of Parliament Cap 210 of the Laws of Kenya is the pioneer institution of University education in Kenya and the region.

The only institution of higher learning in Kenya for a long time, the University of Nairobi responded to the national regional and Africa's high level manpower training needs by developing and evolving strong, diversified academic programmes and specializations in sciences, applied sciences, technology, humanities, social sciences and the arts. To date, the range of programmes offered number approximately two hundred.



(The main entrance to University of Nairobi Source; university website www.uonbi.ac.ke)

Through module II (continuing education) programmes, invaluable opportunity has been opened to hundreds of Kenyans and non-Kenyans, on a paying basis, who meet university admission requirements, but who have not been able to access university education due to restricted intake into the regular programmes that is determined by limited resource allocation by Government.

In this effort, the location of the seven campuses of the University in the capital city and its environs and facilitating easy access, has been an asset that has seen the university increasingly become the busy hub and citadel of academic activity at all times.

BACKGROUND OF THE UNIVERSITY

The inception of the University of Nairobi is traced back to 1956, with the establishment of the Royal Technical College which admitted its first lot of A-level graduates for technical courses in April the same year. The Royal Technical College was transformed into the second University College in East Africa on 25th June, 1961 under the name Royal College Nairobi and was admitted into a special relations with the University of London whereupon it immediately began preparing students in the faculties of Arts, Science and Engineering for award degrees of the University of London. Meanwhile, students in other faculties such as the Faculty of Special Professional Studies (later renamed Faculty of Commerce) and Faculty of Architecture continued to offer diplomas for qualifications of professional bodies/ institutions.

On 20th May 1964, the Royal College Nairobi was renamed University College Nairobi as a constituent college of inter-territorial, Federal University of East Africa, and henceforth the enrolled students were to study for degrees of the University of East Africa and not London as was the case before. In 1970, the University College Nairobi transformed into the first national university in Kenya and was renamed the University of Nairobi.

In view of the rapid expansion and complexities in administration, the University underwent a major restructuring in 1983 resulting in decentralization of the administration, by creation of six (6) campus colleges headed by principals. The following are the names and respective locations of the colleges:

- College of Agriculture & Veterinary Sciences situated at Upper Kabete Campus
- College of Architecture & Engineering situated at the Main Campus
- College of Biological & Physical Sciences situated at Chiromo Campus
- College of Education & External Studies situated at Kikuyu Campus
- College of Health Sciences situated at the Kenyatta National Hospital
- College of Humanities and Social sciences situated at the Main Campus -Faculty of Arts ;
Parklands-Faculty of Law; Lower Kabete Campus -Faculty of Commerce

Truly, the University's development has been as broad as its current scope is wide. From a humble beginning as a technical college to the status of a major international teaching and research institution, the University of Nairobi has produced more trained human resources than any other' institution of higher learning in Kenya, with over 40,000 graduates to its credit.

CHAPTER 4: DATA PRESENTATION & ANALYSIS

4.1 INTRODUCTION

This chapter presents the results, analysis and findings on the data collected. Analysis of the results was done according to the research objectives. The data examined the maintenance management system in the two public universities; University of Nairobi, Kenyatta University. The systems were compared against best practice for effective maintenance management systems. A survey of the maintenance condition was also carried out on selected buildings at the universities. This is to establish whether these practices have a bearing on the maintenance condition built facilities in the university

4.2.1 Maintenance policy and strategic planning

All the maintenance managers interviewed have qualifications with at least undergraduate degree training or backgrounds relevant to maintenance management in the following disciplines:

- Land Economics/Estate Management
- Building Economics/ QS

None of the universities maintenance departments had a well defined and documented maintenance policy.

None of the maintenance departments had a departmental strategic plan for managing maintenance works. They operated within the institutions strategic plan which broadly touched on maintenance works.

The maintenance strategy for all the universities was corrective maintenance with little planned preventive maintenance.

None of the universities set minimum condition standards at which their buildings should be maintained. The challenge in setting standards was due to age of buildings, complexity of the exercise, lack of knowhow and personnel to effectively carry out the exercise.

All the maintenance managers prepare an annual maintenance works program as is a requirement of performance contracting that has been introduced in Kenyan Universities.

