DETERMINANTS OF UTILIZATION OF BIOMEDICAL ENGINEERING PROFESSION IN PRIVATE HOSPITALS IN KENYA A CASE OF NAIROBI COUNTY

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2016

DECLARATION

This Research Project is my original work and has not been submitted for academic award in any university/institution.

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DEDICATION

This project report is dedicated to my late Dad Ghands Aloo, My Mum Pristla Alooh and my Guardians Mr. and Mrs Julian Sibo who taught me the true value of education. You are forever my heros.

ACKNOWLEDGEMENTS

I thank God for his grace, sustenance and providence that has seen me through this study program successfully. Thank you Lord for bringing me this far.

My sincere gratitude to my husband, Erick Angara for your love and support. Your encouragement has been a pillar of strength.

I am extremely grateful to my supervisor, Dr. Raphael Nyonje and Dr. John Ouru for their valuable advice, suggestions, criticism and encouragement that they gave me during the research period. Thank you for creating the time and having the patience to ensure that not only did I get the best out of the research but also anyone who reads the report gets it as well.

Special appreciation goes to the Aga Khan University Hospital Nairobi and my boss Mr. Shekar Iyer who gave me time off work and helped me realize my dream. Thank you Shekar for your support and encouragement and most especially for believing in me. God Bless You.

I am grateful to my fellow colleagues at work for your valuable input towards my research. Thank you for believing in me and encouraging me even when the going became so tough.

Finally, I thank all my classmates for your support and encouragements even during the toughest times of the study.

God Bless you All

ABSTRACT

Biomedical engineering Professionals work at the intersection of engineering, the life sciences and healthcare. These engineers take principles from applied science (including mechanical, electrical, chemical and computer engineering) and physical sciences (including physics, chemistry and mathematics) and apply them to biology and medicine(R.A Malkin 2007).Biomedical engineering is *the* fastest-growing career and this trend is expected to continue over the next decade .With accelerated healthcare competition Globally and the popularity of biomedical technology usage, there is a need to understand what factors are most important in enabling biomedical engineering healthcare professionals to develop and foster collaborations with healthcare professionals. This study closely looks at Kenyan Private Hospitals registered by Kenya Association of Private Hospitals (KAPH) based in Nairobi County. The objectives of the study are: (1) To determine the extent to which Hospital Management system influences the utilization of BME professionals (2) To examines the level at which Hospital policy contributes to the Utilization of BME professionals? (3)To examine how the Challenges faced by BME Professionals influence their utilization (4) To asses level at which Equipment specialty training affects utilization of BME professionals. The study employed a descriptive survey research design with a focus on those hospitals registered under the Kenya Association of Private Hospitals (KAPH) in Nairobi county. The target population of the study was 120 persons from 10 private Hospitals in Nairobi County to give sample size 92. A semi structured questionnaire was used to collect primary data. The data was summarized, coded and tabulated. Descriptive statistics such as means, standard deviation and frequency distribution was used to analyze the data. Data presentation was done by the use of pie charts, bar charts and graphs, percentages and frequency tables. There is a strong positive relationship ($r=0.794$, $p<0.000$) between hospital management system and utilization of MBE professionals. There was fairly strong positive relationship between hospital policy and Utilization of BME professionals ($r=0.523$, $p<0.000$).It was found out that the relationship between the challenges faced by BME Professionals influence on their utilization was a weak negative but significant ($r=-0.014$,$p= 0.038$). It was established that there was a strong positive and significant between equipment specialty training and utilization of BME Professionals, ($r=0.625$, $p=0.012$).The researcher concluded that the, hospital management system, hospital policy, challenges faced by BME Professionals and equipment specialty training on the utilization of MBE professionals. It was recommended that the private hospitals need to strengthen hospital management system, hospital policy, equipment specialty training and address the challenges faced by BME Professionals for better utilization of MBE professionals and improved quality of healthcare to clients.

LIST OF ACRONYMS AND ABBREVIATIONS

AMEK-Association of Medical Engineers of Kenya

BDM-Break down Maintenance

BME-Biomedical Engineering

ECRI-Emergency Care Research Institute

HMS-Hospital Management System

HTA-Healthcare Technology Assessment

ICT-Information and communication Technology

JCIA-Joint Commission of International Accreditation

KAHP-Kenya Association of Healthcare Professionals

KAPH-Kenya Association of Private Hospitals

KEBS-Kenya Bureau of standard

ME –Medical Equipment

MEM-Medical Equipment Management

MRI-Magnetic resonance Imaging

PPM-Planned preventive maintenance

WHO-World Health Organization

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Biomedical Engineering departments are globally provided in most large and medium sized hospitals to maintain and manage their biomedical equipment (Frize& Shaffer 1991). Administrators normally know in general what these departments have to do based on the terms established in the Joint Commission of International Accreditation'(JCIA) Manual. Moreover, they presume they are getting the appropriate services when their hospital meets the only standards imposed on it, namely that of passing the JCIA's or their state's inspections like.

The American College of Biomedical engineering (1992) defined a biomedical engineer as "a professional who supports and advances patient care by applying engineering and managerial skills to healthcare technology". The main role of the biomedical engineer is healthcare-technology management, which is defined by ECRI, a healthcare technology research and advisory organization, as "an accountable, systematic approach to ensuring cost-effective, efficacious, safe and appropriate equipment is available to meet the demands of quality patient care" (Clark, 2004, p. 20). A biomedical engineering department's core functions include technology management, risk management, technology assessment, facilities design and project management, quality assurance, and training (Bronzino, 2004).

