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Technology management program – as part of hospitals strategic planning (case study Khartoum state public hospitals)

برنامج إدارة التكنولوجيا ضمن إدارة التخطيط الاستراتيجي

(دراسة حالة: المستشفيات المرجعية بولاية الخرطوم)

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Dedication

To my father and my mother… No words can describe my gratitude and love….

To Mohamed Dhahir my soulmate

To the apple of my eye Abd-Elkareem…

To family and friends…

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I wish to express my most sincere gratitude to my supervisor, Dr.Fragoon M. Ahmed, for his encouragement, guidance, assistance, patience.

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Abstract

Technology including medical devices represents an essential investment in healthcare facilities; technology management therefore is a milestone in healthcare strategic planning, this research aimed to highlight the importance of technology planning and the role of clinical engineering profession in technology management.

The research investigated the presence of technology management program as part of healthcare strategic planning in some of Khartoum state public general hospitals and questioned the contribution of clinical engineers in these activities.

Simple questionnaire was presented to engineers working in the targeted hospitals and the responses were collected and analyzed; it resulted that all the clinical engineering department of the targeted hospitals do not have strategic plan elements. 66.7% could identify the essential clinical engineering services within technology management program.

المستخلص

المؤسسات الصحية تستثمر الكثير من الموارد المالية و البشرية في الأجهزة و المعدات الطبية

لذلك يعد التخطيط الإستراتيجي لإدارة التكنولوجيا من أركان التخطيط الإستراتيجي للمؤسسة الصحية , هذا البحث عمد لتسليط الضوء على أهمية ممارسة التخطيط في إدارة التكنولوجيا و الدور الذي تقوم به مهنة الهندسة الطبية في هذه النشاطات.

استعلم الباحث عن وجود برنامج إدارة التكنولوجيا كجزء من التخطيط الإستراتيجي و المساهمة التي يقدمها قسم الهندسة الطبية الحيوية في هذا البرنامج في بعض من المستشفيات الحكومية العامة بولاية الخرطوم و عددها ست مستشفيات تحوي قسم داخلي للهندسة الطبية.

استخدم الباحث استبيان وجه إلى المهندسين الطبيين في المستشفيات المعنية و بعد تحليل الاستبيان ببرنامج (إس بي إس إس) النسخة رقم 20 خلص الباحث إلى إن جميع أقسام الهندسة الطبية في المستشفيات المعنية لم يكن لديها خطة إستراتجية معرفة وأن 66.7% من العينة تمكنت من تعريف العناصر الأساسية في برنامج إدارة التكنولوجيا.

CHAPTER ONE

1. INTRODUCTION

1.1 background:

In healthcare the increases in the size of the population, their needs and the diagnostic and treatment options has led to physical growth in the size of hospitals and increased organizational complexity beside the professional and skilled competitors along with limited resources all these circumstances clearly affect hospitals, immersing them in an environment of constant and sudden change both externally and internally rising the need for strategic planning as an applicable tool that is both useful and relevant to healthcare facilities.

Strategy is a plan or courses of action that help managers attain the organization's goals. In strategic thinking an organization's managers purse the organization's mission.

Strategies is needed for enhancing the market share or achieving competitive advantage, satisfy customers better than the peers by providing better services; a strategy is successful, if it results in superior performance and competitive advantage.

Strategic management is identifying and describing the strategies that managers can purse to attain superior performance and competitive advantage for the organization. The strategic management process mainly consists of three phases. starting from the formulation of strategies and that's by setting and identifying major goals and objectives, secondly analyzing the internal and the external environments by performing

SWOT (strength and weaknesses , opportunities and threats) analysis, internal analysis pinpoint the strengths and weaknesses of the organization as well as defining the quantity and/or quality of the resources needed and their availability while the external analysis identifies strategic opportunities and threats of the organization which affect how it purse its mission, thirdly Best utilization and deployment of the resources guide the organization to earn capabilities (intangible assets). Earning capabilities means that the organization has unique attributes and characteristics or skills that advance its competitors. The core competencies are the source of the organization competitive advantage which requires the organization to achieve superior efficiency, innovation and quality.

Having chosen a set of strategies that will achieve sustainable competitive advantage and superior performance, and then those strategies must be put into actions. Implementation stage refers to how organizations should create, use, and combine the organization structure, the control system and corporate culture and polices and administrations. The choice of the strategy is considered by the ability to alert past resource commitment, organization structure, polices and administrations.

Strategic planning is an ongoing activity, it never ends. Once a strategy has been implemented, its execution must be evaluated to determine the extent to which strategic goals and objectives are actually being achieved and to what degree competitive advantage is achieved and superior performance is realized and sustained.

The research addressed the need for strategy in public hospitals of Khartoum state – Sudan, especially in managing healthcare technology

and recommended more involvement of clinical engineers in planning and managing medical technology.

1.2 Research problem:

The challenge of maintaining balance between quality of care -which involve adopting new medical technologies- on hand and cost effectiveness and financial gain on another hand beside the continually changing environment of healthcare and increasing competence; are facing all healthcare providers, the researcher means to address strategic planning as proposed solution for this situation and the contribution of clinical engineering in planning the technology within the general plan of hospital.

1.3 Research main objective:

This research aims to highlight the importance of strategic planning and technology management program and to investigate clinical engineer role in this processes.

1.4 Research specific objectives:

1. The research aims to investigate the presence of strategic planning and technology management program in some of Khartoum state hospitals
2. And measure the contribution of clinical engineering department in strategic planning and technology management program.

1.4 Thesis layout:

Chapter one provided general introduction to strategic planning, chapter two is the theoretical background and literature review, chapter three is the research methodology, chapter four is results and discussion and chapter five is the conclusion and recommendation.

CHAPTER TWO

2.Theoretical Background:

2.1 Background: Clinical Engineering

2.1.1 History and Evolution of Clinical Engineering:

The twentieth century has seen technological innovation that has reshaped the field of medicine and the delivery of healthcare services. Advances in medical technology have provided a wide range of diagnostic, therapeutic and rehabilitative instruments that are now routinely used in the treatment and management of specific illnesses and diseases [1].

2.1.2 Emergent Need for Clinical Engineering:

The period after World War II, particularly in the 1960s, saw the beginnings of unprecedented advances in electronic instrumentation and the marriage of particular engineering fields with the medical field. This resulted in various innovations, including the intensive-care unit (l.C.U.), the open-heart operation, the artificial organ and computerized electrocardiography [2].

Unlike industrial and scientific users, the healthcare delivery system was initially ill-prepared to manage this new technology [3].

On November 16th 1970, an article reporting "1200 Silent Electrocutions in American Hospitals appeared in The Wall Street Journal, subsequently launching an equipment safety scare. Hospitals and industry thus

responded through various voluntary regulatory groups that randomly and hastily devised codes, standards and guidelines. A new engineering discipline was needed to provide the technical support necessary to meet the new safety requirements. In response to these newly defined needs, the clinical engineering profession was born [3].

2.1.3 Evolution of Clinical Engineering:

Clinical engineering evolved from being primarily concerned with patient and user electrical safety in the early 1970s, to assuming responsibility for cost-effective maintenance, then equipment evaluation and procurement in the mid-1970s. According to Newhouse et al. by this time it was revealed that many devices did not perform according to manufacturers' specifications or users' expectations. Complete performance inspections before and after medical equipment installation became the norm, and much time was spent in developing sensible inspection procedures.

By the early 1980s, the health care delivery industry's increased concern over the cost, safety and performance of medical equipment caused many hospitals to rely heavily on clinical engineering departments for the selection and support of medical instrumentation [3].