Two universities rated their implementation as Good while one rated the implementation as average due to inherent challenges in the actual implementation.

Kenyatta University has maintenance manual while University of Nairobi indicated that they have no manual which outlines all information regarding maintenance.

4.2.2 Maintenance Information system

In both universities asset registers containing information on all buildings are kept by the finance department.

Kenyatta University has a computerized database of all maintenance works executed recorded by a data entry clerk. University Nairobi had initiated processes towards computerizing its maintenance works.

None of the universities had put in place a computerized maintenance management system and relied on manual filing of maintenance information. The main challenge raised of instituting a CMMS was the high cost of acquiring the software based programme.

4.2.3 Organisation of Maintenance

University of Nairobi organization structure for maintenance is highly decentralized with autonomous maintenance units in each of the colleges while Kenyatta University is centralized.

Maintenance is budgeted and managed centrally at Kenyatta university while in University of Nairobi each college has its own budget for maintenance which is managed at college level.

Kenyatta University reported that 100% of her maintenance works are executed by direct labor i.e in-house while university of Nairobi outsources some of its major maintenance works.

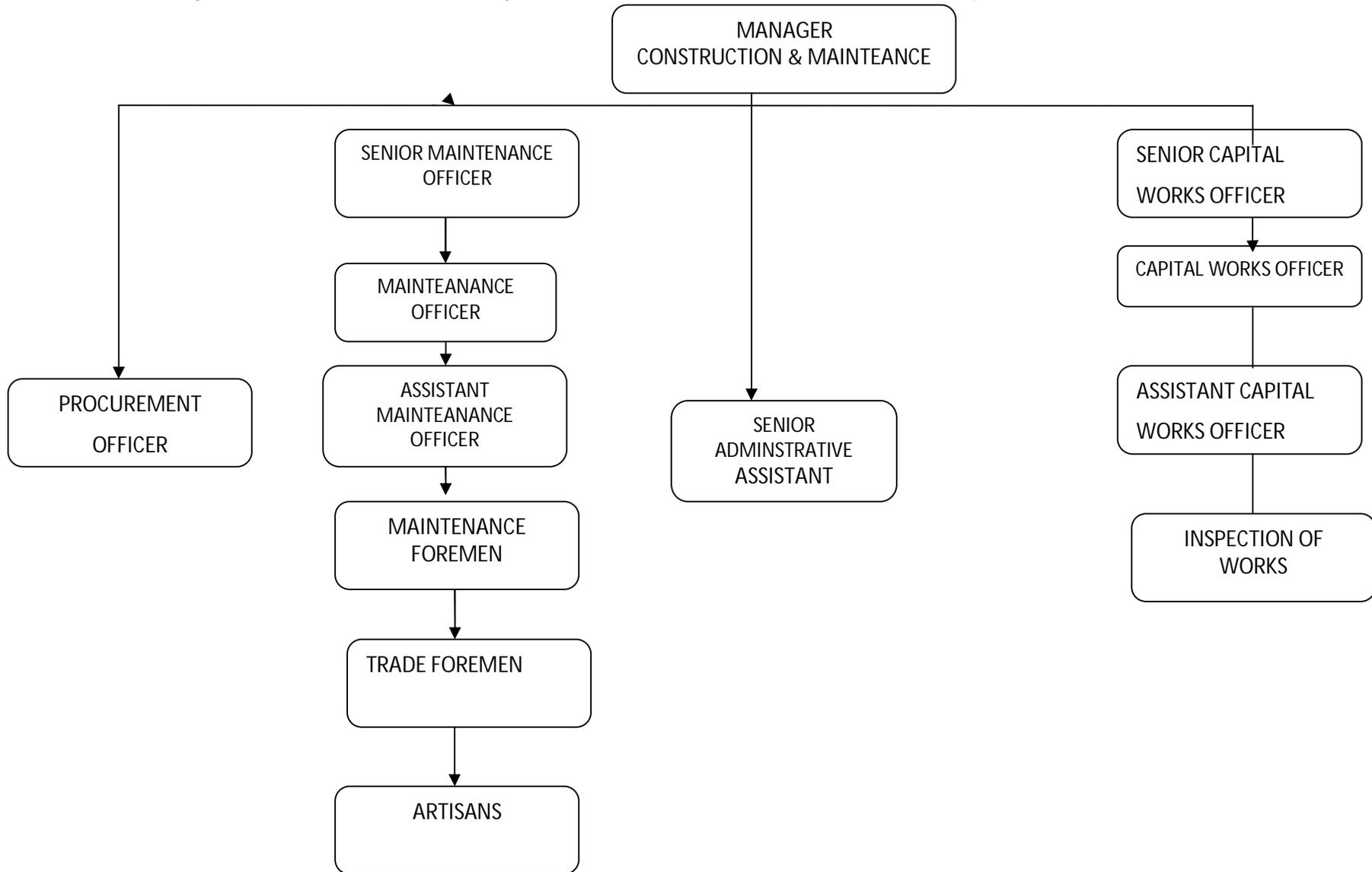
Managers at the universities concurred that the number of staff at the operatives' level is insufficient to deal with the demand of maintenance requests. At both universities there's heavy reliance on casual laborers.