The practice trends in biomedical engineering are continuously evolving, largely because the very reason for its being- healthcare technology- is always advancing. It appears to be in a particularly active phase of change now, because of several significant factors including: the escalating cost to provide healthcare, technological advances including the growing presence of information technology in healthcare, the recently elevated priority placed on patient

safety, and regulatory requirements, such as those put in place to protect the privacy of health records (Cohen, 2003; David &Jahnke, 2004; Rosow& Grimes, 2003; Zambuto, 2004a, 2004b).

As a technology-based field, the future brings many opportunities and challenges for biomedical engineering. The rapidly changing world of technology has, and continues to, significantly impact healthcare. Devices are more complex and sophisticated, and are beginning to employ information technology-based clinical applications and be interfaced to hospital information systems. Wireless technology is changing how patients are monitored, and concerns about patient safety are focusing on new areas of opportunity, such as human factors engineering, to help ensure safer medical technology (Baker, 2004a; Draper, 2004). In addition to skill development, BME needs to partner with the other departments within the organization, such as the Information Management/Information Systems department, to produce and support the safest medical device systems possible.

The BME department's role has, and continues to expand to encompass the full range of healthcare technology management, for most patient-care areas of the hospital. The level of effort continues to increase in several key areas such as healthcare technology planning and acquisition. BME is uniquely positioned to understand the technical requirements of the equipment, as well as the clinical issues, while remaining impartial to individual clinical departments. This ensures the capital resources are allocated most appropriately, while keeping the best interest of the hospital in mind.

In addition to the technological and support requirement changes, biomedical engineering also faces human resource challenges. Biomedical engineering is a relatively young field. Both the technologist and engineering positions have suffered from significant wage erosion over the past ten years. They are now paid significantly lower than comparable positions in

both the public and private sectors (Association of Professional Engineers and Geoscientists of British Columbia [APEGBC], 2002; Baker, 2004b; Campbell & Piotrowski, 2005). Staffing has been relatively stable for the department for many years, but now it faces the loss of many senior experts and leaders to retirement, as well as potential recruitment and retention problems due to wages.

In Canada the utilization of biomedical Engineers is determined largely by the health care system's overall structure. Factors promoting or limiting the health care system's expansion have significant effects on utilization of this [profession. Among these are structural factors,

Autonomy of both hospitals and physicians is the main force favoring technology acquisition and hence utilization of Biomedical engineers. Hospitals' pursuit of institutional development and physicians" pursuit of professional development combine to favor the rapid uptake and diffusion of innovative health care technologies. (Am, J .Public Health 78:251-254, 1998)

Canadian Commission of Healthcare Technologies (CCHT, 2004) identified three major problems affecting optimum utilization of Biomedical Engineers namely: obsolescent equipment and a technological lag, haphazard diffusion of certain technologies, and a need for technology assessment. Addressing obsolescent equipment and the technological lag, the Commission noted that the lag perceived in relation to the United States vanished when European countries were compared with Canada. Haphazard technology diffusion occurred when diffusion did not follow the priorities dictated by hospital size and expertise—for instance, when a region's first magnetic resonance imaging (MRI) device was placed in a hospital other than the one responsible for neurological and neurosurgical services .Regarding the effectiveness and efficiency of health care technologies, the Commission called attention to the frequent lack of solid data that could guide decision making. In response to perceived technological lags, the annual investment in new technologies was increased (from $15 to

$25 million a year).] To rationalize the diffusion of expensive and Sophisticated technologies, increased powers were granted to the Minister of Health and Social Services to control the organization and deployment of highly specialized services.

The Utilization of Biomedical Engineering Profession in France is highly based on Federal Regulation and it basically entails approval of the location of equipment, and pre-market approval of the equipment itself—two distinct processes. Since 1970, allocation of BME professions has been decided by a planning system for hospital beds and major equipment that is aimed largely at guaranteeing equal coverage across the country. Generally speaking, ANDEM is in charge of leading any program of technology and health care assessment with an impact on public health (with the exception of pharmaceuticals). ANDEM was established by law in 1989 as a nonprofit, independent association with the following goals: to develop internal projects in technology assessment, to validate the methods and means of external projects, and to disseminate the results of assessments, in cooperation with BME and Other concerned professionals, to build a network of BME professionals, to develop a proper curriculum for the training of Biomedical Engineering(Weill, C.,2005 "French National Policies in the Domain of Medical Technology Assessment,")

Back to the Developing Countries a case of Kenya Biomedical Engineering has huge responsibilities to improve the health facilities available and develop new ones for human use; hence potential in this study discipline is very high some of the additional Roles include but not limited to the following; Technical support for biomedical instruments and biomedical machinery like installation and troubleshoot ,Testing of biomedical equipment for safety and efficiency training to other clinicians on use of biomedical equipment and also to work with researchers on emerging new technology. AMEK, 2010

However full utilization is not realized due several factors namely Incompetent training institution, inadequate trainers of BME course, Governments lack of support on Technology management, Incompetent BME professions, Few available BME professionals in the country and lack of tools for BME professionals to use.

1.2 Statement of the Problem

As a part of the changing world, the healthcare industry and healthcare system have encountered dramatic changes in information and communication technology (ICT) in addition to general healthcare technology that will influence the way healthcare services are delivered and used, and the relationship between healthcare provider and consumers. The rapid progress in healthcare technology provides both opportunities and challenges in delivering high-quality and efficient health care, curbing the scourge of medical errors, facilitating point-of-care decision support, streamlining workflow, and reducing costs and improving the patient–physician relationship. It can therefore be said that the influence of electronic healthcare (E-healthcare) will increasingly affect the very roots of our current healthcare system (Wu et al., 2006).

