THE EFFECTIVENESS OF STRATEGIC APPROACHES ADOPTED BY UNIVERSITY OF NAIROBI ICT UNITS IN MAINTENANCE OF INFORMATION COMMUNICATION TECHNOLOGY EQUIPMENT

BY

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Dedication

This project is dedicated to my late Uncle Yohannes Desta. Without his knowledge, wisdom, and guidance, I would not have the goals I have to strive and be the best to reach my dreams!

Declaration

This research project is my original work and has not been presented for a degree at any other university.

Signed …… Date ……..

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This research project has been submitted for examination with my approval as the University Supervisor.

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Abstract

Maintenance is an imperative activity in an organization. Breakdown in poor equipment health lead to inconsistencies in output as well as deviance from established work specifications/quality. Poor maintenance leads to more frequent failures, poor utilization of equipment and delayed schedules. Regularly scheduled equipment maintenance not only prevents sudden and unexpected equipment failure, but also reduces the overall life-cycle costs of the equipment thus gives an organization a competitive edge. In learning institutions, where generation of knowledge through research is emphasized, good and consistent performance of ICT equipment is extremely vital. Thud, there is need to become more conscious on the role of ICT maintenance management in improving the quality of their services. This study sought to establish how effective the current strategic management practices adopted by the University of Nairobi on its ICT equipments and the extent to which ICT maintenance practices are applied.

The study used descriptive survey research design approach on a target population of the 11 ICT units within the University and officers in charge (OIC) sampled purposively. The study used semi-structured questionnaires. Descriptive analysis technique through the use of frequencies, percentage, mean and standard deviation was applied. Based on the findings, the study concludes that the University recognizes the important role of the Maintenance in providing quality services to its users, by ensuring that their equipment are well maintained and repaired in good time. From the findings it can be concluded that there is a centralized maintenance policy which guide the maintenance personnel at the ICT Central Facility as well as those at the various campuses. However slow response time to failure/corrective action on failed ICT equipment needs to be addressed.

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Lists of Abbreviation

CMMSs	Computerized maintenance management systems
FIS	Fuzzy Inference System
FMEA	Failure Mode Effect Analysis
ICT	Information Communication Technology
JIT	Just-In-Time
MD	Maintenance Department
OEE	Overall Equipment Effectiveness
PDM	Predictive Monitoring
RCM	Reliability-Centered Maintenance
TQM	Total Quality Maintenance
TPM	Total Productive Maintenance
UoN	University of Nairobi

CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Approximately three decades ago, companies realized that to manage maintenance adequately it was necessary to include maintenance management in the general scheme of the organization and to manage the maintenance processes in interaction with other functions (Pintelon and Gelders, 1992). As organizations embrace the use of Information Communication Technology (ICT) and automation of processes, it is important for associated ICT equipment such as servers and networking routers together with the software to operate efficiently for continues service in any organization.

Every organization wants its equipment and systems to operate and be operated in a reliable fashion. When the equipment performs optimally, output and profitability is maximized. No organization wants its equipment or systems or processes to break down, to produce poor quality products, or to operate inefficiently. Unfortunately, we do not live in an ideal world; no physical asset operates flawlessly forever, and hence in most organizations, breakdowns are evident, which may lead to productivity losses (Life Cycle Engineering, 2007).

Attention is paid to maintenance when equipment that affects the core business of the organization fails and there is demand that they get it running again, and quickly. The majority of work is done on a reactive basis. Performing sustaining levels of maintenance is a fundamental requirement of long-term survival of all organizations and should be a strategic concern for organizations (Franklin, 2008).

1.1.1 Strategic Management

The strategic management process is a theoretical approach that incorporates human capital, skill and technical structures in an institution to boost efficiency, effectiveness, and customer fulfillment, while enhancing employees' satisfaction, adding value to the services and increasing business income (Pearce and Robinson, 2001). It's a holistic application and handling of the employees, technology, information so as to achieve the preferred results.

Strategic management enables an organization to recognize the existing environmental opportunities and threats, and also to understand or estimate the

organization's resources capabilities considering the strengths and weaknesses of its resources so as to align itself and to battle with the environmental challenges. Strategic planning practices therefore aid an organization in its management practices that also enhance its performance.

1.1.2 Information Communication Technology Equipment

Due to the changes in technology and conveyance of the information that has translated the world to global, many industries and learning institution had embraced the change by accessing ICT that facilitates transaction of information (Yoshikawa, 2005). For this to be effective concept of maintaining ICT equipment in todays widespread of technological change has been very critical to the institution. Institutions integrate ICT (Information and communication technologies) within the maintenance strategy and/or plan (Li et al., 2005) to deal with the new needs emerging from innovate ways for supporting production (e-manufacturing), business (e-business) and (e-learning).

1.1.3 The University of Nairobi

The University of Nairobi (UoN) is the largest university in Kenya with an assets value of Kshs 41.437 billion (4.25% representing land values and 92.75% representing buildings, plant, machinery, equipments, motor vehicles and other assets) (UoN, 2010).

Although its history as an educational institution goes back to 1956, it did not become an independent university until 1970 when the University of East Africa was split into three independent universities: Makerere University in Uganda, the University of Dares Salaam in Tanzania, and the University of Nairobi.

The university has launched several policy frameworks and introduced module 2 degrees to cope with the demand of higher education in Kenya. In view of the rapid expansion and complexities in administration, the university has undergone major restructuring resulting in decentralization of the administration through the creation of seven campus colleges headed by principals, i.e. College of Agriculture and Veterinary Sciences (Upper Kabete Campus), College of Architecture and Engineering (Main Campus), College of Biological and Physical Sciences (Chiromo Campus), College of Education and External Studies (Kikuyu Campus and Kenya

science campus), College of Health Sciences (Kenyatta National Hospital), College of Humanities and Social Sciences (Main Campus), and College of Business (Lower Kabete Campus).

At UoN, ICT equipment are composed of computers, laptops, liquid crystal display (LCDs) televisions and projectors, uninterruptible power supply (UPSs), operating systems, closed-circuit television (CCTV) cameras, networking switches, scanners, photocopiers, printing machines, servers, digital cameras among others.(UoN, 2010). UoN (2010) outlined that only 36.2% of ICT areas had quarterly preventive maintenance done while the rest did not, resulting in prevalent ICT failure.