At both universities the training policy for staff is formulated by the human resource division .
at both universities.

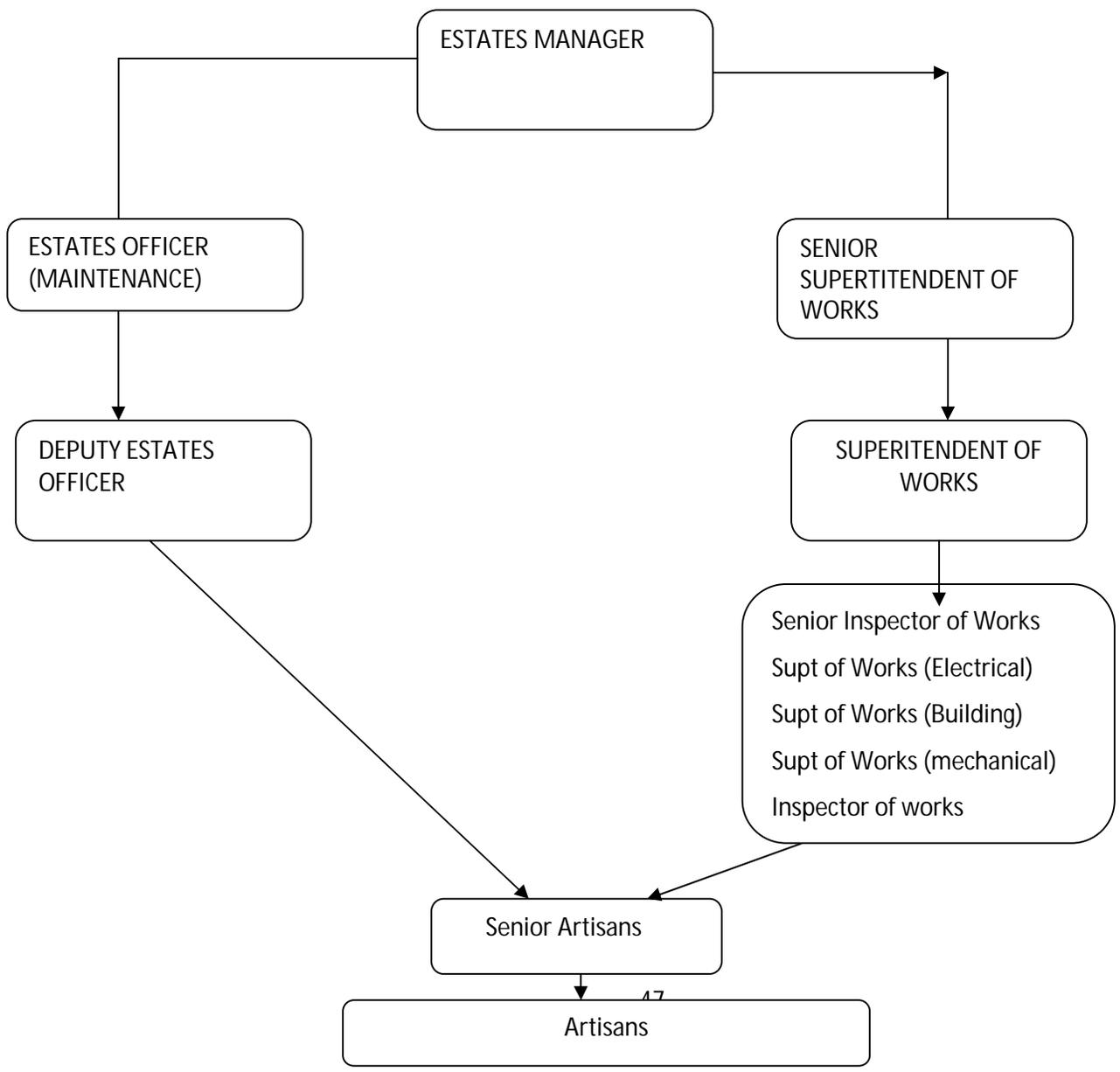
At the University of Nairobi the maintenance function has been removed from the once larger Estates department after restructuring to the Construction and Maintenance department headed by manager who must be a professional in the built environment. Further the maintenance officer is directly the technical head of the building maintenance function and advises the manager on the technical issues relating to maintenance.