With accelerated healthcare competition and the popularity of biomedical technology usage, there is a need to understand consequences of Optimum utilization and Under-utilization of BME healthcare professionals .Comprehending these issues/consequences with respect to the proactive attitude of BME professional to develop partnerships can potentially provide management insights in determining effective strategies to enable health care organizations to be competitive and better able to retain their customers and/or patients (Payton&Ginzberg, 2001). The need to effectively communicate with healthcare professionals requires that IS professionals develop some commonality of vocabulary and conceptual knowledge, as well

as which can only be achieved when they experience working with BME healthcare professionals.

Most healthcare Technology and IT/IS-related research has focused on the technology developments and clinical applications essential to successful implementation in the healthcare environment (Berg, 2001; Chau & Hu, 2002). For instance, considerable effort is devoted to characterizing broad knowledge areas concerning leadership and business knowledge/skills in healthcare administration (HLA, 2006; Robbins, Bradley & Spicer, 2001), health/medical informatics training and education(Hersh, 2006; Hersh& Williamson, 2007; Moore & Bernera, 2004), leveraging of health IT for business value and strategy (Arlotto, 2006; Vogel, 2003) and healthcare information resource management (Austin, Hornberger & Shmerling, 2000; Major & Turner, 2003) as aspects of the training and expertise of healthcare practitioners in the disciplines of medical informatics and healthcare management (Haux, 2006; Reichertz,, 2006).

However, little attention has been paid to investigating the role of BME professionals, hence their utilization and their impact in gaining strategic advantages by development of partnerships with people from different divisions of healthcare organizations. This is the research gap that this research project filled.

In developing countries like Kenyan, Private Hospital's a case of Nairobi County, failure to fully utilize the Biomedical Engineering professionals have led to the following ;Service to Acquisition cost (S/A) ratio is so high that most of these hospitals are unable to acquire, Expected equipment life is also limited due improper management hence making it difficult to plan by anticipating equipment life cycles, Equipment failure data has sky rocketed – as many BME professionals are not empowered to perform their sole duties of Medical Equipment management(MEM).The Planned Preventive Maintenance frequencies are also

minimized as the service Kits are not available and BME have no knowledge of innovation and Finally the Service contract costs are becoming so high as the manufacturers take advantage of poor Private Hospitals impacting the high Cost of Healthcare (ECRI,2013)

1.3 Purpose of the Study

The main purpose of this research was to understand the determinants of Utilization of Biomedical Engineering Professionals in Private Hospitals in Kenya a case of Nairobi County.

1.4 Objectives of the Study

The study was guided by the following objectives:

(i) To determine the extent by which Hospital Management system influences the utilization of BME professionals

(ii) To examines the level at which Hospital policy contributes to the Utilization of BME professionals.

(iii) To understand how the Challenges faced by BME Professionals influence their utilization

(iv) To asses level at which Equipment specialty training affects utilization of BME professionals.

1.5 Research Questions

This research sought to address three research questions:

(i) How does Hospital Management system influences the utilization of BME professionals?

(ii) How has the Hospital policy contributed to the Utilization of BME professionals?

(iii) How are the challenges are faced by BME Professionals influence their utilization?

(iv) How does Equipment specialty training affects utilization of BME professionals?

1.6 Significance of the Study

These study findings contributes towards Optimum utilization of BME by various stakeholders including the management of Private hospitals in Kenya, health insurance providers, future researchers and academicians, regulatory authorities and the general public.

The findings and recommendations of this study are useful to the management of new hospitals in Kenya intending to hire biomedical engineers by enabling them to formulate and target recruitment objectives and to get the best employees for the job. The human resource department in hospitals will also be able to understand the roles and responsibilities of biomedical engineers in their hospitals and be able to deploy them effectively ensuring maximum Utilization. The management will also be able to use biomedical engineers to deliver healthcare effectively and to help their businesses gain competitive advantage.

Knowledge seekers in the fields of economics, research methods, management, development and healthcare studies will find this research study useful. In particular, this research study will be beneficial to the researchers with research interests in biomedical engineering and human resource management by serving as a point of reference. In addition, future researchers will be able to formulate further studies based on the recommendations of this study.

Government and regulatory agencies will find the findings and recommendations of this study useful in formulating future biomedical policies and laws that will aid in regulating and operationalization of the biomedical engineering profession in Kenya hence optimum utilization BME professionals resulting to quality Healthcare.

The study will benefit the members of the public by helping demystify the operations of the biomedical engineers and thereby appreciate the role they play in healthcare in Kenya.

1.7 Basic Assumptions of the study

The study had the assumption that the respondents would not be biased on their opinion and perspective on the roles of biomedical engineers.

The study had the assumption that all the respondents are fully aware of what biomedical engineering professional is and their basic functions in the organization.

It was assumed that all the targeted private hospitals have medical equipment to be maintained by the BME professionals hence employ or plan to employ the BME personnel.

1.8 Limitations of the Study

This research study had a number of limitations. The data collection was subjected to hospital management staff who may have had their own formed opinions on the biomedical engineers, which they may fail to articulate or tend to overemphasize for fear of the information being used for other reasons other than academic. This was curbed by prior explanations to the respondents the importance and significance of the study, this in turn changed their way of thinking. Data collection procedure was restricted to the use of questionnaires thereby locking out other vital data collection tools like document analysis, as they may not be availed by the hospitals for scrutiny. This was managed by having a comprehensive questionnaire to capture all the relevant information needed.