1.2 Statement of the Problem

Maintenance is an important factor in any organization, which is another basis for the successful competitive edge. Inconsistencies in equipments lead to variability in product characteristics and result in defective parts that fail to meet the established specifications. Effective maintenance is critical for the success of an organisation as poor maintenance leads to more frequent failures, poor utilization of equipment and delayed schedules (Djerdjouri, 2005). Breakdown maintenance postpones repairs and allows damage to accumulate, compounding an organization's problems.

Regularly scheduled equipment maintenance not only prevents sudden and unexpected equipment failure, but also reduces the overall life-cycle costs of the equipment (Rondeau, 2006). The planning process should result in a comprehensive plan that covers all areas of concern. Developing a good plan requires the commitment of everyone involved in the maintenance and operations process, including senior management (Wheeler, 2007).

Labor costs per unit rise because of idle labor due to machine breakdowns. When machine malfunctions result in scrap, unit labor and material costs increase. Besides, cost of maintenance which includes such costs as costs of providing repair facilities, repair crews, preventive maintenance inspections, spare parts and stand by machines will increase as machines break down frequently (Vagliasindi, 1989).

The institutions need to become more conscious on the role of maintenance management in enhancing their equipment performances and consequently improving the quality of their services. Good equipment maintenance practices can improve the

reliability of our system; maintenance has become the prominent management issue for organisations. In recent years, ICT organisations have started using benchmarking to identify the best practices for enhancing their maintenance works (Allen, 1993).

In 2006, the Kenya Education Network Trust (KENET) carried out an e-readiness survey to determine the degree to which higher education institutions in Kenya were prepared to participate in the networked world for learning, teaching, research, and management (Meoli and Waema, 2007). The findings indicated that more than 50 percent of the 17 universities and 8 tertiary institutions of higher learning in Kenya did not have sufficient ICTs to support teaching and research. A further study of the e-readiness assessment of 50 East African universities in the five countries of Kenya, Uganda, Tanzania, Rwanda and Burundi was conducted. The results show that universities in East Africa were at a lower stage in developing ICT workforce. This means that the faculty is not trained in common productivity tools or using ICT for training with internal e-learning systems. This affects the adoption of ICT for learning and research by the university community (Meoli and Waema, 2008).

The essence of maintenance is to increase the service life of equipment by delaying deterioration, decay and failure. Maintenance must therefore be considered a strategic process if the value of equipment is to be sustained. The study was guided by the following research questions: How effective are the current strategic management practices at UoN and to what extend are they these management practices applied?

1.3 Objectives of the Study

i. To establish the extent to which ICT maintenance practices are applied at the University of Nairobi.

ii. To determine the effectiveness of the strategic maintenance practices adopted by the University of Nairobi on its ICT equipments

1.4 Value of the Study

The study provided deeper insights into what the University needs to do to ensure proper maintenance management strategies

The research information provides vital data to assist and benefit researchers, development practitioners, academicians, policy makers, planners and programme

implementers to monitor and evaluate existing maintenance management strategies. The benefits include generation of knowledge and information on maintenance management strategies. This might catalyze policy thus, influence decision-making processes regarding maintenance management strategies and serve as a reference for further research.

The results of this study can benefit other universities in particular in terms of improving service delivery for increased customer satisfaction, with serene and conducive environment for learning where maintenance of the premises and facilities is done in a way that ensures satisfaction.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents theoretical and empirical literature pertinent to ICT maintenance management. Presented is a review of the related literature on the subject under study by various researchers, scholars, analysts and authors. Models by writers are used to illustrate the topics mentioned in the objective of the study.

2.2 Strategic Maintenance Approaches

The two key elements of the strategic maintenance approach are that maintenance management is a vital core business activity crucial for business survival and success, and as such it must be managed strategically. Secondly, effective maintenance management needs to be based on quantitative business models that integrate maintenance with other decisions such as production and operations.

In the strategic maintenance approach, maintenance is viewed as a multi-disciplinary activity. It involves scientific understanding of degradation mechanisms and linking it with data collection and analysis to assess the state of equipment; building quantitative models to predict the impact of different actions (maintenance and operations) on equipment degradation; and managing maintenance from a strategic perspective (Tsang, 2002).

A survey studied by Lientz and Swanson (1970) exposed the very high fraction of life-cycle costs that were being expended on maintenance. They categorized maintenance activities into four classes: Adaptive (dealing with changes and adapting in the software environment), perfective (accommodating with new or changed user requirements which concern functional enhancements to the software), corrective (dealing with errors found and fixing it) and preventive (concerns activities aiming on increasing software maintainability and prevent problems in the future). The survey showed that around 75% of the maintenance effort was on the first two types, and error correction consumed about 21%. Many subsequent studies suggest a similar magnitude of the problem (Lientz and Swanson, 1980).

2.2.1 Preventive Maintenance

Preventive maintenance (PM) is the care and servicing by personnel for the purpose of maintaining equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of incipient failures either before they occur or before they develop into major defects; that is, maintenance of equipment or systems before fault occurs. These maintenances include tests, measurements, adjustments, and parts replacement, performed specifically to prevent faults from occurring. It can be divided into two subgroups planned maintenance and condition-based maintenance (Bobby, 2001).

While preventive maintenance is generally considered to be worthwhile, there are risks such as equipment failure or human error involved when performing preventive maintenance, just as in any maintenance operation (Horner, et al., 1997).

2.2.1.1 Condition-Based Maintenance

Condition-based maintenance (CBM), shortly described, is maintenance when need arises. This maintenance is performed after one or more indicators show that equipment is going to fail or that equipment performance is deteriorating. As systems get more costly, and instrumentation and information systems tend to become cheaper and more reliable, CBM becomes an important tool for running an organization in an optimal manner. Better operations lead to lower production cost and lower use of resources. And lower use of resources is one of the most important differentiators in a future where environmental issues become more important by the day (Horner, et al., 1997).