The intent of the restructuring was to increasing efficiency in the management of building maintenance. The function is further decentralized with each college having a almost autonomous maintenance unit headed by an Assistant Maintenance Officer who administratively reports to the respective College Principal.

Organization Structure ; University of Nairobi Construction and Maintenance Department



Organisation structure of Kenyatta University Estates Department



4.2.4 Maintenance Implementation

At both universities the maintenance departments have service charters that specify the time taken to respond to various different maintenance request of varied nature.

At the universities no formal condition assessment of physical buildings is done on scheduled basis. Assessment is done as and when disrepair or fault is reported and only for the scheduling of maintenance work.

All universities confirmed that the budget for maintenance work is barely adequate to address all maintenance needs but there's goodwill from management at both universities to increase funding for building maintenance.

The other major challenge cited for implementation of maintenance works are the stringent procurement laws and regulations that delay the procuring of materials for building maintenance. This is a hurdle for implementing urgent repairs.

In the questionnaire both university maintenance managers in Kenyatta and University of Nairobi rated the respective university's procurement system for maintenance materials as barely meeting their expectations

4.3 PRESENT MAINTENANCE CONDITION OF BUILDING SURVEYED

This section examines the current maintenance condition of buildings at the University of Nairobi and Kenyatta University. A building constitutes of various elements each performing specific functions. The effective functioning of these elements determines the condition of the building. All the elements have well defined and distinct functions irrespective of the design of the building, its specifications and constructions. The condition rating allocated per building survey was on the scale below:

RATING	CONDITION	DESCRIPTION
5	<u>AS NEW/VERY GOOD</u>	The fabric, element or building is either new or has recently been maintained: does not exhibit any signs of deterioration
4	<u>MINOR REPAIRS/GOOD</u>	The fabric element or building exhibits superficial wear and tear, minor defects, minor signs of deterioration to surface finishes and requires maintenance/servicing. It can be reinstated with routine scheduled or unscheduled maintenance
3	<u>SERIOUS REPAIRS/FAIR</u>	Significant sections or elements require repair usually by a specialist, The fabric element or building has been subjected to abnormal use or abuse and its poor state of repair is beginning to affect surrounding elements. Backlog maintenance work exists
2	<u>CRITICAL REPAIRS/BAD</u>	Substantial sections or elements have deteriorated badly, suffered structural damage and require critical repairs, upgrading or replacement. There is a serious risk of imminent failure. The state of repair has a substantial impact on surrounding elements or creates a potential health or safety risk
1	<u>CONDEMN /REPLACE/VERY BAD</u>	The fabric element or building has failed, is not operational or deteriorated to the extent that it does not justify repairs but should rather be condemned or replaced. The condition of the element actively contributes to the degradation of surrounding elements or creates a safety, health or life risk.

The maintenance condition of buildings for this study will be done by assessing the following elements:

- a) External finishes
- b) Internal finishes
- c) Suspended floor
- d) Doors
- e) Windows
- f) Electrical fittings
- g) Mechanical fittings
- h) Roofing**

4.3.1 EXTERNAL FINISHES

External finishes enhances the beauty of buildings and the built environment in general and protects the buildings against vagaries of weather. The predominant external finish for most university building is paint. Paint as a finishing material adds aesthetic value.