1.9 Delimitations of the study

The researcher carried along an introduction letter from the University to confirm that the data requested would only be used for academic reasons. The researcher also visited the hospitals websites to add on the information collected. The study looked into other studies that have been done by other scholars on this subject.

The study focused on the determinants of Utilization of Biomedical engineering staff in Kenyan Private Hospitals in Nairobi County. The target population of this study was be 120 senior management staff from 10 major private hospitals in Nairobi County. Data was collected by administering a questionnaire to managerial and Biomedical staff in the private hospitals.

1.10 Definition of Significant Terms as used in the Study

Biomedical Engineering- Application of Engineering principles and design concept to medicine and Biology for healthcare purposes.

Biomedical: This refers to the application of engineering and technology principles to the domain of living or biological systems.

Breakdown maintenance: is **maintenance** performed on equipment that has broken down and is unusable. It is based on a **breakdown maintenance** trigger. It may be either planned or it can be unplanned

Emergency Commission Research Institute: ECRI Institute, is a nonprofit organization dedicated to bringing the discipline of applied scientific research to discover which medical procedures, devices, drugs, and processes are best, all to enable you to improve patient care.

Engineering: is the application of mathematics, empirical evidence and scientific, economic, social, and practical knowledge in order to invent, innovate, design, build, maintain, research, and improve structures, machines, tools, systems, components, materials, and processes

Healthcare Technology: application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of lives. This includes the pharmaceuticals, devices, procedures and organizational systems used in health care.

Join commission of International Accreditation: The Joint Commission, formerly known as the Joint Commission on Accreditation of Healthcare Organizations, is an independent, not-for-profit organization that evaluates and accredits more than 15,000 healthcare organizations in the United States and Globally.

Medical Equipment: is an equipment designed to aid in the diagnosis monitoring or treatment of medical conditions

Planned Preventive Maintenance: **Planned preventive maintenance** ('PPM'), more commonly referred to as simply **planned maintenance** (PM) or scheduled **maintenance**, is any variety of scheduled **maintenance** to an object or item of equipment..

Private Hospitals: A **private hospital** is a **hospital** owned by a for-profit company or a non-profit organization and **privately** funded through payment for medical services by patients themselves, by insurers, Governments through national health insurance programs, or by foreign embassies.

1.11 Organization of the Study

The study is organized into five chapters as follows;

Chapter one, This is the introduction of the study which constitutes background of the study, statement of the problem, purpose of the study, objectives of the study and research questions, significance of the study, basic assumptions, limitations, delimitations of the study and definition of significant terms as used in the study.

Chapter two, this is the literature review of the whole study.

Chapter three entails research methodology and constitutes research design, target population, sample and sampling techniques to be used, research instruments, validity and reliability of the instruments, data collection procedures, data analysis techniques and finally ethical considerations.

Chapter four has data analysis, presentation, interpretation and discussions.

Finally Chapter five consists of a summary of findings, conclusions, recommendations of the study, contributions of the study to body of knowledge and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter summarizes the information from other researchers who had carried out their research on biomedical engineering utilization in hospitals and in the healthcare industry. The chapter specifically covers the theoretical discussions, conceptual framework and research gap. This study acknowledges the fact that a researcher cannot perform research without first understanding the literature in the field" (Boote & Beile, 2005, p.3).

Determinants of the Utilization of Biomedical Engineering have been researched globally and they include hospital management system and utilization of Biomedical Engineering Professionals, Hospital Policy and utilization of BME professionals; Challenges faced by BME professionals and utilization of BME professionals ;Equipment specialty training and utilization of BME professional .This sections end with a theoretical and conceptual framework which is a diagrammatic representation of the relationship between the independent variables and the dependent variable and finally the section is summarized.

2.2 Influence of Hospital management system (HMS) on utilization of BME professionals

Managing a private Hospital comes with a number of challenges unique from those of other organizations one of which is the main area of the study which is utilization of the professional staff of which BME professionals are among them.

The Global Network of WHO Collaborating Centres for HTA also recognizes many of these challenges and has come forward with approaches and next steps to address them. In addition, some WHO collaborating centres have developed toolkits that will assist in capacity building

to incorporate BME professionals into decision-making and allocate resources within local health systems. (WHO, 2014, Healthcare management)

Hospital Managers struggle with BME professional identity: Private Hospital Managers struggle to understand BME professional identity, as BME is hybrids who see themselves primarily as clinicians. They often see their clinical role sidelined by managers (Paliadelis, 2008). Dopson (1996) argues that inherent tensions exists between the professional values of clinical and Clinical or Non clinical staff, and managerial demands for efficiency, cost control, and resource reallocation. This therefore leaves Biomedical Engineers not clearly identified as either Non clinical or clinical staff hence underutilization.

Negative perceptions of management-The negative perception of Private hospital management presents several challenges to BME professional Utilization, especially as this stereotype is held both by the Management and by colleagues (Preston and Loan-Clarke 2000).Llewellyn (2001argues that BME professionals in Hospital risk loss of respect and clinical visibility; they have to work to dispel mentality that being a BME is not because they lack the ability to progress in other careers, but it's a career just like any other clinical career, Management system is therefore seen as one of increased pressure with no tangible rewards or recognition for the BME professionals.

Human Resource system- Many Private hospitals have problems in recruiting enough appropriately skilled BME professionals and also Retaining them (Loo and Thorpe 2004;savage and scott 2004) The research suggests that BME professionals also feel their role lacks definition compounded by the lack of definitive job description.