Clinical engineering departments became the logical support centre for all medical technologies .in 1990s Clinical engineers assumed additional responsibilities, including the management of complex devices and systems used in hospitals; the training of medical personnel in equipment use and safety; and the design, selection and use of technology to deliver safe and effective health-care [1].

In recent years' clinical engineers provide extensive engineering services for the clinical staff and have been increasingly accepted as valuable team members by physicians, nurses, and other clinical professionals. Furthermore, the acceptance of clinical engineers in the hospital setting has led to different types of engineering-medicine interactions, which in turn have improved health care delivery [1].

2.1.4 Definition of Clinical Engineering:

In keeping with the evolution of the field, the definition of clinical engineering has also evolved with time. Several definitions exist, "The application of the art and science of industry, that is, technology, to healthcare delivery and clinical problems in medicine"[2].

Goodman quotes a definition of a clinical engineer, which the AAMI originally applied to certified practitioners as:

"A professional who brings to healthcare facilities a level of education, experience and accomplishment which will enable him to responsibly, effectively and safely manage and interface with medical device, instruments and systems, and the user thereof during patient care ... "[4].

COHSASA defines the field as:"Medical equipment management and maintenance and equipment user support within a healthcare delivery institution or system"[5].

A more recent definition reads:

"The management, support, development and quality assurance of

healthcare technology as part of safe, cost-effective and sustainable

healthcare delivery" [6].

According to the definition of the American College of Clinical Engineering (ACCE) “a clinical engineer is a professional who supports and advances patient care by applying engineering and managerial skills to healthcare technology”

The terms 'clinical engineering' and 'biomedical engineering' are sometimes used interchangeably, although several authors provide distinctions between the two. Units responsible for providing clinical engineering services are also known as Health Care Technical Services, Medical Physics Departments, Biomedical Technology, Engineering Services, Medical Apparatus, Equipment Workshops, etc. [1].

Individuals involved in the management of medical technology are commonly referred to as clinical engineers; however, the terms biomedical equipment technicians, equipment managers and healthcare engineers are sometimes used [7].

Biomedical engineers may work primarily in one or a combination of the following fields:

• Bioinformatics – developing and using computer tools to collect and analyze data.

• Bioinstrumentation – applying electronic and measurement techniques.

• Biomaterials – developing durable materials that are compatible with a biological environment.

• Biomechanics - applying knowledge of mechanics to biological or medical problems.

• Bio-Nano-engineering – developing novel structures of nanometer dimensions for application to biology, drug delivery, molecular diagnostics, Microsystems and Nano systems.

• bio photonics – applying and manipulating light, usually laser light, for sensing or imaging properties of biological tissue.

• Cellular and tissue engineering – studying the anatomy, biochemistry and mechanics of cellular and sub-cellular structures, developing technology to repair, replace or regenerate living tissues and developing methods for controlling cell and tissue growth in the laboratory.

• Clinical engineering – applying the latest technology to health care and health care systems in hospitals.

• Genomics and genetic engineering – mapping, sequencing and analyzing genomes (DNA), and applying molecular biology methods to manipulate the genetic material of cells, viruses and organisms.

• Medical or biological imaging – combining knowledge of a physical phenomenon (for example, sound, radiation or magnetism) with electronic processing, analysis and display.

• Molecular bioengineering – designing molecules for biomedical purposes and applying computational methods for simulating bio molecular interactions.

• Systems physiology - studying how systems function in living organisms.

• Therapeutic engineering – developing and discovering drugs and advanced materials and techniques for delivering drugs to local tissues with minimized side effects [8].

2.1.5 Clinical Engineering Programs Today:

Clinical engineers nowadays are facing a lot of challenges hence clinical engineering as a part of healthcare providing system is affected by multiple factors include administrative, clinical, financial, and regulatory parameters that influence how the integration of medical technological tools are planned for, funded, and executed. It also guides how these tools are selected, installed, trained for, integrated, safely operated, serviced, upgraded, and retired or replaced. These are essentially the phases of all technology, including medical technology. The application of knowledge about the optimal management of various life-cycle phases of capital assets will maximize system utilization during each one of the phases [3].

In biomedical engineering department engineers are usually involved in the following core functions:

3. Technology management (including specification, evaluation, installation and support of technology, and review of equipment replacement needs)
4. Technology assessment (assessment of clinical efficacy, safety, appropriateness and cost benefits and monitoring of emerging technologies)
5. Asset/inventory management
6. Risk management and safety (reducing technology-related patient and staff incidents)
7. Preventive maintenance and repair
8. Project management

9. Quality assurance and improvement
10. Training equipment users
11. Management of service contracts
12. Clinical research and development; modification of medical devices
13. Project management

In some cases, the role would also include Management and Maintenance of Facilities and Plant Telecommunications and Information Technology systems [9].

2.2 A background to developments in healthcare technology management HTM:

The World Health Organization (WHO) uses the broader term ‘health technology’, which it defines as including: ‘devices, drugs, medical and surgical procedures – and the knowledge associated with these – used in the prevention, diagnosis and treatment of disease as well as in rehabilitation, and the organizational and supportive systems within which care is provided’ [10].

The healthcare delivery system presents a very complex environment where strategy, facilities, equipment, drugs, information, and the full range of human interventions are interacting. It is in this clinical environment that patients in various conditions, staff, temporary skilled labor, and the wide variety of technology converge. The technology that has been developed for and is deployed in the healthcare delivery system ranges from the “smart” facilities within which care is being provided to the products that are used around the provision of healthcare services and

to its regulation and management. Technology means merely the use of tools; that is, the involvement of any agent which assists in the performance of a task. Of all the factors and resources that will shape the future of the health of mankind, the one that most often stretches the imagination is medical technology from this view the need of technology management program and strategic planning was crucially important in healthcare providing systems [5].

2.2.1 Functions of (HTM):

According to WHO guides for health care technology management ‘’(HTM) involves the organization and coordination of all of the following activities, which ensure the successful management of technology:

- Gathering reliable information about medical equipment.
- Planning technology needs and allocating sufficient funds for them.
- Purchasing suitable models and installing them effectively.
- Providing sufficient resources for their use.
- Operating them effectively and safely.
- Maintaining and repairing the equipment.
- Decommissioning, disposing, and replacing unsafe and obsolete items.
- Ensuring staff have the right skills to get the best use out of the equipment.

2.2.2 The creation of sophisticated biomedical technology programs:

The creation of sophisticated biomedical technology programs was not noted until 1971, when an article describing the technology-related hazards patients faced while being treated in US hospitals was published by R. Nader 1971, It suggested that 1,200 patients were injured in US hospitals from small amounts of electrical energy known as micro shock. The public, government and accreditation and regulatory agencies applied pressure to correct the situation and demanded safer environment. Skilled clinical engineers rose to the occasion and met the challenge by providing competent technology services. This was the beginning of the biomedical technology management program [12].

Technology management program is critical for sustainment of operations since it is deployed in life critical environment dependent upon complex integration of legacy and new systems, on direct and derived physiological measurements, on tethered and wireless environment, on utilities unpredictable conditions in addition to variances among user's competency, work processes and cultures from one hospital to another [3].

2.2.3 Medical equipment management definition:

Healthcare Technology Management (also referred to as biomed, biomedical engineering, bio-medical engineering, biomedical equipment management, biomedical equipment services, biomedical maintenance, clinical engineering, clinical engineering management, clinical equipment management, clinical technology management, clinical technology services, medical equipment management, and medical equipment repair), as a fundamental part of managing, maintaining, and/or designing medical devices used or proposed for use in various healthcare settings from the home, the field, the doctor's office, and the hospital. It includes

the business processes used in interaction and oversight of the medical equipment involved in the diagnosis, treatment, and monitoring of patients. The related policies and procedures govern activities such as the selection, planning, and acquisition of medical devices, incoming inspection, acceptance, maintenance, and eventual retirement and disposal of medical equipment. Medical equipment management is a recognized profession within the medical logistics domain. The healthcare technology management professional's purpose is to ensure that equipment and systems used in patient care are operational, safe, and properly configured to meet the mission of the healthcare; that the equipment is used in an effective way consistent with the highest standards of care by educating the healthcare provider, equipment user, and patient; that the equipment is designed to limit the potential for loss, harm, or damage to the patient, provider, visitor, and facilities through various means of analysis prior to and during acquisition monitoring and foreseeing problems during the lifecycle of the equipment, and collaborating with the parties who manufacturer, design, regulate, or recommend safe medical devices and systems [4].