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	2	14.3	1	6.3	3	10%
4-Good	5	35.7	7	43.7	12	40%
3-Fair	7	50.0	8	50.0	15	50%
2-Bad	0		0	0	0	0
1-Very Bad	0		0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	51	3.64	Fair-Good
Nairobi	16	53.3	57	3.56	Fair-Good
Composite	30	100	108	3.6	Fair-Good

Source: Field Survey

4.3.2 INTERNAL FINISHES

4.3.2.1 Floor finishes

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	3	21.4	2	12.5	5	16.7
4-Good	2	14.3	5	31.25	7	23.3
3-Fair	9	64.3	8	50.0	17	56.7
2-Bad	0	0	1	6.25	1	3.3
1-Very Bad	0	0	0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	50	3.57	Fair
Nairobi	16	53.3	56	3.5	Fair
Composite	30	100	106	3.53	Fair

4.3.2.1 Wall finishes

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	1	7.1	1	6.3	2	6.7
4-Good	2	14.3	1	12.5	3	10.0
3-Fair	9	64.3	12	75.0	21	70.0
2-Bad	2	14.3	2	12.5	4	13.3
1-Very Bad	0	0	0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	44	3.14	Fair
Nairobi	16	53.3	49	3.06	Fair
Composite	30	100	93	3.10	Fair

4.3.2.1 Ceiling finishes

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	5	35.7	6	37.5	10	33.3
4-Good	7	50.0	7	43.8	15	50.0
3-Fair	2	14.3	3	18.8	5	16.7
2-Bad	0	0	0	0	0	0
1-Very Bad	0	0	0	0	0	
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	59	4.21	Good
Nairobi	16	53.3	67	4.19	Good
Composite	30	100	126	4.20	Good

4.3.3 SUSPENDED FLOORS

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	8	57.1	11	68.8	19	63.3
4-Good	6	42.9	5	31.2	11	36.7
3-Fair	0	0	0	0	0	0
2-Bad	0	0	0	0	0	0
1-Very Bad	0	0	0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	64	4.57	Good
Nairobi	16	53.3	75	4.68	Good
Composite	30	100	139	4.63	Fair

4.3.4 DOORS

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	4	28.6	2	12.5	6	20.0
4-Good	8	57.14	12	75.0	20	66.7
3-Fair	2	14.3	2	12.5	4	13.3
2-Bad	0	0	0	0	0	0
1-Very Bad	0	0	0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	58	4.14	Good
Nairobi	16	53.3	64	4.00	Good
Composite	30	100	122	4.07	Good

4.3.4 WINDOWS

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	3	21.4	2	12.5	5	16.7
4-Good	6	42.9	7	43.75	13	43.3
3-Fair	5	35.7	7	73.75	12	40.0
2-Bad	0	0	0	0	0	0
1-Very Bad	0	0	0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	54	3.85	Fair
Nairobi	16	53.3	59	3.69	Fair
Composite	30	100	113	3.77	Fair

4.3.5 ELECTRICAL FITTINGS

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	5	35.7	4	25.0	9	30.0
4-Good	8	57.1	10	62.5	18	60.0
3-Fair	1	7.1	2	12.5	3	10.0
2-Bad	0	0	0	0	0	0
1-Very Bad	0	0	0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	60	4.28	Good
Nairobi	16	53.3	66	4.13	Good
Composite	30	100	126	4.20	Good

4.3.4 SANITARY FITTINGS & PLUMBING

University/ Rating	Kenyatta		Nairobi		Composite Score	
	No	%	No	%	No	%
5-Very Good	1	7.1	0	0	1	3.33
4-Good	2	14.3	2	12.5	4	13.33
3-Fair	6	42.8	6	37.5	12	40.00
2-Bad	5	35.7	8	50.0	13	43.00
1-Very Bad	0	0	0	0	0	0
Total	14	100	16	100	30	100%