Condition-based maintenance was introduced to try to maintain the correct equipment at the right time. CBM is based on using real-time data to prioritize and optimize maintenance resources. Observing the state of the system is known as condition monitoring. Such a system will determine the equipment's health, and act only when maintenance is actually necessary. It is Department of Defense policy that condition-based maintenance (CBM) be implemented to improve maintenance agility and responsiveness, increase operational availability, and reduce life cycle total ownership costs (Morales, 2002)

CBM has advantages over planned maintenance as it improves system reliability, decrease maintenance costs and decrease number of maintenance operations causes decreasing of human error influence. However, disadvantages of CBM are high installation costs, for minor equipment items more than value of equipment, unpredictable maintenance periods causing costs to be divided unequally and increased number of parts (CBM installation) that need maintenance and checking.

2.2.1.2 Planned Preventative Maintenance

Planned Preventative Maintenance (PPM) or Planned Maintenance (PM) or Scheduled Maintenance is any variety of scheduled maintenance to an object or item of equipment. Specifically, Planned Maintenance is a scheduled service visit carried out by a competent and suitable agent, to ensure that an item of equipment is operating correctly and to therefore avoid any unscheduled breakdown and downtime (Wood, 2003).

Together with CBM, planned maintenance comprises preventive maintenance, in which the maintenance event is preplanned, and all future maintenance is preprogrammed. Planned maintenance is created for every item separately according to manufacturer's recommendation or legislation. Plan can be based on equipment running hours, date based, or for vehicles distance travelled. Good example of PM program is machine maintenance whereby after long time of use the machine must be serviced, parts renewed (Horner, et al., 1997).

Planned maintenance has some advantages over CBM such as: easier planning of maintenance and ordering spares, costs are distributed more evenly and no initial costs for instruments for supervision of equipment. Disadvantages are that equipments with planned maintenance are less reliable than equipment with CBM and more expensive due to more frequent parts change. Parts that have scheduled maintenance at fixed intervals, usually due to wear out or a fixed shelf life are sometimes known as time-change interval or TCI items.

2.2.2 Corrective Maintenance

Corrective maintenance can be defined as a maintenance task performed to identify, isolate, and rectify a fault so that the failed equipment, machine, or system can be restored to an operational condition within the tolerances or limits established for in-

service operations (Grubb and Takang, 2003). Corrective maintenance is the most commonly used maintenance approach, but it is easy to see its limitations. It covers all activities, including replacement or repair of an element that has failed to a point at which it cannot perform its required function. Corrective maintenance is sometimes referred to as failure-based or unplanned maintenance. Corrective maintenance tasks often take places in an ad hoc manner in response to breakdowns or user requests (David and Arthur, 1989).

Corrective maintenance can be extremely expensive for two reasons: The failure of a machine can cause a large amount of consequential damage to other elements in learning. For example, failure of the gadget could cause damage to the documents and the information intended for learning. Failure of a machine can occur at a time which is inconvenient to both the user and the maintaining authority (Lientz et al., 1980). This can make manpower and spare parts planning extremely difficult. According to Nakajima (1988), when equipment fails, it often leads to downtime in production, and sometimes damages other parts. In most cases, this is expensive. Also, if the equipment needs to be replaced, the cost of replacing it alone can be substantial. However, corrective maintenance is still an important part of any maintenance management strategy. It is from such work that we can gather vital predictive information.

For failure modes which lend themselves to condition monitoring, corrective maintenance is the result of a regular inspection which identifies the failure in time for corrective maintenance to be planned and scheduled, then performed during a routine plant outage. When corrective maintenance is done, the equipment is inspected to identify the reason for the failure and to allow action to be taken to eliminate or reduce the frequency of future similar failures (Horner, et al., 1997). A good example is the failure of machine in a process of retrieving document or information (Lientz et al., 1980).

2.3 Models for Maintenance Management

Several maintenance models have been proposed; these include, total quality maintenance (TQM), total productive maintenance (TPM), Reliability-Centered Maintenance (RCM).

2.3.1 Total Quality Maintenance (TQM)

TQM is an integrative philosophy of management for continuously improving the quality of products and processes. TQM functions on the premise that the quality of products and processes is the responsibility of everyone who is involved with the creation or consumption of the products or services offered by an organization (Ahire, 1997). TQM model was developed by Al-Najjar (1996), which includes the development from life-cycle cost (LCC) to life-cycle profit (LCP). It is soundly based on the Deming cycle (plan-do-check-act-plan) which is the foundation of TQM.

Cua, McKone, and Schroeder (2001) identified the nine common TQM practices as cross-functional product design, process management, supplier quality management, customer involvement, information and feedback, committed leadership, strategic planning, cross-functional training, and employee involvement. TQM approach seeks to improve quality and performance to meet or exceed customer expectations and achieved by integrating all quality-related functions and processes throughout the company. TQM looks at the overall quality measures used by a company including managing quality design and development, quality control and maintenance, quality improvement, and quality assurance.

Oliverson, (2006) pointed out that total quality maintenance management is a business function of which is the considerable operational and tactical importance that favors the continuous operation of the institutions. As problems and opportunities are needed to be anticipated in time in order to make the necessary adjustments which will lead to sound performance reporting that is indispensable.

Another principal strand of TQM is that maintenance should be integrated with production and scheduled with it. This argument is also compelling. It involves two-way traffic. The preventive maintenance, whether age or on-condition, should be scheduled to avoid busy production periods, but on the other hand, production schedules should incorporate time for the maintenance calculated to be essential to sustain quality and minimize total down time. It is recognized in TQM Main that integration of maintenance and production schedules will require an integrated data system based upon the Deming P-D-C-A cycle, and sufficiently discriminatory to choose and optimize a policy for maintenance. It does not prescribe how exactly this should be achieved.

2.3.2 Total Productive Maintenance (TPM)

TPM is a maintenance model that ensures the maximum use of the existing equipment and performs the increased production within regular working hour to achieving the cost reduction without sacrificing the product quality. The goal of TPM program is to markedly increase production while at the same time increasing employee morale and job satisfaction. TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity (Ahmed, Ali, Allama and Parvez, 2010).