Healthcare technology management professional's functions are:

- Equipment Control & Asset Management
- Equipment Inventories
- Work Order Management
- Data Quality Management
- Equipment Maintenance Management
- Equipment Maintenance

- Personnel Management
- Quality Assurance
- Patient Safety
- Risk Management
- Hospital Safety Programs
- Radiation Safety
- Medical Gas Systems
- In-Service Education & Training
- Accident Investigation
- Analysis of Failures, Root-Causes, and Human Factors
- Safe Medical Devices Act (SMDA) of 1990
- Health Insurance Portability and Accountability Act (HIPAA)
- Careers in Facilities Management

Every medical treatment facility should have policies and processes on equipment control & asset management. Equipment control and asset management involves the management of medical devices within a facility and may be supported by automated information systems. Equipment control begins with the receipt of a newly acquired equipment item and continues through the item's entire life-cycle. Newly acquired devices should be inspected by in-house or contracted Biomedical Equipment Technicians (BMETs), who will receive an established equipment control/asset number from the facilities Equipment/Property

Manager. It is similar to creating a new chart for a new patient that will be seen at the medical facility. Once an equipment control number is established, the device is safety inspected and readied for delivery to clinical and treatment areas in the facility. Facilities or healthcare delivery networks may rely on a combination of equipment service providers such as manufacturers, third party services, in-house technicians, and remote support. Equipment managers are responsible for continuous oversight and responsibility for ensuring safe and effective equipment performance through full service maintenance. Medical equipment managers are also responsible for technology assessment, planning and management in all areas within a medical treatment facility (e.g. developing policies and procedures for the medical equipment management plan, identifying trends and the need for staff education, resolution of defective biomedical equipment issues [5].

This industry is new, and there is not a clear line between IT and Bio med.

Work order management involves systematic, measurable, and traceable methods to all acceptance/initial inspections, preventive maintenance, and calibrations, or repairs by generating scheduled and unscheduled work orders. Work order management may be paper-based or computer-base and includes the maintenance of active (open or uncompleted) and completed work orders which provide a comprehensive maintenance history of all medical equipment devices used in the diagnosis, treatment, and management of patients. Work order management includes all safety, preventive, calibration, test, and repair services performed on all such medical devices. A comprehensive work order management system can also be used as a resource and workload management tool by managers responsible for personnel time, total number of hour’s technician spent

working on equipment, maximum repair dollar for one time repair, or total dollar allowed spending repairing equipment versus replacement. Post-work order quality checks involve one of two methods: 100% audit of all work orders or statistical sampling of randomly selected work orders. Randomly selected work orders should place more stringent statistical controls based on the clinical criticality of the device involved. For example, 100% of items critical to patient treatment but only 50% of ancillary items may be selected for sampling. In an ideal setting, all work orders are checked, but available resources may dictate a less comprehensive approach. Work orders must be tracked regularly and all discrepancies must be corrected. Managers are responsible to identify equipment location.

Accurate, comprehensive data are needed in any automated medical equipment management system. Data quality initiatives can help to insure the accuracy of clinical/biomedical engineering data. The data needed to establish basic, accurate, maintainable automated records for medical equipment management includes: nomenclature, manufacturer, nameplate model, serial number, acquisition cost, condition code, and maintenance assessment. Other useful data could include: warranty, location, other contractor agencies, scheduled maintenance due dates, and intervals. These fields are vital to ensure appropriate maintenance is performed, equipment is accounted for, and devices are safe for use in patient care.

- Nomenclature: It defines what the device is, how, and the type of maintenance is to be performed. Common nomenclature systems are taken directly from the Emergency Care Research Institute (ECRI) Universal Medical Device Nomenclature System.

• Manufacturer: This is the name of the company that received approval from the FDA to sell the device, also known as the Original Equipment Manufacturer (OEM).

• Nameplate model: The model number is typically located on the front/behind of the equipment or on the cover of the service manual and is provided by the OEM

• Serial number: This is usually found on the data plate as well, is a serialized number (could contain alpha characters) provided by the manufacturer. This number is crucial to device alerts and recalls.

• Acquisition cost: The total purchase price for an individual item or system. This cost should include installation, shipping, and other associated costs. These numbers are crucial for budgeting, maintenance expenditures, and depreciation reporting.

• Condition code: This code is mainly used when an item is turned in and should be changed when there are major changes to the device that could affect whether or not an item should be salvaged, destroyed, or used by another Medical Treatment Facility.

• Maintenance assessment: This assessment must be validated every time a BMET performs any kind of maintenance on a device.

Several other management tools, such as equipment replacement planning and budgeting, depreciation calculations, and at the local level literature, repair parts, and supplies are directly related to one or more of these fundamental basics. Data Quality must be tracked monthly and all discrepancies must be corrected.

2.2.4 Healthcare Technology Management's Place in the Health System:

All health service providers want to get the most out of their investments. To enable them to do so, they need to actively manage health service assets, ensuring that they are used efficiently and optimally. All management takes place in the context of health system's policies and finances. If these are favorable, the management of health service assets can be effective and efficient, and this will lead to improvements in the quality and quantity of healthcare delivered, without an increase in costs.

The health service's most valuable assets which must be managed are its human resources, physical assets, and other resources such as supplies. Physical assets such as facilities and healthcare technology are the greatest capital expenditure in any health sector. Thus it makes financial sense to manage these valuable resources, and to ensure that healthcare technology

is selected appropriately, is used correctly and to maximum capacity and do last as long as possible.

Such effective and appropriate management of healthcare technology will contribute to improved efficiency within the health sector. This will result in improved and increased health outcomes, more sustainable health service.

in further details benefits of healthcare technology management (HTM) are:

- Health facilities can deliver a full service, unimpeded by non-functioning healthcare technology.

- Equipment is properly utilized, maintained, and safeguarded.
- Staff makes maximum use of equipment, by following written procedures and good practice.

Health service providers are given comprehensive, timely, and reliable information on:

1- The functional status of the equipment

2- The performance of the maintenance services

3- The operational skills and practice of equipment-user departments

4- The skills and practice of staff responsible for various equipment-related activities in a range of departments including finance, purchasing, stores, and human resources.

- Staff control the huge financial investment in equipment, and this can lead to a more effective and efficient healthcare service [13].

The mismanagement of physical assets impacts on the quality, efficiency and sustainability of health services at all levels; in a tertiary hospital setting with sophisticated life-support equipment, or at the primary healthcare level where simple equipment is needed for effective diagnosis and safe treatment of patients. What is vital – at all levels and at all times – is a critical mass of affordable, appropriate, and properly functioning equipment used and applied correctly by competent personnel, with minimal risk to their patients and to themselves. Clear policy, technical guidance, and practical tools are needed for effective and efficient management of healthcare technology for it to impact on priority health problems and the health system's capacity to adequately respond to health needs and

expectations. On another hand good management practices will create sustainable circumstances for healthcare technology. To achieve this, healthcare facilities will need to plan and budget for the regular replacement of equipment, effective maintenance, and training needs. [14]

2.3 A background to strategic planning:

Strategic planning is a process that brings to life the mission and vision of the enterprise. A strategic plan, well-crafted and of value, is driven from the top down; considers the internal and external environment around the business; is the work of the managers of the business; and is communicated to all the business stakeholders, both inside and outside of the company.