University	No	%	Total Condition Rating Score	Average Condition Rating	Comments on maintenance condition
Kenyatta	14	46.6	41	2.92	Bad –Fair
Nairobi	16	53.3	42	2.63	Bad- Fair
Composite	30	100	83	2.77	Bad-Fair

Overall condition rating of surveyed buildings

Element	Kenyatta University Average Condition Rating Score	University of Nairobi Average Condition Rating Score	Composite Average Condition Rating Score	Comments
External finishes	3.64	3.56	3.6	Serious Repairs
Floor finishes	3.57	3.50	3.53	Serious Repairs
Wall finishes	3.14	3.06	3.1	Serious Repairs
Ceiling finishes	4.21	4.19	4.2	Minor Repairs
Suspended floors	4.57	4.68	4.63	Minor Repairs
Doors	4.14	4.00	4.07	Minor repairs
Windows	3.85	3.69	3.77	Serious Repairs
Electrical Fittings	4.28	4.13	4.2	Minor repairs
Sanitary & Plumbing	2.92	2.63	2.77	Critical repairs
Total	3.81	3.72	3.76	Serious Repairs

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter outlines and discusses the key research findings of the study.

5.2 CONCLUSIONS ON KEY RESEARCH FINDINGS

A survey of maintenance condition of the buildings in the two public universities revealed that their condition is need but in need of repair especially the older building stock. In Kenyatta University most of the buildings are relatively new and so majorities have not been subjected to a lot of disrepair.

The following were the key research findings of this study:

Firstly, In the two case studies there was no clear and well defined and documented departmental maintenance policy. There was some indication on plan of action on building maintenance but it was apparent that the plan of action is not documented and well defined in form of a policy document.

Secondly, the predominant maintenance strategy for both case studies was corrective maintenance with very limited planned preventive maintenance, where there was a maintenance plan, this was hardly adhered to in the course of the year for which its intended. This has resulted in a backlog of maintenance works.

Thirdly, no condition standards are set for the universities buildings therefore no clear performance indicators are set from the outset to gauging effectiveness of the building maintenance strategies. Some building conditions are therefore left to deteriorate to very low standards as there are no guidelines or benchmarks for maintenance activities.

Fourthly annual maintenance works program have recently been adopted in both universities but its implementation was reported to be average due a lot of intervening factors. It also became apparent that this was introduced as part of performance contracting concept that has been introduced in Kenyan public universities.

Fourthly it was also evident that at both there was also no maintenance management manual where all information regarding maintenance of building and other facilities is recorded. From perusal of records it was not possible to collate historical information of all maintenance activities relating to specific building.

Fifthly the maintenance management system in both universities was not IT based. The system is not a computerized and it was established that there were no near future plans to introduce computerized maintenance management systems (CMMS). This has result a lot of inefficiencies in performance of certain paper based tasks and limited data analysis that would aid decision making.

Sixthly there was no established condition assessment system in the maintenance departments that would accurately establish maintenance needs of buildings for universities.

Seventhly, an analysis of the organization of maintenance in the universities established a mix of both centralization and decentralization of their organization structure. The University of Nairobi had a more decentralized structure where maintenance management was devolved to constituent colleges. The effect of this that the “well-funded” maintenance units had buildings that were well maintained as compared to the others. Kenyatta University had a more centralized organization structure and control was from the main office. There was a mix of outsourcing and in-house work for maintenance works at university of Nairobi while Kenyatta almost always does bulk of its works “in-house”.

It was evident that at both universities there was a shortage of qualified and experienced staff at the artisan level when related to the demand of work in maintenance. There was heavy reliance on casual labourers.

The development of the human resource for maintenance departments is apparently neglected as the staff are not trained further to upgrade or improve their skills. Staff at lower cadres reported that they are not taken for refresher courses or trained in modern technologies of building maintenance.

An in-depth analysis of maintenance management system at both universities revealed various shortcomings as compared to best practice criteria leading to an overall conclusion that an effective maintenance management system impacts positively on the maintenance condition of buildings as maintenance activities are focused and efficiently implemented. Regardless of the myriad of challenges faced by public universities such as low funding for maintenance work, the available scarce resources also to be managed effectively to ensure maintenance objectives are met at the least cost.