Tajiri and Gotoh (1992) recognize full definition of TPM in five points: it aims at getting the most efficient use of equipment (i.e. overall efficiency); establishes a total (company-wide) PM system encompassing maintenance prevention, preventive maintenance, and improvement related maintenance; requires the participation of equipment designers, equipment operators, and maintenance department workers; involves every employee from top management down; and, promotes and implements PM based on autonomous, small group activities. Wireman (1991) suggests that TPM is maintenance that involves all employees in the organisation and accordingly includes everyone from top management to the line employees.

Nakajima (1988) summarize an entire TPM philosophy in succinctly as: “productive maintenance involving total participation in addition to maximizing equipment effectiveness and establishing a thorough system of PM”, where PM is a comprehensive planned maintenance system. According to Nakajima, it relies upon the fact that the deterioration of machines is accelerated by abusive operation and lack of primary care, such as greasing, tightening and cleaning, all of which can be alleviated by the operator. The problems come later, the efforts of the operator can postpone the need for PM, but unnecessary, costly failures will still occur if it is never done.

2.3.3 Reliability-Centered Maintenance (RCM)

Reliability-centered maintenance (RCM) is a process to ensure that assets continue to do what their users require in their present operating context (Moubray, 1997). It is generally used to achieve improvements in fields such as the establishment of safe minimum levels of maintenance, changes to operating procedures and strategies and the establishment of capital maintenance regimes and plans. Its successful

implementation lead to increase in cost effectiveness, machine uptime, and a greater understanding of the level of risk that the organization is presently managing (Netherton, 1998).

Technical standard SAE JA1011 sets out the minimum criteria that any process should meet before it can be called RCM. This starts with the 7 questions: what the item is supposed to do and its associated performance standards, in what ways it can fail to provide the required functions, what events can cause each failure, what happens when each failure occurs, in what way each failure matter, systematic task that can be performed proactively to prevent, or to diminish to a satisfactory degree, the consequences of the failure, and, what must be done if a suitable preventive task cannot be found (Netherton, 1998).

The popularity of RCM probably depends mainly upon its not requiring any significant input or investment from higher management. In fact they are told by its proponents that savings are to be expected in the maintenance budget. RCM tries to deal with reliability and maintenance in relative isolation from costs and profits. It contains many good ideas, most of which appear in other methods also, such as FMECA, but also some erroneous concepts like the Resnikoff conundrum, most of which are unique to RCM, the notable exception being the misconstrued bathtub curve, which is unfortunately only too common in both difficult mathematical models and simplistic analyses of maintenance needs.

2.4 Maintenance, Quality and Productivity

Automation is one reason for the importance of physical asset management to a firm's success. Industries have to delegate more tasks to machines, thus making maintenance and asset management more crucial. There are different perceptions on importance of maintenance by management. According to Tsang et al., 1999, some perceive it as simply repairing broken equipment in a plant; others take a broader view and see it as vital to a firm's profitability. In the past, maintenance was viewed as an obligatory expense that had to be minimized. Wireman, (2004), observed that automation, maintenance costs increased and gradually attracted the attention of management. In a benchmarking exercise, Wireman, T. (2004), found that maintenance costs as a percentage of operational costs depend on the design of the plant and the quality and type of machinery, but overall the maintenance departments have more influence on the top management where maintenance costs are a larger portion of operating costs.

Mather, (2003), noted that the importance of asset management has increased therefore making it a strategic function. Most environmental and safety related accidents can be connected to asset management practices, and companies now pay more attention to safety and environmental aspects of their operation due to growing public awareness and stricter government regulations.

Few papers have been published recently that discuss issues related to strategic maintenance planning. Tsang (2002) identified four strategic dimensions of maintenance. The first dimension is the service delivery strategy. Outsourcing versus in-house maintenance are two possible alternatives for maintenance delivery strategies. Many petrochemical processing plants outsource all their equipment and facility maintenance. Others outsource particular specialized or risky aspects of maintenance. The potential benefits of outsourcing maintenance activities include less hassle, reduced total system costs, better and faster work done, exposure to outside specialists, greater flexibility to adopt new technologies and more focus on strategic asset management issues (Watson, 1998; Campbell, 1995).

Tsang (2002) has an excellent analysis of the two options in terms of things that should not be outsourced. An activity that is considered to be the organization's core competency should not be outsourced. An activity may be considered as a core competency if it has a high impact on what customers perceive as the most important service attribute or the activity that requires highly specialized knowledge and skills. The costs involved in the internal service include personnel development and infrastructure investment and managing overhead. The costs involved in the outsourcing include the costs of searching, contracting, controlling and monitoring.

Murthy et al. (2002) explored the outsourcing issue and discussed the long-term costs and risks of different alternatives. Some general guidelines are laid out in relation to this issue including that maintenance management and planning should not be outsourced. The maintenance implementation, however, may be outsourced based on cost and risk consideration. Risks are very much linked to the service supply market. Having a single dominating supplier in the market makes the user company hostage to that supplier services. On the other hand if the suppliers are weak, they might not be able to supply quality and reliable service as much as the internal service can do. Furthermore, the service should not be outsourced if the company does not have the

capability to assess or monitor the provided service and when it lacks the expertise in negotiating sound contracts.

2.5 Summary

As reviewed in this chapter, maintenance approaches used on ICT equipment are: preventive and corrective maintenance. In preventive maintenance, an organization can use condition based maintenance; that is maintenance when one of the indicators shows that the system is going to fail or planned preventive maintenance whereby maintenance is scheduled for ICT equipment. Corrective maintenance is normally done to identify, isolate and rectify a fault in ICT equipment.

Among the nine key strategic objectives identified by the University of Nairobi in its vision towards world-class excellence, is the support and development of the ICT function within the University. This is done with an aim of maximizing student, staff productivity and service delivery, enhance teaching and learning and improve quality of research through ICT. In order to maintain this, there is a need to develop strategic approaches that is favorable to maintenance with a strong external and internal focus on intended purposes.