As a company grows and as the business environment becomes more complex the need for strategic planning becomes greater. There is a need for all people in the corporation to understand the direction and mission of the business.

Companies consistently applying a disciplined approach to strategic planning are better prepared to evolve as the market changes and as different market segments require different needs for the products or services of the company.

The benefit of the discipline that develops from the process of strategic planning, leads to improved communication. It facilitates effective decision-making, better selection of tactical options and leads to a higher probability of achieving the owners' or stakeholders' goals and objectives [15].

Positioning the organization for the future is the purpose of strategic planning. The strategic planning process provides a system with the ability to determine its future and achieve it.

2.3.1 Definition of strategic planning:

The concept of strategy has roots in both political and military history, the word strategy comes from the Greek ‘stratego’, which means “to plan the destruction of one’s enemies through effective use of resources [16].

Many terms associated with strategic planning, such as objective, mission, strength, and weakness, were developed by or used in the military [17].

A number of definitions have evolved to pinpoint the essence of strategic planning. According to (Ginter, 2008), “strategic planning defines where the organization is going, sometimes where it is not going, and provides focus. The plan sets direction for the organization and—through a common understanding of the vision and broad strategic goals—provides a template for everyone in the organization to make consistent decisions that move the organization toward its envisioned future. Strategic planning, in large part, is a decision-making activity.”

(Beckham, 2000) describes true strategy as “a plan for getting from a point in the present to some point in the future in the face of uncertainty and resistance.” (Campbell, 1993) adds the concept of measurement to his definition: “Strategic planning refers to a process for defining organizational objectives, implementing strategies to achieve those objectives, and measuring the effectiveness of those strategies.”

According to (Evashwick, 1988) Strategic planning incorporating the concepts of vision and mission, define strategic planning as “the process

for assessing a changing environment to create a vision of the future; determining how the organization fits into the anticipated environment based on its institutional mission, strengths, and weaknesses; and then setting in motion a plan of action to position the organization accordingly." [18].

2.3.2 Core principles for effective strategic planning:

Five elements comprise a strategic plan:

- Define mission, vision, activities and values
- Scan the environment using a SWOT analysis
- Identify and prioritize strategic issues
- Define strategic goals and objectives
- Establish an implementation plan and schedule

Whichever methods the organization use for strategic planning and whichever process it follows, experience suggests a number of core principles needed for an effective process:

- Ensure leadership driving:

Nothing will happen if the Organization's leadership are not driving the process. Acquiescence to a suggestion from outside is not enough. Leaders have to be fully one board as strategic planning usually involves organisational change. This can be a profoundly sensitive process, as an organisation's past strategies are often a reflection of what the leadership thinks are best. To bring authentic strategic change may require leaders to change their views; their priorities and even themselves.

- Get staff ownership:

Any organizational change, including strategic planning, is a human process of change. It can be emotional and painful. Some people will see themselves as winning; others losing. Staff needs to be encouraged to look to the interests of the whole organization, not just their particular departments. In the end, it is the staff who will ensure the new strategy is implemented (or not). They have to believe in its value, if they are to go through the pain of change.

- Listen and learn:

(Particularly to beneficiaries) Strategic planning is about listening and learning. It is essential to learn from past experience – basing future decisions on the findings of past evaluations. Evaluations and strategic planning should always be interlinked.

It is also particularly vital to take the opportunity to listen to beneficiaries. It is also about learning from others' experience. There is often no need to reinvent wheels, as other Organizations may have already learnt a lot about what works. For many faith-based organizations, they may also leave space for reflection and spiritual discernment about the way ahead.

- Make hard choices:

Strategic planning is about prioritizing. It is about letting things go; about avoiding the temptation to simply add to the shopping list. There may be a need to close down programs and perhaps have strategic funerals to celebrate elements of your work that have been good, but are no longer a priority. It may be important to mark endings. In a changing environment, prioritization is crucial so that we can 'take change by the hand and lead

it where we want to go, rather than waiting for it to grab us by the throat and drag us where we don't want to go.'[19].

- Keep it simple

A good strategic plan is accessible and succinct. It often helps if you are able to characterize strategic choices with some sort of metaphor or image.

Learning from the Survivor's Fund One small UK NGO highlighted ten key lessons for strategic planning:

- Learn from others:

  Look widely at the strategic plans of organizations of a similar size, with similar work or with a similar geographical focus.

- Consult widely:

  First consult with the Board, partners and then staff.

- Regularly review the plan:

  Ensure that during the course of the plan, regular views take place to ensure it remains relevant.

- Should be practical:

  It is enough to work out an operational plan from it.

- Publishing and sharing the plan:

  Once developed, the plan should be published and share beyond the board and staff.

- Process is as important as product.

- It should be succinct and easy to remember
- It should be contextualized, including to the funding environment Aligned: making clear choices and priorities
- Ask difficult questions:

  This can be particularly difficult for founder directors or those with strong vested interests [20].

2.3.3 Strategic planning in healthcare:

Strategic planning is the process of determining what an organization wants to be in the future and how it will get there. Hospitals that develop and implement strategic plans tend to be more successful than those that don't.

Strategic planning is different from short-term or operational planning. Operational planning usually focuses on an annual cycle and requires the development of yearly objectives and plans. This becomes part of the annual budgeting process. Operational plans lay out how the hospital will move toward its future during that year. The future is described in the hospital's strategic plan.

Strategic planning requires that choices be made about hospital's future. These choices concern vision and mission, the goals to be pursued, what services will be offered and to whom, the resources that will be needed (people, facilities, technology, money and knowledge) and how they will be acquired [21].

(Bellenfant and Nelson,2010) wrote, “Those organizations that look to the future, by planning and evolving to meet expected changes head on, will have a better chance of survival. Strategic planning has added value to hospitals that are looking for ways to protect their financial viability while adapting to the ever-changing environment around them.”

Rapidly changing technology; increasing competition from physician entrepreneurs and private sector healthcare providers; and the looming shortage of physicians, nurses, and other healthcare professionals will also contribute an element of uncertainty to the healthcare environment. Healthcare organizations with comprehensive, sound strategic plans will be best positioned to respond with contingency plans as change emerges [22].

2.3.4 The Strategic Planning Process:

Many variations of a strategic planning model have emerged in the business and healthcare communities, but the basic model remains relatively unchanged. Two similar approaches to strategic planning were developed in the 1980s. The first, documented by Sorkin, Ferris, and Hudak (1984) features the following steps:

- Scan the environment
- Select key issues
- Set a mission statement and broad goals
- Undertake external and internal analyses
- Develop goals, objectives, and strategies for each issue
- Develop an implementation plan to carry out strategic actions

- Monitor, update, and scan

The second was tailored to healthcare and included these steps (Simyar, Lloyd-Jones, and Caro 1988):

- Identify the organization's current position, including present mission, long-term objectives, strategies, and policies
- Analyze the environment
- Conduct an organizational audit
- Identify the various alternative strategies based on relevant data
- Select the best alternative
- Gain acceptance
- Prepare long-range and short-range plans to support and carry out the strategy
- Implement the plan and conduct an ongoing evaluation

Zuckerman developed a synthesis model for the strategic planning process in healthcare. The figure below illustrates this model:

The first stage is the environmental assessment, which focuses on the question, where are we now? It includes four activities:

1. Organizational review, including mission, philosophy, and culture

2. External assessment

3. Internal assessment

4. Evaluation of competitive position, including advantages and disadvantages.

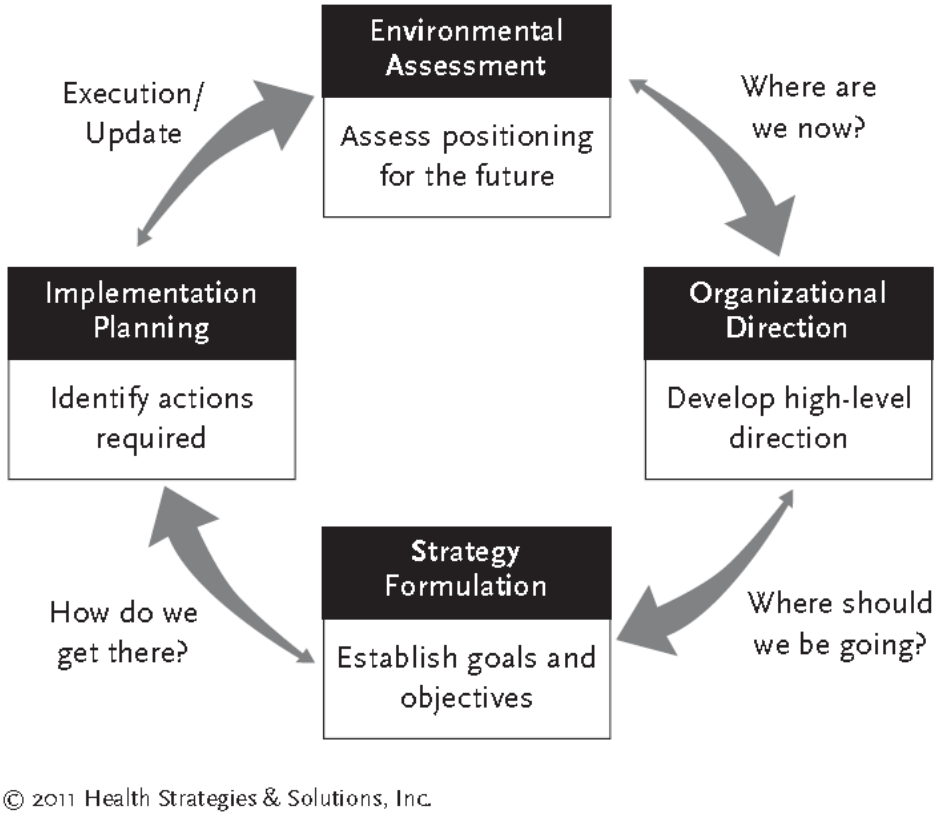

Figure 1: four stage strategic planning model by Zuckerman 2011

The second stage of the planning process is organizational direction, followed by the third stage, strategy formulation. Stages two and three address the question, where should we be going? The main activity of the organizational direction stage is to develop a future strategic profile by examining alternative futures, mission, vision, values, and key strategies for the organization. Strategy formulation establishes goals, objectives, and major initiatives for the organization.

In this stage the healthcare organization defines:

- The organizational core values or operating principles – those beliefs or principles that guide the organization; these values are shared by Board and staff, strongly held, and not easily changed.

- Community Vision – your vision for the community; it might be viewed as the image of what the community the organization serve would be like if its values were shared and practiced by everyone. Note that this is the organization vision for the community, not the vision of what the organization will look like in three to five years or more.

- Mission – the stated purpose for the organization's existence; it might be viewed as the organization's public statement of the contribution it promises to make to help accomplish the community vision.

Agreeing on values, vision, and mission is usually best accomplished as a part of a planning retreat or at a special meeting; the process will usually take several hours, and should include Board and at least senior staff [23].

The fourth stage is implementation planning—how do we get there? This stage involves identifying the actions needed to implement the plan. Key activities include mapping out the tasks to accomplish the goals and objectives, setting a schedule, determining priorities, and allocating resources to ensure implementation. Implementation should occur as soon as possible after completion of the plan, if not during the final stage. Commitment to ongoing monitoring of plan implementation and completion of periodic updates and revisions, as needed, should be in place prior to finalizing the plan [19].

A strategic plan cannot succeed unless it is derived from a clear vision of what the organization will look like at a specific point in the future. This

vision is encapsulated in a written description of the organization's desired future state in terms of budget size, client base, staffing levels and program areas and other parameters. (Alternatively, a vision statement may focus outward on the organization's societal impact. [24]

Every health service provider needs a realistic vision of the service it can offer. This should include a clear understanding of its role in relation to other health service providers in the National Health Service. Only when this vision is known can the health service provider decide what healthcare technology is needed, and prioritizes the actions required to develop its stock of equipment. It is unhelpful if lots of individual health facilities pull in different directions, with no coordinated plan for the health service as a whole. The central authority of each health service provider should be responsible for considering what sort of healthcare should be offered at each level of their health service. Preferably they will collaborate with the Ministry of Health, or follow their guidance if regulated to do so [21].

The mission is a statement defining the dimension and scope of responsibility of the organization or business unit. Basically, what products and services, for what markets and which customers, will build the success of the particular organization or business unit?

According to (Christopher, 1993) the essentials are to:

1. Define the Mission

2. Make the Mission specific through strategic goals and performance measures.

3. Integrate the Mission with subordinate unit goals and measures.

4. Develop the organizational effectiveness that will make the goals attainable.

5. Design the information system and feedback measures.

6. Involve everyone in the process.

7. Recognize and reward performance achievement.

The mission statement and list of objectives of a CES must conform to the overall strategic plan of the hospital. [2]

2.3.5 Clinical and Technology Strategic Plan:

A clinical strategic plan is updated annually. For a given year, the program includes:

- Assess what clinical services the hospital should be offering in its referral area taking into account health care trends, demographic and market share data, and space and facilities plans.
- Analyze facility's strengths and weaknesses, goals and objectives, competition, and existing technology base.

The outcome of this process is a clinical strategic plan that establishes the organization's vision for the year and referral area needs and the hospital's objectives in meeting them.

A clinical strategic plan is never complete without engaging in the process of strategic technology planning. An essential task for technology managers is to assist their organizations throughout the strategic planning processes.

Technology manager contribution in strategic planning is providing information about available technical capabilities, both existing and new, matched to their clinical requirements. To accomplish this, technology managers must be aware of the institution's values and mission, pursue their institution's strategic plans through that knowledge, and plan in a way that effectively allocates limited resources.

Although a technology manager may not be assigned to develop an institution's overall strategic plan, he or she must understand and believe it in order to offer good input for hospital management. In providing this input, a technology manager should:

- determine a plan for evaluating the present state of the hospital's technological deployment
- assist in providing a review of emerging technological innovations and their possible impact on the hospital
- articulate justifications and provisions for adoption of new technologies or enhancement of existing ones
- Visit research and laboratories and exhibit areas at major medical and scientific meetings to view new technologies.

Key elements of strategic technology planning involve

- performing an initial audit of existing technologies
- conducting a technology assessment for new and emerging technologies for fit with current or desired clinical services
- planning for replacement and selection of new technologies
- setting priorities for technology acquisition

- Developing processes to implement equipment acquisition and monitor ongoing utilization. [5]

2.3.6 Performance measurements

In the planning process first of all the organization needs to know ‘where is it now?’ here comes the importance of measuring the performance. Performance measurement is essential for achieving and maintaining high levels of productivity and quality

However, the most valuable benefit of proper performance measures is a sound understanding of how a production system works - be it a department, a person or a physical process - and the forces that drive it.

Performance measures can help any organization:

- Determine where they are.
- Establish goals based on their current performance
- Determine the gap between a set of desired goals and current performance.
- Track progress in achieving desired performance goals.