Unpreparedness for role-Many BME professionals are given Jobs in private Hospitals without having had any prior field experience hence not vey conversant with current technology therefore limited utilization(.Amek,2010).The few years of experience that

private Hospitals in Kenya consider to offer employment to BME professionals is alarming with their selfish reason of cutting on staffing cost. This has led to several lives lost due to equipment failure and no experienced BME to repair them as quickly as needed. A case of Maria Nursing Hospital where a child was completely burnt in an Incubator because unexperienced BME staff use space heater elements to replace with Special asbestos element meant for Incubator. (Doctors essence newsletter, 2014)

The Biomedical Engineering Professionals are not fully empowered to execute their duties in Private Hospitals in Kenya as most of the Equipment are maintained on contractual basis, this is usually a decision made by Management instead of sending the BME staff abroad for training in order to maintain their equipment like the manufacturing companies does.(Biomed Essence, 2015)This has inturn demoralized the BME staff in Private Hospitals and most of them have lost hope in their career development on BME field.(KAHP,2012).

2.3 Influence of Hospital policy on Utilization of BME Professionals

The Private Hospital Policy on Healthcare technology procurement, use, maintenance, and management policy is a serious issue recognized by research undertaken worldwide. Some of the critical literature discussing 'private hospital policy issues' come from the Kenya Association of Private Hospitals and the World Health Organization.(WHO healthcare Policy, 2015)

BME professionals' utilization is an extremely complex area within Private Hospitals, it covers the procurement, training, maintenance and management of medical Equipment ranging from magnetic resonance imaging (MRI) to a simple thermometers. Many different professionals from within the Hospital with a good knowledge of their particular responsibility with regard to Medical equipment, (whether from procurement department

buying devices, from clinical departments using devices, from maintenance departments repairing and maintaining the devices, or the governance department ensuring compliance with internal policies and external regulations)have a policy to ensure they select and use medical equipment to deliver quality health services.

Medical equipment are used in Hospitals for diagnostic and therapeutic purposes .Most private Hospitals have policies to ensure that these devices are used correctly to ensure the safety of the patient; indeed, there is evidence that patients are sometimes harmed or die because devices are not used correctly. Even. Discussing the reasons for these incidents with the clinicians and nurses involved leads to a conclusion that there is too wide a variety of Medical Devices within healthcare organisations that do the same job. This variety makes it difficult to ensure BME professional training is carried out on all devices. Therefore, many private Hospitals also make a policy to only train on the highest risk devices that can harm or kill (in the event of misuse), and allow self-certification on all other devices. This risk-based approach is the only one that is considered feasible in the short term. This therefore leaves a wider range of equipment not covered in the ME training plan. (ECRI ,2013)

Consequently, the only way to improve BME professional utilization , and thereby reduce the risk of harm to patients in private Hospitals, is to have a policy on medical equipment standardization, standardize devices to a single equipment type from a single supplier for each type of medical technology application. This is difficult to achieve at the moment because purchasing mechanisms, although moving towards standardisation of devices, still have a long way to go in Kenya. Mainly, this is because private Hospitals have hundreds of different technology groups in use for different diagnostic and therapeutic purposes. It therefore makes it extremely difficult to find agreement from users within each technology group, when there can be hundreds of device users across multiple wards and departments who all want to have a say in what they use on patients with BME professionals also fighting

to give in their input (AMEK 2010).With Equipment Standardization policy, BME professionals will be able to get acquainted with the model type, equipment accessories can be shared and even old equipment can be vandalized for spareparts for the new broken down equipment.

The age profile of medical equipment can be wide, from the newest to the oldest equipment across individual technology groups, which leads to some equipment being less than a year old whilst other equipment in the Hospital from same technology group (with the same clinical function) are more than ten years old and already past their useful life. This issue happens as a result of multiple budgets, multiple purchases by different budget holders, and limited or unplanned funding. As long as there are multiple budgets and device users continue to have individual choice and BME professionals are not given opportunity to give input, the risks will remain. The private hospital should have a policy for planned funding and purchasing from a centralized place to close the Equipment age Gap. The Policy should be as per the figure below:

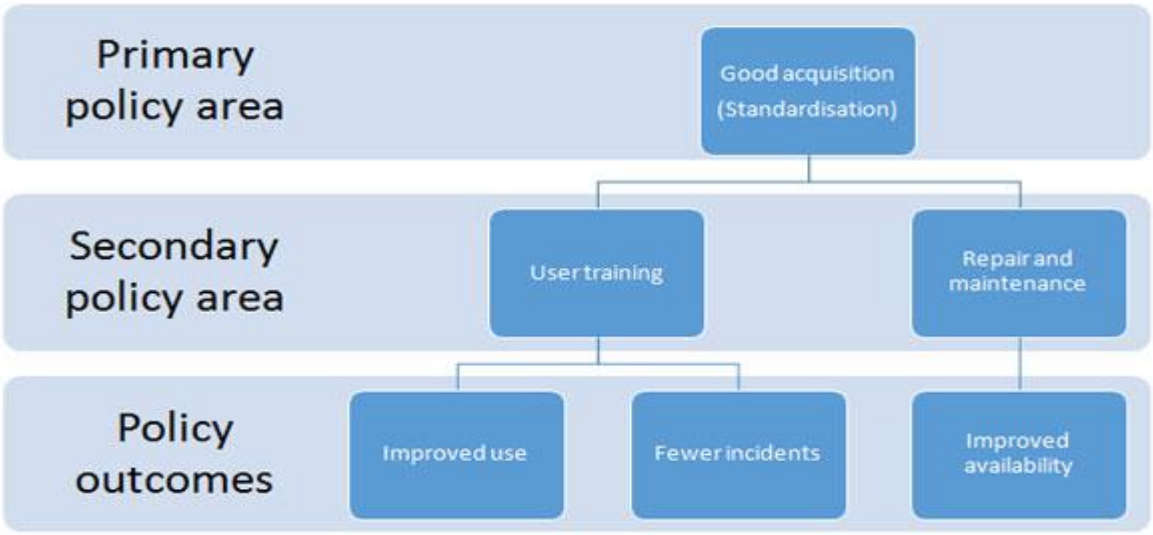


Fig 2.1 Influence of Hospital policy on Utilization of BME Professionals

Procurement and BME Professionals in Private Hospitals must work together to understand this issue and find policy solutions that improve use and availability, thereby leading to fewer incidents. Not only does this impact on patient safety, it also affects cost because the procurement manager cannot access the same level of discount when Equipment are bought individually.

Medical equipment users such as nurses and doctors need equipment that they are able to use safely, is up-to-date, and functions well. BME professionals, engineers and technicians also want standardisation, and want users to be trained because with standardisation they could carry less spare parts and become more expert in repairing devices, thereby reducing down-time. Moreover, with trained users there would be fewer callouts to equipment that is not at fault. BME professionals often discuss the number of calls they receive because users do not know how to use the equipment correctly and therefore 'think it is faulty' rather than there being an actual fault.

Kenyan Government are also concerned about meeting inspection standards from KEBS. To achieve this, they work with private Hospitals to ensure that medical equipment management policy is inclusive not only of the internal requirements of the hospital (such as procurement conduct, user training and maintenance), but must also meet external regulatory requirements from JCIA. Therefore, it is the responsibility of a wide range of healthcare professionals with BME included to bring together their joint knowledge to impart best practice.

2.4 Challenges faced by BME professions and their Utilization

While developed countries constantly pioneer new medical technologies, developing countries have been plighted with a lack of medical equipment, resulting in poor health,

poverty, and social inequality. Much of the medical equipment that these countries do have is broken, unusable due to a lack of electricity and infrastructure, or inappropriate for local needs. In 2000, the Global Forum for Health Research coined the term "10/90 Gap" to describe the fact that only 10% of health research funds are spent on the problems of 90% of the world's population. If the developing world is to acquire useful medical technologies, it must come from within, as the developed world has shown minimal interest in pursuing technologies for markets where the financial return is only nominal. If engineers in developed countries put their energy and resources into building the capacity of their counterparts in developing countries, they will be able to maximize their impact on the most relevant issues in global health. In order to succeed in their work abroad, biomedical engineers from developed countries must transition from being providers of solutions, to enablers of local innovation, thus contributing directly to quality Healthcare. Daniel R. Lustick,2001.

A. In Kenya, over 95% of the medical equipment in public and private hospitals is imported, with virtually no local production (Amek,2009) Moreover, most of the equipment is inappropriate for local needs and unable to be sustained with the lack of local infrastructure. Referring to a study of donations to Columbia from 1974-1979, Pena-Mohr, of the Pan American Health Organization, points out that five years after donation, "96% of foreign-donated equipment was not working." That same study revealed that 36% of the donations did not work upon arrival due to lack of training, manuals, or accessories [2, pp. 571].In kenyan private Hospitals alone, 40% of existing equipment is not used, while "at least half of all medical equipment in the country is unusable" [Amek 2009 pp. 54]. The lack of working Medical Equipment in Kenyan private hospitals is due to a multi-faceted, systemic failure.

B. Lack of Supporting Technology/Infrastructure

Electricity: While the paucity of medical devices is significant, one of the main obstacles to successful utilization of BME professionals is lack of supporting technologies and infrastructure. Unreliable electricity, including spikes and burnouts, make it difficult even for the BME to perform proper Preventive maintenance in their respective private Hospitals in Kenya. Additionally, donated units may be incompatible with local power supplies of different voltages and frequencies than their countries of origin. As Malkin and Anand, 2001 explained, "[The phototherapy device] would only be useful for babies born when the electricity was on, and then only those that required treatment lasting less than the time until the electricity was off again" [8, pp. 37].

C.BME professionals in Kenya often lack the expertise and training to maintain, troubleshoot, and repair imported Medical Equipment (Malkin and Anand 2001) . This issue is particularly true for private hospitals in Kenya , where skilled labor is expensive to afford , and appropriate jobs for skilled engineers and technicians are influenced by political, tribal, and regional developments. Many medical equipment designed in developed countries require specialized technicians and tools and are not built with the intent to be fixed easily by general Kenyan BME Professionals with only basic tools . Unfortunately, curriculum in BME and technical colleges is outdated and the graduates are not able to fill the void needed in the society.

D. Parts availability: High-tech Equipment often require expensive replacement parts. Due to the rugged environments in Kenya, the equipment fail frequently and access to replacement parts is often difficult and expensive.

E .Lack of financial resources, manufacturing equipment, and capacity to fabricate parts is nonexistent in Kenya and more so private hospitals. Lack of quality control also affects the quality of the parts available in the Nairobi county market.

F. Financial burden of donated devices: A donated device may cost more to maintain and use than can be afforded, thus making the donated device a greater financial burden than help, especially if the scarce resources are needed elsewhere.