According to the University's ICT policy, maintenance is done in four levels: at the first level, the users resolve basic problems as the first level of maintenance and support. At the second level, the officer-in-charge (OIC) in each campus offer support to the users on issues they cannot resolve. At the third level, specialist Maintenance Engineers at the Central Facility handle issues escalated from various campuses. The fourth and final level, the Central Facility work in liaison with vendors, suppliers and hardware manufacturers to repair and/or replace faulty equipment. The Central Facility is, thus, in charged with the responsibility of enforcing any maintenance contracts, agreements and warranties. According to the policy, every campus has a designated repair facility in the form of a room reserved for the purpose of conducting all hardware repair and maintenance activities. Preventive maintenance is carried out according to the recommendations of the manufacturer of the hardware, in terms of frequency and method of maintenance (UON, 2010). This study will assess the effectiveness of these maintenance approaches at the University.

CHAPTER THREE: RESEARCH METHODOLGY

3.1 Introduction

This chapter presents methods that were adopted by the study in obtaining the research data: research design, population of the study, data collection techniques and data analysis.

3.2 Research Design

The study was a descriptive survey. Descriptive design is used when the purpose is to describe characteristics of certain goals, estimate the proportion of people who behave in a certain way and make specific predictions (Churchill, 1991). This method is preferred because it allowed for a description of what, who, where and how of the various maintenance policies adopted for ICT equipment in the University.

3.3 Target Population

The targeted population of this study was the University of Nairobi ICT units in all the campuses as listed in Appendix III. The sample was the 11 ICT units who are the offices in charge of ICT equipment within the learning institutions in the University of Nairobi.

3.4 Data Collection

Emphasis was given to primary data sources collected from the ICT Units. These units were 11 in number and the respondents were the Chief Officers in Charge of these units. Chief Officer's in charge based in the campuses located in Nairobi take care of the Mombasa and Kisumu Campus; hence data was collected from the ICT units based in Nairobi.

Primary data was collected using semi-structured questionnaires. Closed-ended questions were used to conserve time and facilitate easier analysis as they are in immediate usable form. Some of the close-ended questions had a five point Likert scale, along which the respondents were required to rank given factors. Open-ended questions were used to encourage the respondent to give an in-depth and felt response. The drop and pick method was used to administer the questionnaire. In addition, the

researcher made telephone calls to the respective respondents to remind them to fill-in and submit the questionnaires.

3.5 Data Analysis

The data collected were both quantitative and qualitative from open-ended questions and close-ended questions respectively. Quantitative data were analyzed using descriptive statistics while qualitative data were analyzed using content analysis. That is, qualitative data were analyzed based on the content matter of the responses as responses with common themes or patterns were grouped together into coherent categories, these categories were used to explain the findings. Only the relevant non-redundant content was presented.

Quantitative data were analyzed using descriptive statistics. Descriptive statistics involved the use of absolute and relative (percentages) frequencies, measures of central tendency and dispersion (mean and standard deviation respectively). Quantitative data were presented in tables and graphs (pie charts and bar graphs) while the explanation to the same and qualitative data were presented in prose. Data presentation was done in line with the study's objectives.

CHAPTER FOUR: DATA FINDINGS AND ANALYSIS

4.1 Introduction

This chapter presents analysis of the findings on the effectiveness of strategic approaches adopted by University of Nairobi in maintenance of ICT equipments. Semi-structured questionnaires were used to collected data from 11 officers in charge (OIC) of ICT units within the University who all filled-in the questionnaires making 100% response rate. The response rate was made possible as the researcher administered the questionnaires in-person and waited for them to be filled-in. In few cases, the questionnaires were dropped and respondents reminded continuously to fill them in.

4.2 Demographic Characterization of Respondents

The respondents were asked to indicate their gender. The findings show that 72.7% of the respondents were male while 27.3% were female. This shows that the ICT departments in the University of Nairobi were mostly headed by male which underscores that ICT field, just as most technological careers, are predominated by male. The respondents were further asked to indicate their higher academic qualifications. The results are as shown in Table 4.1.

Table 4.1: Education Qualification of respondent

Level of Education	Frequency	Percent
Masters Degree	4	36.4
Bachelors Degree	4	36.4
Diploma	2	18.2
Others	1	9.1
Total	11	100.0

The findings presented in Table 4.1 indicate that 36.4% of the respondents had bachelor or master degree as their highest level of education and 18.2% of the respondents had a diploma, while 9.1% had other academic or professional credentials such as certificates in ICT related fields. This shows that while majority of the OIC had good academic credentials (masters and diplomas), others were considered for

their ICT prowess despite being in possession of ICT certificates only. This owes to the volatile nature of ICT related knowledge which changes faster than the rigid academic curricula can accommodate.

Finally the respondents were asked to indicate the number of years they had worked at the ICT units. The results are as shown in Table 4.2

Table 4.2 Duration in Years of Work Experience at the ICT department

No. of Years worked	Frequency	Percent
5 years or less	4	36.4
6 to 10 years	1	9.1
11 to 15 years	4	36.4
Above 15 years	2	18.2
Total	11	100.0

Table 4.2 illustrates the findings on the number of years the respondents had worked at the ICT department. This depicts the experience of the respondents at the ICT unit of the University thus the reliability of the information they would give. The findings indicate that 36.4% of the respondents had worked for 11-15 years and the same percentage had worked for 5 and less years. Those who had worked for over 15 years were 18.2% while 9.1% had worked for 6-10 years. This indicates that most of the OIC had worked at the ICT department for long (at least 5 years) and had the relevant experience and knowledge with the information sought by the study.

4.3 Maintenance of ICT Equipment

4.3.1 Inspection and Monitoring Maintenance Policies of ICT Equipment

The respondents were asked if there existed in the ICT unit of the University an inspection and monitoring maintenance policies of ICT equipments. From the findings, 45.5% of the respondent revealed that the Unit they worked at had inspection and monitoring policy of ICT equipment while the same percentage were of contrary opinion. The respondents averred that in some Units, ICT equipments are serviced twice a year by the user support staff and recommendations given on required repairs and replacement in obsolete equipments. Some respondents stated

that in their maintenance policy ICT equipments are monitored and maintained regularly and reports generated from time to time.