- Compare and benchmark their competitors' performance levels with their own control performance levels within predetermined boundaries
- Identify problem areas and possible problem causes
- Better plan for the future.

Achieving maximum performance is a balancing act, not a simple problem of optimizing one variable. Management must determine the most important factors for the entire institution, and then assign departmental objectives and performance measures that are consistent with them.

The variables of measurement are defined as:

- Work inputs: demands made on the production system
- Quality inputs: measures of the quality of incoming work
- Resource inputs: money, manpower and materials used to produce the products
- Environmental factors: forces or conditions outside the production system which affect its performance
- Product outputs: useful products or services produced
- Quality outputs: measure how well the goods or services produced conform to their specifications
- Variance outputs: as with variance inputs
- Waste: any resource that does not result in useful output
- Productivity: ratio of output to input
- Performance measures: top level gauges of how well the production system is operating in a good/bad sense (depends on point of reference)

- Behavior measures: second level factors that explain how the major parts of the production system interact (depends on point of reference)
- Diagnostic measures: used to isolate problems to their actionable level (depends on point of reference). [12]

CHAPTER THREE

3. LITERATURE REVIEW

The clinical engineering department as a practitioner of technology management program is essential actor in the strategic planning process their role is continuous and valuable since the information and knowledge they convey can determine the future of the healthcare organization. Many studies were conducted in clinical engineering as a part of technology management program and several searches were done in clinical engineering performance indicators and clinical engineering department benchmarking and clinical engineering service sustainability yet few studies linked this various management trends with healthcare strategic planning from clinical engineering prospective.

Strategic Planning in Healthcare Organizations by Francisco de Paula Rodríguez Perera, Manel Peiró provided a definition of strategic planning and why should healthcare organizations use it but didn't didn’t mention planning technology as part of institutional strategic planning.

Best Practices for Medical Technology Management by James P. Keller, Jr., Stephen Walker This research is concentric around patient safety, It didn’t provide detailed information about technology management program in these facilities. ECRI disseminated patient safety medical device information to key staff at all Air Force hospitals the Air Force collaboration with ECRI has led to the development of a “best practice” for the management and dissemination of medical device patient safety information from which the entire health care industry can benefit.

Benchmarking Clinical Engineering Services in Egyptian Hospitals by F. A. Ali, B. S. Tawfik identified deficiency points and evaluate the

performance of CESs in Egyptian Hospitals It didn't address the effect of the CED on hospital's technology management program.

PERFORMANCE AND SUSTAINABILITY INDICATORS by Rutendo L Ngara explores most of the services provided by CE and the performance indicators they focused on the need

for in-house CES's to justify their existence by providing institutional management and policy-makers with quantitative evidence of their value.

Planning Hospital Medical Technology Management by YADIN DAVID AND ERNEST GUS JAHNKE provided the concepts of medical equipment management program and defined the importance of this concepts and the role of clinical engineer in this process

It didn't provide information about specific facility and the evaluation of it medical equipment management program.

Practical Techniques for Strategic Planning in Health Care Organizations by Prathibha Varkey, MD, MPH, MHPE, and Kevin E. Bennet Briefly provided the component of strategic plan and its importance for healthcare organizations but It didn't mention any thing about technology management in specific manner and the clinical engineering role as planners and executors of the institution strategic plan.

Trends in clinical engineering practices by Yadin David, P.E., C.C.E., Ed.D.

Defined technology management program achieving goals and the clinical engineer best

practice that delivers technological solutions based on carefully determined needs and specified set of organization objectives and abilities. On the other hand, it lacked information about specific facility and the evaluation of it medical equipment management program.

CHAPTER FOUR

4. METHODOLOGY

The absence of information or previous studies on CED as part of technology management program and its contribution in conducting strategic planning in the healthcare provider it belongs to ruled out the option of conducting a study based on secondary data. However, an extensive literature review was conducted around the topic of strategic planning in general; and technology management program in clinical engineering specifically. This provided a background for developing the methodology and is described in the preceding chapter.

The use of observation techniques for collecting primary data was found to be inappropriate, because most of the information required depended on the professional opinions of both experts in the field and users/employers of clinical engineering services, and not on factors that could be directly observed by the researcher.

4.1 Selection of study sample:

The research was targeting relevant participants for the study. Relevant participants are described as those individuals, units or organizations that have a significant interaction with, interest in or impact (direct or indirect) on the process of strategic technology planning which are clinical engineers.

The researcher used a mixture of Quota sampling: sampling procedure that ensures that certain characteristics of a population sample will be represented to the exact extent that the investigator desires and Convenience sampling: the sampling procedure used to obtain those units/people most conveniently available. Judgment/purposive sampling

is a technique in which an experienced researcher selects the sample based upon some appropriate characteristic of the sample members [24].
The chosen sample was general public hospitals with clinical engineering service unites, hospitals which lay under the supervision of Khartoum state ministry of health and conduct the health polices of quality and future planning. The importance of these hospitals manifested in:

- They are referral hospitals
- They are Educational hospitals
- They cover the three large cities of Khartoum state
- They represent national health state
- They have the largest technology assets in the country

4.2 The questionnaire:
This phase is all about the questionnaire which is the practical part of this study it begins with determining the questionnaire's objectives then the design of the questionnaire and finally administration of the questionnaire.

4.2.1 Defining Objectives for the Questionnaire:

The objectives of the new instrument were based on the objectives of the study as a whole.
The specific objectives of the questionnaire(s) were:
1. Obtain information on the general mission and basic strategy of Clinical Engineering Services (CES's).
2. To gather information about the functions and services of different CES's.
3. Determine the existence of documented management activities for CES's

4. Investigate the performance measures usage within the clinical engineering department.

5. Gather information pertaining to quality, performance, cost-effectiveness

4.2.2 Organization of Questionnaire:

The questionnaire was divided into sections, with each section representing a particular theme or survey topic. A funnel approach was used which is'' A procedure whereby general questions are asked before specific questions in order to obtain unbiased responses [24].

with respect to the order of sections within the questionnaire i.e. sections asking more general questions were placed at the beginning, and the most specific sections at the end of the questionnaire. There were six sections in total, namely:

1. Demographic data.
2. Mission and Objectives.
3. Service provided by the CES (technology management component)
4. Equipment Management documentation.
5. Performance Factors.
6. Budget and Costs.

The questionnaire was targeted at the management and personnel of Clinical Engineering Services. The following section describes this questionnaire in detail.

4.2.3 Specifying Themes for the Questionnaire:

Themes for the questionnaire were:

- Demographic (background) information:

This section focused on general information about the respondent's institution and the Clinical Engineering Service supporting it. The

questions were adapted from surveys conducted by (Frize,1990) and (Glouhova,1999).

Mission, strategy and objectives of CES:

In this predominantly qualitative (unstructured) section CEs were asked to indicate whether they were aware of the mission statement and strategy, respectively, of the CES supporting their institution. Respondents were then asked to state what, in their opinion, would be an appropriate mission statement and appropriate elements/objectives in the strategy or business plan. The last question asked whether the strategy (if it existed) of the CES supported the overall strategic plan of the institution – a factor vital to the sustainability of the Clinical Engineering Services [25]

- Services provided by the CES and rating of importance:

The second objective of the study, as stated in the research proposal, was to determine if the concept of technology management is fully understood in healthcare facilities of the study. Findings from the literature review showed that an effective measurement system must be aligned to the major functions and business processes of the unit, department or organisation which is the purpose of technology management. This section therefore focused on the services provided by the CES and the importance of the services to the healthcare institution.

- Performance of CES:

In order to gauge general trends, the performance measurement at an institutional level of a healthcare facility, a question asked respondents to indicate which of the following performance indicators were used in their institution:

Productivity: relationship between output and input of a given process i.e. productivity is the ability to combine and convert inputs (labor, capital,

materials and other resources) into outputs (goods and/or services) which satisfy market needs.