G. Devices are Culturally Inappropriate, The common thinking with private hospitals that "something is better than nothing" is incorrect at best, and dangerous at worst, when used in regard to health care delivery in these Private Hospitals in Nairobi. The fact that resources are scarce makes it imperative that technology works well, as there are no resources to correct problems or alternatives to treatment. Malkin and Anand 2010found that the homemade appearance of their prototype phototherapy device elicited concerns of dubious quality and possible feelings of inferiority, making locals reluctant to use it. With no alternative treatments

Available, individuals were willing to forgo treatment altogether due to their concern over the appearance, and thus, efficacy of the device [8].

Lack of Biomedical Engineering Innovation In Kenya -There is a clear lack of biomedical engineering (BME) education in Kenya. Of the 9,659 BME patents reported by the Organization for Economic Co-operation and Development (OECD) in 2008,4,062 (42%) are from the United States, while only 97 (1 %) are from India [9] and none from Kenya. Moreover, of the 194 World Health Organization (WHO) member countries of which Kenya is a member , 102 (53%) have at least one BME teaching facility contact, 64 (33%) have more than one contact, and only 44 (23%) have more than two contacts [10]. This global lack of BME teaching institutions makes it clear that there are few cohorts of biomedical engineers in the Kenya to focus on issues in their own private Hospitals.

Other Challenges which contributes to limited Utilization of BME professionals in Kenya are

- Limited educational opportunities in-country
- Limited on the job training opportunities
- Limited opportunities for career advancement
- Inadequate numbers of qualified personnel to fill posts
- Absence of a national professional regulatory body
- Competition with the private sector for scarce skilled professionals There is a critical need for more biomedical engineering training opportunities for biomedical engineering professionals in low-resource settings.

2.5 Effects of Biomedical Equipment specialty training on Utilization of BME Professionals

After a thorough review of the literature, the following researchers established the theoretical underpinnings of this study. Doig, Kotlarz, and Leibach (2005) addressed the epistemology for the need to advance the BME and clinical science profession to include a terminal doctorate degree and addressed the benefits a doctorate-prepared clinical laboratory science practitioner and BME professional would provide for the delivery of health care. Due to advances in scientific and medical knowledge, Kotlarz (1994) established the principle of new roles and responsibilities for BME professionals in the areas of education, research, and laboratory management. Doig (2005) focused the need for a clinical doctorate through her research and publications. Leibach's (2007a) findings, from extensive research about the direction of the health care delivery system and preparation of the practitioners functioning within health care, indicated the potential for a Doctoral prepared Clinical Laboratory Science professional (DCLS) prepared practitioner to lead the laboratory profession.

Kotlarz (1994) explored the relationship between the historical development of medical technology and the occupation's progress toward achieving professional status. Kotlarz

consolidated and built upon the many sources of information about the history of medical technology to develop a single integrated study. Kotlarz noted the profession was fragmented, the scope of practice not clearly defined, and autonomy and control over professional practice was a significant issue for medical technologists.

Doig (2005) demonstrated the need for a defined career path, within the BME profession, culminating in a doctorate degree. Doig depicted support for the next phase in the advancement of the BME profession and correction of weaknesses in the current career model. Doig noted several challenges resisting the advancement of the BME profession in the delivery of health care.

Leibach (2007a) provided research for the need of a doctorate in BME Technology. Leibach highlighted the concept of an advanced practice degree established on complex rigor of specific medical equipment knowledge, coordinated patient care, and a need to participation in research. Leibach addressed the fundamentals for the proposed doctorate in BME profession and the proposed skills needed for successful implementation of full utilization of BME professionals prepared ensuring full participation on the interdisciplinary health care team.

In Kenya there is no specialty training for BME professionals the curriculum covers a wide range of equipment making it difficult for a BME professional to have expertise in a given field of Medical technology. With the specialty involved the private hospitals would deploy Biomed in their different specialty areas hence reduced Breakdowns and down times, therefore leading to Maximum utilization of BME.

Private Hospitals prefer to contract specialized company to oversee a specialized department than a general Biomedical practioner. This leaves the the profession of BME not very effective in the longrun. An example of Radiology equipment Private hospital would rather

transfer ownership to specilised engineer from abroad to maintain the equipment and as for Lab equipment the private Hospitals in Kenya Would rather lease the equipment than do an outright purchase.

2.6 Theoretical Frame work

2.6.1 Risk Management

At all times the safety of the patient is the paramount concern of a biomedical engineer (Simendingee, Natal& Lee, 1982). S/he achieves this by keeping proper records of equipment and establishing a risk-management programme. This includes preventive maintenance, incident reporting and analysis, overseeing the provision of alarms, implementing safety precautions and ensuring that the equipment meets national and international standards. In addition s/he ensures that the cause of an equipment-related accident is thoroughly investigated, and that both the nature of the accident and the subsequent corrective measures are properly documented to prevent future mishaps.

Furthermore, persistence in regular preventive maintenance procedures and visual inspection during ward rounds would ultimately reduce equipment failure. As a qualified and competent person the biomedical engineer is able to propose and implement an effective safety programme as part of risk management. In order to ensure that up-to-date standards are maintained, s/he carries out periodic inspections and reviews of preventive maintenance schedules and checks that all medical devices used by patients, whether in hospital or at home, are tested for safety and proper function before being documented and released for use.

2.6.2 Roles of Biomedical Engineers in Hospitals

2.6.2.1 Developmental Research

One of the most important functions of the biomedical engineer is to undertake developmental research. S/he also supplies a consultative service available to all who come for advice and require a feasibility study for their research projects. This involves advice on apparatus and methodology. The main problem with any medical engineering project is one of communication and exchange of ideas between people of different disciplines. There is no-one better placed than a biomedical engineer to provide information for all those involved in the design, manufacture and use of equipment in the medical environment. S/he holds huge resources of information relating to product liability, accidents, setting up procedures and ease of use, as well as medical ethics which can be used in drawing up specifications and evaluation protocols (Saha&Saha, 1986; Grant, 1990).