The study sought to establish whether there is a service contractor charged with maintenance of ICT equipment. 90% of respondents indicated that there wasn't a service contractor in charge of ICT maintenance and only 10% were positive and this was for heavy duty equipments such as Generators, Air Conditioners and Interrupted Power Supplies. This depicts that most ICT equipment maintenance duties were in-sourced as it is cost effective. The respondents indicated that maintenance was done by user support staff in colleges assisted by maintenance ICT at the ICT center.

The study further aimed at establishing whether the ICT maintenance policy at the university is centralized or if each ICT unit has its own policy as shown in Table 4.3.

Table 4.3: Presence of a Maintenance Policy

Response	Frequency	Percentage
Have their own	5	45.5
Centralized	5	45.5
Others	1	8.9
Total	11	100

From the findings of Table 4.3, 45.5% stated that the maintenance policy is centralized, while an equal number stated to the contrary. A minority (8.9%) stated that the maintenance policy in ICT units were partly centralized and partly owned/formulated by the individual Unit.

On whether the Operating systems (OS) of computers are configured optimally, antivirus installed and updated, all the respondents were positive. This depicts that the computers within the University were at least in good condition as they had optimally configured operating systems, antivirus installed and updated to fend-off virus attacks and consequent security breaches that may lead to loss of information or data.

To the question on whether the ICT units conform to the equipment operating manuals from manufacturers in daily operations of the equipments, 81.8% of the respondents stated that the ICT units conformed to the ICT equipment operating

manuals while 18.2% were of contrary opinion. This depicts that the Units adopt what is stated in ICT equipment operations manual to ensure that the equipment are optimally operated. The Operations manual are aimed at minimizing equipment breakdown as the use of the manual make the equipment function more efficiently.

On what maintenance practices that ICT equipment is accorded at the University, the results are presented in Table 4.4.

Table 4.4 Maintenance Practices Accorded to ICT Equipment

(Tick all that applies); 1 = never, 2 =annually, 3=semi-annually, 4=quarterly, 5=bi-monthly, 6=monthly, 7=weekly, 8=daily.

	Never	Annually	Semi-Annually	Quarterly	Bi-monthly	Monthly	Weekly	Daily	Mean
Checking System Firewalling	1	1	1	3	0	1	0	1	2.91
Software upgrade/update	0	1	4	1	1	0	1	1	3.45
Hardware upgrade	1	5	2	1	0	0	1	0	2.55
Virus scanning	1	1	0	0	0	0	1	7	6.00
Periodic Diagnostics	0	1	2	3	0	2	2	0	4.18
Greasing	2	1	5	3	0	0	0	0	2.82
Backup of /deleting unnecessary data	0	1	2	1	1	1	3	0	4.00
Cleaning	0	2	3	2	0	0	2	1	3.91

The mean score in Table 4.4 is on a scale of 1-8, where 1 signifies the maintenance practice that was carried out less frequently and a mean of 8 indicates the maintenance practice carried out most frequently. The findings reveal that virus scanning is the most frequently used maintenance practices given a mean of 6.0, followed by periodic diagnosis of ICT equipment (mean = 4.18), backup of /deleting unnecessary data (4.0), cleaning (3.91) and software upgrade/update (3.45). However, hardware update (2.55), greasing (2.82) and checking system firewall (2.91) were least adopted as ICT equipment maintenance practices. This indicates that as a maintenance practice, most ICT units, at the University, does virus scanning with a preinstalled software as well as periodic diagnosis of ICT equipment and backup of /deleting unnecessary data. The results show that the Units scan the computers more frequently.

4.3.2 Conditions of the ICT Equipment

The respondents were requested to give the conditions of the ICT equipment at the University. The results are as shown in Table 4.5

Table 4.5: Conditions of the ICT Equipment

Conditions of ICT Equipment	Frequency	Percentage
As New	3	27
Needs Minor Repair	7	64
Needs Reconditioning	1	10
Total	11	100

Table 4.5 presents the aspect of the conditions of the ICT equipment in the university. The majority (64%) of the respondents indicated that ICT equipment needs minor repairs, 27% indicated that ICT equipment were as new, 10% of the respondents argue that ICT equipment needs reconditioning. This reveals that though ICT equipment are in moderate condition and can perform their duties they needs to be maintained with immediate effect to prevent total damage. The respondents were also asked to indicate how he/she assesses risk when using ICT equipment as shown in Table 4.6.

Table 4.6: Risk assessment and rating of the ICT equipment used

Risk Assessment & Rating	Frequency	Percentage
Moderate	7	64
Serious	1	9
Limited	2	18
Negligible	1	9
Total	11	100

Majority (64%) of the respondents thought that the risk of the ICT equipment they use was moderate, 18% thought that the risk of the ICT equipment was limited, 9% though that risk of ICT equipment risk was negligible and the same percent of (9%)

though that risk of ICT equipment risk was serious. Other 27% respondents had different opinions on the risk availability on the ICT they use.

The respondents were requested to give a summary of the frequency at which the university conducts wide preventive maintenance of the ICT equipment as shown in Table 4.7

Table 4.7: Frequency of Conducting Preventive Maintenance

No. of times Preventive Maintenance is carried out	Frequency	Percentage
Nil	2	18.2
Once a year	1	9.1
Twice a year	5	45.5
Quarterly	3	27.3
Total	11	100

Most (45.5%) of the respondents indicated that preventive maintenance was conducted twice a year, 27.3% indicated that preventive maintenance was conducted quarterly, 18.2% had their opinion that no preventive maintenance was being done to ICT equipment while the rest (9.1%) indicated that preventive maintenance was exercised once a year.

In regards to the frequency of failure of the ICT Equipment, the data findings show that majority of the respondents (54.5%) argued that failure of the ICT equipment was low, 45.5% argued that failure rate of the ICT equipment was normal. This depicts that even though the ICT equipments were rated as being in moderate healthy condition and needed minor repairs, they were not prone to failure; this may be due to the preventive maintenance practice done by the ICT department and users.