5.3 RECOMMENDATIONS

Maintenance managers at Kenyan public universities to embrace proactively preventive maintenance tasks into their work order systems. The condition based approach or maintenance on crisis should be avoided and they need to incorporate planned preventive maintenance program in the annual maintenance works program.

As an integral part of their maintenance management system, the managers need formulate and document their maintenance policy, strategic maintenance plan for effective and efficient management of building maintenance works.

Need for Introduction of maintenance performance evaluation, maintenance departments should develop a condition assessment system for all their built facilities that set minimum condition standards at which various building should be maintained. Likewise they need to introduce or intensify their periodic condition assessment/surveys from which their maintenance workload and prioritization of maintenance work is determined.

Managers in Kenyan public universities need to embrace the application of modern information technology in maintenance management by computerization of their maintenance records and also embracing computerized maintenance management systems to improve the efficiency of managing their maintenance tasks. In the modern times university managers must invest in software that would improve efficiency of their maintenance management systems.

Managers must weigh the benefits the pros and cons of “outsourcing of maintenance works and executing the works “in-house” with a view of determining the mix of the two that serves the university well in terms of effectively and efficiently managing building maintenance. Such a mix should be also be cost effective .

Public universities should view building maintenance as an integral part of their operations that contributes to their success in meeting their strategic objectives. A deliberate and proactive effort must be taken to facilitate the work of maintenance departments by enhancing budget for maintenance work and also staffing the latter with requisite manpower with appropriate skills, qualifications and experience to manage and execute maintenance works.

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APPENDIX I: STRUCTURED QUESTIONNAIRE FOR ESTATE/MAINTENANCE MANAGERS

SECTION 1: MAINTENANCE POLICY AND STRATEGIC PLANNING

Q1 Kindly specify your academic background/ field of training.....

Q2 What are your level of qualifications: [**please tick as appropriate**]

Postgraduate degree []

Professional qualifications []

Undergraduate degree []

Higher Diploma/Diploma []

Other (Please specify) -----

Q3 Does the department have a well defined and documented policy on the maintenance of university buildings?

Yes [] NO []

If Yes, how would you evaluate its implementation

Very Good 5 []

Good 4 []

Average/Fair 3 []

Poor 2 []

Very Poor 1 []

Q4. Have you formulated a strategic plan for maintenance of the university buildings?

Yes [] NO []

Q5 Does the department have a maintenance strategy?

Yes [] NO []

Q6 If Yes, What is the maintenance strategy:

- 1. **Planned preventive maintenance**
- 2. **Corrective maintenance**
- 3. **maintenance by crisis/ adhoc**
- 4. **unplanned maintenance**
- 5. **condition based maintenance**
- 6. **other (Please specify)** -----

Q7 Does the department set minimum condition standards at which various buildings should be maintained

Yes **NO**

If NO what challenges hinders this-----

Q7b If YES how regularly do you review and evaluate the above condition standards

- Monthly**
- Quarterly**
- Annually**
- Other (Please specify)**

Q8 Does the department prepare an annual maintenance works program ?

Yes **NO**

If Yes, how would you rate its implementation

- Very Good** 5
- Good** 4
- Average/Fair** 3
- Poor** 2
- Very Poor** 1

Q9 Does the department have in place a maintenance management manual which outlines all information regarding maintenance of buildings and other facilities?

Yes [] NO []

SECTION II: MAINTENANCE INFORMATION

Q10 Does the department maintain an asset register of all buildings maintained?

Yes [] NO []

Q11 If Yes, which of the following information does it contain

[] **Building name**

[] **Location and Age**

[] **Construction details**

[] **Functions of buildings**

[] **Maintenance history-maintenance work done on it**

[] **Replacement cost of building**

[] **Previous and current condition assessment reports**

Q12 Is the asset register updated regularly?

Yes [] NO []

Q13 Do you have a computerized data base of maintenance records?

Yes [] NO []

Q14 Do you have in place a computerized maintenance management system (CMMS)

Yes [] NO []

Q15 Briefly enumerate the challenges faced in developing a maintenance information system for the department.....

SECTION III: ORGANISATION OF MAINTENANCE

Q16 How would you describe the organization structure for the department

Centralised []
Decentralised []
Other (Please specify).....