Quality: conformance to requirements (stated or implied). This includes internal measurements e.g. number of rejects; and external measures such as customer satisfaction rating. Alternatively, the degree of excellence of a product or service

Timeliness: assesses whether process takes place at time intended

Resource utilization: resources used versus resources available (e.g. hospital, equipment, in-house tools)

Cycle time: amount of time to proceed from one defined point in process to another i.e. how long a process takes (equipment maintenance, inspection, etc.)

Outcome: measures of the effects of the outputs of the system.

Cost and budget: Finances are often a major factor in determining the efficiency of clinical engineering services, in any socio-political environment referring to lifecycle costs of equipment are often ignored when purchasing medical equipment; this section asked respondents whether there was adequate budget allocated for all equipment-related costs, e.g. maintenance costs, transport and installation costs, training costs.

4.2.4 Administrating the questionnaire:

the questionnaire was administrated in an interview face to face way; that ensure the CE understands the questionnaire purpose and give the researcher good insight of limitations and threats that obstacle clinical engineers from establishing an effective management procedure.

CHAPTER FIVE

5. RESULTS AND DISCUSSION

5.1 Overview of Data Analysis Methods:

Due to the exploratory nature of the study, descriptive statistical- which is statistics such as averages and measures of spread, used to condense and summarize the data to make facts more visible, as well as to indicate the degree to which the sample data is likely to represent the entire population were used to determine and describe patterns in the quantitative data. The structured questions in the questionnaire either provided nominal data or ordinal data, which limited the types of analytical tools that were permissible; the descriptive statistics appropriate for the nominal data are also appropriate for the ordinal data. [27]

All data entry and management was performed using Microsoft Excel 2010 spreadsheets; and the statistical package SPSS version20 used for the data analysis.

5.2 The results and discussion:

The question of existence of vision, mission statement and strategic goals were posed to CES personnel of the research sample, in all the cases CE personnel were not aware of an existing of a strategic plan elements specific to the clinical engineering department

Table1: frequency and percentage of CED with a documented vision

Does your department have a documented vision?					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
16.7	16.7	16.7	1	Yes	
100.0	83.3	83.3	5	No	
	100.0	100.0	6	Total	

Table2: frequency and percentage of CED with a documented mission

Do you have a documented mission, defining dimension and scope of responsibility of the CED?					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
16.7	16.7	16.7	1	Yes	
100.0	83.3	83.3	5	No	
	100.0	100.0	6	Total	

Table3: frequency and percentage of CED with documented strategic goals

Does your department have documented strategic goals?					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
100.0	100.0	100.0	6	No	

The respondents suggested some strategic elements to develop clinical engineering department strategic plan.

Suggested Strategic Elements for a CED

l. Improve service delivery.

2. Financial management.

3. Ensure sufficient physical infrastructure (test equipment, space, etc.).

4. Improve human resources.

5. Training and continuous education of users and technical staff.

6. Improve collaboration with stakeholders (clients and management) as well as private companies and other CBS's.
7. Implement program for maintenance, inspections, replacements, etc.
8. Procedures for corrective maintenance, specifications and procurement of medical equipment
9. Quality control and improvement

Table 4: frequency and percentage of CED with specific objectives

Is the CED have specific objectives?					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
100.0	100.0	100.0	6	Yes	

All the clinical engineering department of the study defined some of their objectives and management values the most frequented objectives were:
Improves safety and efficiency of essential medical equipment (in-spite of old age and unavailability of parts).
Reduces operational costs and downtime of equipment.
In this section the clinical engineers firstly: were asked: which of the following CE services does your department provide?
Secondly: regardless of the service provision state they were told to rate the service importance on scale of five layers:
1: irrelevant, 2: unimportant, 3: neutral, 4: important, 5: essential

Table5: frequencies and percentages of CED services

Percent		Frequency		Service provided
No	Yes	No	Yes	
00	100	0	6	Specification, evaluation and procurement of equipment
33.3	66.7	2	4	Technology assessment
00	100	0	6	Acceptance testing
66.7	33.3	4	2	Risk and safety management
00	100	0	6	Inspection, preventive maintenance and repair
83.3	16.7	5	1	Quality assurance and improvement
50	50	3	3	Asset/inventory management
100	00	6	0	Equipment performance and cost management
50	50	3	3	Equipment utilization
00	100	0	6	Training equipment users
83.3	16.7	5	1	Research and development
50	50	3	3	Review of equipment replacement needs
100	00	6	0	Project management
50	50	3	3	Facilities and plant management and maintenance

In the table above the highest percentage (100%) of services provided by CED were:

5 Specification, evaluation and procurement of equipment

6 Acceptance testing

7 Inspection, preventive maintenance and repair

8 Training equipment users

The highest percentage (100%, 83.3%) of services not provided by CED were:

- Project managements
- Equipment performance and cost management
- Research and development
- Quality assurance and improvement

The clinical engineers used only three rates from the scale (neutral, important and essential).

The highest percentages of services that considered essential and important were:

- Specification, evaluation and procurement of equipment
- Acceptance testing
- Asset/inventory management
- Review of equipment replacement needs
- Quality assurance and improvement
- Inspection, preventive maintenance and repair
- Technology assessment
- These services represent 50% of total services.

Table6: frequencies and percentages of CED services rating

Percent			**Frequency**			rating
essential	important	neutral	essential	important	neutral	CED services
66.7	33.3	0	4	2	0	Specification, evaluation and procurement of equipment
33.3	66.7	0	2	4	0	Technology assessment
66.7	16.7	16.7	4	1	1	Acceptance testing
50	50	0	3	3	0	Risk and safety management
33.3	66.7	0	2	4	0	Inspection, preventive maintenance and repair
16.7	66.7	16.7	1	4	1	Quality assurance and improvement
66.7	0	33.3	4	0	2	Asset/inventory management
50	50	0	3	3	0	Equipment performance and cost management
50	33.3	16.7	3	2	1	Equipment utilization
50	33.3	16.7	3	2	1	Training equipment users
16.7	50	33.3	1	3	2	Research and development
33.3	66.7	0	2	4	0	Review of equipment replacement needs
16.7	33.3	50	1	2	3	Project management
16.7	33.3	50	1	2	3	Facilities and plant management and maintenance

In Equipment Management section clinical engineers were asked about the existence of computerized management system the answer was 100% no

Then they were asked about CED services documentation.

The figure below represent that three out of six hospital of the research sample have complete documentation system of the services provided by CED.

Performance of CED:

Part one: CED personnel were asked about performance measures used for evaluation the department services, the measures selection was based on extensive literature review, the most redundant performance indicators were adopted.

Negative response to most of the factors of the questionnaire was the highest percentage of responses; this is an indication of lake of management activities and planning within clinical engineering departments of Khartoum state public hospitals.

The performance factors (PF) are:

- Productivity
- Quality
- Timeliness
- Resource utilization
- Cycle time
- Outcome

Table7: productivity (PF) Frequency& Percent

Productivity					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
16.7	16.7	16.7	1	Yes	
100.0	83.3	83.3	5	No	
	100.0	100.0	6	Total	

Table8: Quality (PF) Frequency& Percent

Quality					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
16.7	16.7	16.7	1	Yes	
100.0	83.3	83.3	5	No	
	100.0	100.0	6	Total	

Table9: timeliness (PF) Frequency& Percent

Timeliness					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
33.3	33.3	33.3	2	Yes	
100.0	66.7	66.7	4	No	
	100.0	100.0	6	Total	

Table10: Resource utilization (PF) Frequency& Percent

Resource utilization					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
16.7	16.7	16.7	1	Yes	
100.0	83.3	83.3	5	No	
	100.0	100.0	6	Total	

Table11: Cycle time (PF) Frequency& Percent

Cycle time					
Cumulative Percent	Valid Percent	Percent	Frequenc y	Valid	
100.0	100.0	100.0	6	No	

Table12: Outcome (PF) Frequency& Percent

Outcome					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
33.3	33.3	33.3	2	Yes	
100.0	66.7	66.7	4	No	
	100.0	100.0	6	Total	

Part two: the respondents were asked about certain management issues which could affect the performance of clinical engineering department.