4.3.3 Corrective Maintenance Measures of the ICT Equipment

The study further aimed at investigating whether the University did corrective maintenance once failure arises. From the findings, majority (55%) of the respondents were in agreement that the University responds to the failure of the ICT equipment once it arises while 46% indicated that the university was reluctant to respond to the failure of ICT equipment. The respondents further indicated that the University on

average takes 1-5 days or up to a month to respond to ICT equipment breakdown. Where it took longer than the required two day turnaround, the reasons given were the bottlenecks in the procurement of spare parts.

4.3.4 Level of Training of User's for ICT Equipment

The finding of the results on the training offered to the users of the ICT equipment at the University show that 54.5 % of the respondents pointed to adequacy in the level of training of the ICT equipment users; while 45.5 % were of the opinion that the level of training offered to ICT users was minimal. This shows that the ICT users in the University are somewhat adequately trained on ICT equipment use. This equips them with skill and competence in the use of equipments, thus mitigating occurrence of breakdowns that might be a result of impropriate use of the equipment.

4.3.5 How the ICT Unit Performs Reliability-Centered Maintenance

The study aimed at investigating whether the University performs Reliability Centered Maintenance. Results of the findings are as shown in the Table 4.8.

Table 4.1: How the ICT Unit Performs Reliability-Centered Maintenance

Statement	Frequency		Percentage	
	Yes	No	Yes	No
Assessing what the item is supposed to do and its associated performance standards	10	1	90.9	9.1
Determine what ways it can fail to provide the required functions	5	6	45.5	54.5
Determine the events that cause failure	10	1	90.9	9.1
Determine what happens when each failure occurs	8	3	72.7	27.3
Determine what way does each failure matter	6	5	54.5	45.5
Determine what systematic task that can be performed proactively to prevent the consequences of the failure	10	1	90.9	9.1
Determine what must be done if a suitable preventive task cannot be found	9	2	81.8	18.2

Majority (90.9%) of the respondents stated that the staff in the ICT department assesses what an item is supposed to do and it's associated performance standards; determine the events that cause failure; and what systematic tasks can be performed proactively to prevent the consequences of the failure. Eighty one percent (81.8%) of the respondents stated that the ICT unit determine what must be done if a suitable preventive task cannot be found; 72.7% argued that staff in the ICT department determine what happens when each failure occurs, 54.5% indicated that ICT staff

determine what way does each ICT equipment failure matter as to prioritize maintenance practice while 45.5% stated that the Department, as 'Reliability-Centered Maintenance' practice, determine in what ways an ICT equipment can fail to provide the required functions so as to develop the required maintenance policy.

CHAPTER FIVE: DISCUSSION, CONCLUSION AND POLICY IMPLICATIONS

5.1 Introduction

This chapter summarizes the finding of the study and makes conclusion based on the results. The policy implications from the findings and areas for further research are also presented in this chapter.

5.2 Summary of the Findings

The main objective of this study was to establish the effectiveness of strategic approaches adopted by University of Nairobi in maintenance of ICT equipments. To achieve the objectives of the study, cross sectional data were collected using structured questionnaire in all ICT units in campuses of University of Nairobi. The target population was the personnel serving these units at various departments at different campuses. From the study findings, it was possible to establish that most of the maintenance practices are applied at the University of Nairobi such as in the inspection and monitoring maintenance policies that is a centralized ICT maintenance policy. Majority of the ICT user in the university conformed to the ICT equipment operating manuals from manufacturers and virus scanning was the most preventive maintenance practice that was accorded to ICT equipment in the university. On the condition of the ICT equipment in the university the study found that most of them needed minor repairs where the user of the equipment thought the risk of the ICT equipment they use was moderate. On frequency at which the university conducts wide preventive maintenance of the ICT equipment, the study established that preventive maintenance was conducted twice a year and their operational failure was low where the university responds to the failure once it arises. On training of ICT equipment users the study found that training was adequate. Further the study found that majority of the staff in the department of ICT mostly use Reliability-Centered Maintenance Model to Assess item that are associated to performance standards and to determine the events that cause failure of ICT equipment.

In regards to the effectiveness of the strategic maintenance practices adopted by the University of Nairobi on its ICT equipment the study found that there was need for a

service contract of the critical ICT equipment in the university. The findings also show an issue of slow response time to failed ICT equipment.

5.3 Conclusions

Based on the findings, the study concludes that the University recognizes the important role of the Maintenance in providing quality services to its users, by ensuring that their equipment are well maintained and repaired in good time. From the findings it can be concluded that there is a centralized maintenance policy which guide the maintenance personnel at the University Central Facility as well as those at the various campuses. The ICT unit does routine maintenance and upgrade of the system.

The ICT equipment at the University are also monitored and maintained regularly and reports generated from time to time. Specifically, in most of the campuses, the ICT equipment are serviced twice a year by the user support staff and recommendations given on required repairs and replacement in obsolete equipments. It was also established that the University in-sources most of the ICT maintenance and repairs as a cost cutting strategy. Operating manuals from manufacturers are adhered to in terms of in terms of frequency and method of maintenance. However, this does not deter the ICT unit from providing services on ICT equipment are provided on need/request-basis For instance, on computers, the Operating systems (OS) are configured optimally and antivirus installed and updated regularly. Besides that, virus scanning is conducted on ICT equipment weekly while in some campuses, the same is done on a daily basis. Other maintenance practices include: backup of /deleting unnecessary data, equipment cleaning and other software upgrade and update.

It is also concluded that though the University conducted thorough preventive maintenance twice a year, the response time in doing corrective maintenance on ICT equipments breakdown was taking too long in some cases taking one month. Critical equipment not supportable by ICT Units is placed on maintenance contracts.

The University also conducts adequate training of ICT equipment. According to the University's Maintenance manual, External ICT training shall be organized by the ICTC in response to need, while internal ICT user training targeting the university community shall be scheduled on a continuous basis. The study also concluded that majority of staffs in department of ICT use Reliability-Centered Maintenance Model

to assess items that are associated to performance standards and to determine the events that cause failure of ICT equipment.