Q17 Please indicate by what proportion (%) maintenance is executed

By Direct Labour.....
By Contract (Outsourcing).....
Other (Please specify).....

Q18 Does the department have a policy on the training of staff at all cadres.

Yes [] **NO** []

Q19 Please indicate number of staff in the department at the various levels

Senior Managers []
Middle level managers []
Technical staff []
Supervisors []
Foremen []
Operatives, painters, masons, plumbers, carpenters, welders, electricians []

Q20 Please indicate of the above how many with qualifications at the following levels

- Postgraduate degree** []
- Professional qualifications** []
- Undergraduate degree** []
- Higher Diploma** []
- Diploma** []
- Grade Tests** []
- Other (Please specify)** -----

Q20 What is your evaluation of the sufficiency of the number of staff at the various cadres given the needs of the department in relation to human capital? [**Please tick as appropriate**]

	Very Adequate (5)	Adequate (4)	Fairly Adequate (3)	Barely Adequate (2)	Insufficient (1)
Senior Managers					
Middle level managers					
Technical staff/Supervisor					
Foremen					
Artisans					

Q21 Briefly enumerate the challenges faced in organization of maintenance works

.....

.....

.....

SECTION IV: MAINTENANCE IMPLEMENTATION

Q22 How long does the department respond to maintenance requests [Please specify]

- Less than one month** []
- 1-3 months** []
- 6-12 months** []
- More than 1 year** []

Q23 Does the department conduct condition assessment or physical inspections of buildings (assessment of the current physical condition of building, component, fabric or element)

Yes [] NO []

Q24 If Yes, How frequently do you conduct condition assessments?

- [] **Annually**
- [] **Every two years**
- [] **Every five years**
- [] **Every ten years**

Other (Please specify)_____

Q25 In your evaluation how would you rate the sufficiency of funding received for maintenance works against the maintenance needs of university buildings []

- Very Adequate** 5[]
- Adequate** 4[]
- Fairly Adequate** 3[]
- Barely Adequate** 2[]
- Insufficient** 1[]

Q26 In your evaluation how would you rate the university's system for procurement for materials and services for maintenance works?

- Exceeds Expectations** 5[]
- Meets Expectations** 4[]
- Barely Meets Expectations** 3[]
- Below Expectations** 2[]
- Doesn't meet expectations** 1[]

Q27 Briefly enumerate other challenges faced in implementation of maintenance works

.....

.....

.....

.....

APPENDIX II: INTERVIEW SCHEDULE FOR MAINTENANCE SUPERVISORS/ FOREMEN

1. What trade are you trained in?.....
2. What is your level of training.....
3. Do you keep a record of all your daily activities? Are these records filed or stored also as computer records?
4. Are you computer literate? Do you have knowledge of computerized maintenance systems?
5. How are requests for maintenance handled by your department? Would you rate the department's response as being effective and timely?
6. How would you rate the current maintenance state of the institution's buildings?
7. Has the situation improved or worsened in the last five years? If it has worsened what in your opinion is impeding effective maintenance of buildings.
8. What in your opinion would you rate as the greatest challenge in maintaining the university buildings?
9. Would you say that at you are sufficiently facilitated in your work? If no what is your greatest deficiency
10. Would you say that you have sufficient training and skills to execute your work/ if no what way can this be improved?
11. In your opinion are the departmental maintenance processes and procedures effective in addressing maintenance needs of the university buildings?
12. Does the department have acceptable levels of materials to adequately support maintenance and repair works?
13. In your view is university or departmental management committed to building maintenance
14. Any suggestions on how maintenance management can be improved given challenges faced at implementation stage

MAINTENANCE CONDITION SURVEY CHECK LIST

BUILDING CODE NO:				
ELEMENT	NOTED DEFECTS	CONDITION RATING	COMMENTS & RECOMMENDATIONS	
1	EXTERNAL FINISHES			
2	INTERNAL FINISHES			
	Floor finishes			
	Ceiling Finishes			
	Wall finishes			
3	WALLING			
4	SUSPENDED FLOORS			
5	DOORS			
6	WINDOWS			
7	ELECTRICAL FITTINGS			
8	SANITARY FITTINGS			
9	ROOFING			
OVERALL RATING				