Table13: inventory utilization

Inventory that is not utilized/needed					
Cumulative Percent	Valid Percent	Percent	Frequenc y	Valid	
100.0	100.0	100.0	6	Yes	

Table14: skilled staff vs available resources

Staff without skills to use available resources					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
83.3	83.3	83.3	5	Yes	
100.0	16.7	16.7	1	No	
	100.0	100.0	6	Total	

Table15: staff with skills unused

Staff with skills that are not being used				
Cumulative Percent	Valid Percent	Percent	Frequency	Valid
16.7	16.7	16.7	1	Yes
100.0	83.3	83.3	5	No
	100.0	100.0	6	Total

Table16: mismanagement

Inappropriate management strategy / delegation				
Cumulative Percent	Valid Percent	Percent	Frequency	Valid
66.7	66.7	66.7	4	Yes
100.0	33.3	33.3	2	No
	100.0	100.0	6	Total

Table17: over quality

More quality than is necessary				
Cumulative Percent	Valid Percent	Percent	Frequency	Valid
100.0	100.0	100.0	6	No

Table18: unnecessary meetings

Meetings/reports that do not convey useful info				
Cumulative Percent	Valid Percent	Percent	Frequency	Valid
16.7	16.7	16.7	1	Yes
100.0	83.3	83.3	5	No
	100.0	100.0	6	Total

Table19: absenteeism

Absenteeism				
Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	4	66.7	66.7	66.7
No	2	33.3	33.3	100.0
Total	6	100.0	100.0	

Table 20: lengthy planning

Lengthy planning, budgeting processes				
Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	1	16.7	16.7	16.7
No	5	83.3	83.3	100.0
Total	6	100.0	100.0	

Table 21: lengthy capital appropriation procedures

Lengthy capital appropriation procedures				
Valid	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	5	83.3	83.3	16.7
No	1	16.7	16.7	100.0
Total	6	100.0	100.0	

100% of the clinical engineers reported under and over utilization of medical devices, they mentioned many examples of inventory not used for many reasons for example: unqualified staff to operate the equipment, unavailable physical plant or installation requirements. They also reported lake of devices, spare parts, consumables and tools.

Most of the respondents (83.3%) admitted that there is poor communication between the engineers and the medical managers, they were have not experienced any planning or budgeting process and they are not involved in management meetings. 83.3% complained about staff without skills to operate medical devices. 66.7% admitted absenteeism and inappropriate management procedures.

Budget and Costs:

The funding within the institution was divided into two parts:

Essential costs and additional costs.

83.3% reported available funds for spare parts, while 66.7% positive responses for operating, purchasing cost availability.

Table 22: availability of funding of some essential CED costs

Purchasing costs of Capital equipment					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
66.7	66.7	66.7	4	Yes	
100.0	33.3	33.3	2	No	
	100.0	100.0	6	Total	

Operating costs					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
66.7	66.7	66.7	4	Yes	
100.0	33.3	33.3	2	No	
	100.0	100.0	6	Total	

Transport and installation costs					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
50.0	50.0	50.0	3	Yes	
100.0	50.0	50.0	3	No	
	100.0	100.0	6	Total	

Costs of removal from service					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
33.3	33.3	33.3	2	Yes	
100.0	66.7	66.7	4	No	
	100.0	100.0	6	Total	

Parts and materials					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
83.3	83.3	83.3	5	Yes	
100.0	16.7	16.7	1	No	
	100.0	100.0	6	Total	

In the additional costs category 100% said there is available funds for administrative costs, on another hand 100% of the respondent responded negatively for data recording and training costs availability.

50% percent of these hospitals

Table 23: availability of funding of some additional CED costs

Administrative and supply cots					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
100.0	100.0	100.0	6	Yes	

Services provided by external service sources					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
50.0	50.0	50.0	3	Yes	
100.0	50.0	50.0	3	No	
	100.0	100.0	6	Total	

Costs of recording and evaluation data					
Cumulative Percent	Valid Percent	Percent	Frequency	Valid	
100.0	100.0	100.0	6	No	

Training costs				
Cumulative Percent	Valid Percent	Percent	Frequency	Valid
100.0	100.0	100.0	6	No

Table 24: availability of funding difference between different types of technology

Are there significant differences-between the availability of funds for different types of technology?				
Cumulative Percent	Valid Percent	Percent	Frequency	Valid
66.7	66.7	66.7	4	Yes
100.0	33.3	33.3	2	No
	100.0	100.0	6	Total

66.7% of the sample reported that there is difference in funding between different types of technology; they mentioned that the ICUs and the ORs and radiology have more funding than other department of the hospitals.

CHAPTER SIX

6. CONCLUSION AND RECOMMENDATION

6.1 The conclusion:

The healthcare delivery system presents a very complex environment where strategy, facilities, equipment, drugs, information, and the full range of human interventions are interacting. It is in this clinical environment that patients in various conditions, staff, temporary skilled labor, and the wide variety of technology converge

Healthcare technology is a vital component of the healthcare delivery package; clinical functions - consisting of diagnostic, life support and surgical procedures are a core function of health service delivery - all of which highly dependent on functional medical equipment, healthcare technology. Clinical functions are increasingly dependent on expertise that understands this technology.

The research aimed to investigate the presence of technology management program as part of healthcare strategic planning in some of Khartoum state hospitals and questioned the contribution of clinical engineers in these activities.

Efforts have been done to conduct this research in some of Khartoum state public general hospitals with in-house clinical engineering department, due to complicated procedures the researcher could not include hospitals manager's opinion in the research; there for the questionnaire targeted the clinical engineering personnel in these hospitals.

The questionnaires questioned basic elements of a CES mission and strategic goals of targeted CED which unfortunately was not defined in either of CED. The results driven from questionnaire data analysis showed that clinical engineering personnel were not involved in their institution strategic planning if it exists! They have knowledge of technology management essential services and do apply some of technology management program processes put they do not practice

management fully since they do not have documented management program, do not measure CED performance as reported in the results.

Essential CES services, specific to the sample, were established and included: (i) specification, evaluation and procurement, (ii) inspection and preventive maintenance, (iii) corrective maintenance and (iv)safety checks (v)Acceptance testing, (vi)Asset/inventory management,

(vii) Review of equipment replacement needs (viii) Quality assurance and improvement. These were consistent with 'core' CES functions described in the literature.

6.2 Recommendations:

The research defined the need for strategic planning in healthcare in the continually changing environment, advancing technology innovations and quality of care increasing demands.

The study finding revealed a shortage in planning in clinical engineering department in some of Khartoum state public hospitals and there for it is recommended to:

- Increase the awareness of planning ‘s crucial contribution in the effectiveness of technology management activities in healthcare systems.
- Conduct performance evaluation measure procedure on ministerial level to determine the current situation of clinical engineering departments of Khartoum state hospitals in order to define strengths, weaknesses, opportunities and threats (SWOT).
- Include clinical engineering manager in the facility strategic and long term planning.

- Encourage researches that aim to benchmark clinical engineering departments, evaluate clinical engineering services and define performance indicators.
- Use the outcome of these researches as useful information source for defining a framework for planning technology in the public sector.

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33.2.4For Clinical Engineering Services’