5.4 Recommendations

5.4.1 Recommendations on the Policy Implications

Based on the findings of this study, the following are recommended, foremost that maintenance policy to both be centralized and decentralized. This would reduce slow response to failure/corrective action on failed ICT equipment. Decentralization would enable focus attention to campus-specific ICT maintenance while centralization streamlines the ICT maintenance practices. These would encourage both independent and discretionary decision making whenever the failure occurs and inspection and monitoring of the ICT equipment to be done frequently in order to mitigate the occurrence of the breakdown that might be caused by delayed maintenance.

Secondly the University can obtain on leasehold some of the ICT equipments it finds hard or too complex to maintain. This would substantially eradicate the need to outsource contracting of maintenance of such equipment. Equally, the University can consider employment of staff qualified enough to conduct such maintenance; the staff function can be merged with the mainstream maintenance team to avert or reduce the expenses incurred in outsourcing such functions. Lastly the study recommends that maintenance of the equipment to be practiced at least twice in a year. Such frequent practices include antivirus update and scanning which can be done on daily instead of weekly basis.

5.4.2 Recommendations for Further Studies

The study focused on the effectiveness of strategic maintenance approaches adopted by the University of Nairobi on its ICT equipment. It is therefore recommended that further research should be done on the effectiveness of strategic approaches adopted in other sectors apart from learning institution in order to depict a reliable result in all sectors. The study also recommends that a comparative empirical analysis should be done on the measure of effectiveness of strategic approaches adopted by the ICT department in the public sector and private sector so as to reveal comparative strategies.

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APPENDICES

Appendix I: Letter of Introduction

To: ……..

Dear Respondent

REF: REQUEST FOR RESEARCH DATA COLLECTION

I am a Master in Business Administration, student at the University of Nairobi and currently conducting a research on "The effectiveness of Strategic Approaches Adopted by University of Nairobi in Maintenance of Information Communication Technology (ICT) Equipment".

You have been identified as a potential respondent in this study being in a suitable position to provide the most reliable information on the same. Please respond to all questions as appropriate either by tick or writing your answer on the space provided using you best estimates. This is an academic research and the answers you supply will be treated in utmost confidence and propriety.

Thank you for your co-operation,

Yours Faithfully,

MICHAELINA ALMAZ YOHANNIS

D61/70035/2008

Appendix II: Questionnaire
Kindly fill in the questionnaire provided on the spaces provided or indicate tick.

1. Indicate the campus you are located at.....

2. What is your gender?
   Male [ ] Female [ ]

3. In which ICT units (office) are you current working at?
   …….

4. Kindly indicate your highest level of education? (Tick as applicable)
   Certificate [ ]
   Diploma [ ]
   Bachelors Degree [ ]
   Postgraduate Degree [ ]
   Masters Degree [ ]
   Others (specify) ……

5. Kindly indicate the number of years in service/working period in ICT department within the University?
   0-5 yrs [ ] 5-10 yrs [ ]
   10-15 yrs [ ] 15 yrs and above [ ]

SECTION B: MAINTENANCE OF ICT EQUIPMENT

6. Do you have inspection and monitoring maintenance policies of ICT equipment?
   Yes [ ] No [ ]

   a. If yes, what does it state:
   ……
   ……
   ……

7. Is there an existing service contractor to do the maintenance?
   Yes [ ] No [ ]

   a. Who has been doing ICT equipment maintenance?
   ……
   ……
   ……
   b. Does each ICT office/Unit have a maintenance policy or practices, or is it centralized?
   Have their own [ ] Centralized [ ] Other
   ……..

8. In case of computers, are operating systems configured optimally, antivirus installed and updated frequently?
   Yes [ ] No [ ]

9. Do you conform to the ICT equipment operating manuals from manufacturers in daily operations of the equipments?
   Yes [ ] No [ ]

10. What preventive maintenance practices does the unit accord ICT equipments? (Tick all that applies); 1 = never, 2 =annually, 3=semi-annually, 4=quarterly, 5=bi-monthly, 6=monthly, 7=weekly, 8=daily.

Maintenance	1	2	3	4	5	6	7	8
Checking System Firewalling								
Software upgrade/update								
Hardware upgrade								
Virus scanning								
Periodic Diagnostics								
Greasing								
Backup of /deleting unnecessary data								
Cleaning								

Any Other Specify:
……
……

11. On average, what is the condition of the ICT equipments at the University?
    As new [ ] Needs Minor repairs [ ]
    Needs Major repairs [ ] Needs reconditioning [ ]
    Scrap /Replace [ ]

12. In your own risk assessment, how do you rate the ICT equipments you use?
    Catastrophic [ ] Serious [ ]
    Moderate [ ] Limited [ ]
    Negligible [ ]

13. How frequently does the University conduct an institution-wide preventive maintenance of the ICT equipments?
    Nil [ ] Once a year [ ]
    Twice a year [ ] Quarterly [ ]
    Monthly [ ]

14. Generally, what is the frequency of failure of the ICT equipments?
    No mechanical required [ ] Low [ ]
    Normal [ ] High [ ]
    Very High [ ]

15. Does the university do corrective maintenance once failure arises?
    Yes [ ] No [ ]

a. On average, how long does it take ……

16. What is the level of training of the people who use the University's ICT equipments?
    None [ ] Minimal [ ]

Adequate [ ] Highly trained [ ]

17. Based on reliability-centered maintenance model, does the ICT staff perform the following analysis:

Statement	Yes	No
Assessing what the item supposed to do and its associated performance standards		
Determine what ways it can fail to provide the required functions		
Determine the events that cause failure		
Determine what happens when each failure occurs?		
Determine what way does each failure matter		
Determine what systematic task that can be performed proactively to prevent the consequences of the failure		
Determine what must be done if a suitable preventive task cannot be found		

18. What would you recommend should be done to improve maintenance procedures of the ICT equipments?

……
……
……
……

THANKS FOR YOUR PARTICIPATION

Appendix III: ICT Units at the University of Nairobi

Main Campus

Chiromo Campus

Lower Kabete Campus

Upper Kabete Campus

Kikuyu Campus

Kenya Science Campus

Parklands Campus

Kisumu Campus

Mombasa Campus

Architecture, Design and Development (ADD)

Student Welfare Authority (SWA)

Estates Department

Kenyatta Campus

Appendix IV: List of Tables