Strong interaction with users is extremely important if an innovation or a product is to be successful. The best testing ground for a medical device is a hospital ward, and the biomedical engineer is the best person to carry it out. S/he can also liaise between the health care institution and industry. It is, however, important to remember that a biomedical engineer, as a professional and socially responsible person, is personally liable for injuries resulting from services or a device s/he helps to develop. Therefore, biomedical engineers should not view their role as merely assisting medical doctors. They have a clear responsibility of their own to patients (Walter, 1986).

2.6.2.2Teaching and Training

Technical equipment is an integral part of modern medical care. Understanding its use is essential for doctors and nurses caring for the patient. It is one of the functions of a biomedical engineer to provide in-service training and education for users on the effective

and safe use of technology. S/he is responsible for teaching and spreading a knowledge of his/her profession to medical staff, nurses, students and hospital administrators, laying emphasis on general philosophy and future possibilities. The importance of keeping nonmedical administrators and the general public in the picture cannot be over-emphasized as they need to be reassured that they are getting good value for money (Hewera, 1975). This is achieved by writing articles in journals and giving lectures on the management of technology in the clinical environment.

More than half of all so-called repair calls in a hospital involve operator error rather than failure of equipment. This problem can be easily minimized by regular 'technicians', and promoting the interaction between equipment users and biomedical engineers. Probably the best way of conducting a continuous in-service education programme is to join in ward rounds with medical staff and to establish a routine schedule of visits to various laboratories and theatres. Biomedical engineers can offer their expertise to designers, manufacturers, health care administrators and standardization committees in advocating the special and technical needs of the patients. Their wealth of professional knowledge could make a valuable contribution.

2.6.2.3 Maintenance

Maintenance is provided primarily by technicians who are backed up by in-house biomedical engineers, as well as by outside manufacturers' and independent service representatives. Manufacturers, for their part, are interested in developing this back-up as a new business opportunity. For this, they may limit self-diagnostic programs, test points, and access to the equipment, and may tighten their hold on information and replacement parts, making it more difficult for both hospitals to cope by themselves. Some manufacturers reserve the right to supply replacement parts only on a case-by-case basis and to sell to their own authorized dealers or factory-trained representatives but not the users (Buller 1993).

2.6.2.4 Preventive Maintenance

Preventive maintenance is relatively difficult to do in ensuring that equipment gets the right amount of attention within the manpower and time constraints imposed. Manufacturers' procedures are often overly burdensome and time-consuming in order to avoid claims of inadequacy and to provide a measure of "hold harmless" protection. Some hospitals may then ignore or modify procedures to meet local conditions. In this event, inappropriate modification can turn preventive maintenance into nothing more than a surface inspection that merely checks that the equipment is usable and undamaged, while meaningful indications of impending failures lie undetected. To guard against this, manufacturers' service manuals preferably should be available for reference when a hospital has to design the modifications and determine what maintenance may be done safely by its staff. Biomedical engineers, who are familiar with equipment design techniques, should be in the best position in the hospital to be responsible for these modifications.

2.6.2.5 Breakdown Maintenance

Possible corrective maintenance is likewise dependent on the manufacturer's cooperation. Without adequate manuals and self-diagnostics, the hospital has three options as follows:

1. To have sufficient quantities of standby parts available for substitution by lesser experienced staff in order to locate the failed component by process of elimination (board swapping)

2. To employ sophisticated or specially designed test equipment and more experienced staff to identify the failed component

3. To execute a contract with the manufacturer or independent service contractor for the repairs (Shaffer and Shaffer 1990)

The option selected depends upon the number of each type of device to be maintained, the skills of those doing the maintenance, allowable downtime, and, possibly, the medico-legal advantage in diverting responsibility to more knowledgeable others. The number of a particular type of devices will determine whether the hospital's investment in spare parts, personnel, and training would be worthwhile, or whether the outside contract route makes more sense.

With regard to staff training, some manufacturers restrict the supply of replacement parts and service manuals only to technicians trained by them, in order to assure the quality of work and to protect their reputations for reliability. One state, New Jersey, has enacted a law for anesthesia care in which the credentials of each servicing agent must be approved by the machine manufacturer or be determined by the hospital's physician director of anesthetic services to be equivalent to the credentials of these agents (New Jersey Register, 1989).

Manufacturers, furthermore, may encourage service contracts by bestowing higher priority to those hospitals with such contracts. In line with this, the annual full-service maintenance contract typically is on the order of 10 percent of the original equipment cost. With competent hospital staff, the manufacturer may be induced to enter a partnership arrangement under which technician training, spare parts on consignment, and back-up advice are provided by the manufacturer; the hospital then acts as the first line of defense (first-call screening) to limit the manufacturer's involvement. The annual cost of such a contract may be negotiated down, perhaps to half that of the full-service contract (Hibbs 1990).

Based on their knowledge of design concepts, in-house biomedical engineers could act as consultants to support the maintenance technicians. For this, the engineers may also be required to participate regularly in the maintenance of the equipment in order to familiarize themselves with its intricacies.

2.6.2.6 Management

The management of biomedical equipment encompasses the five basic functions: selecting good equipment, assuring compliance with standards, assuring proper use monitoring performance and supporting improvement (Shaffer, 1989; Shaffer & Shaffer, 1991)

Although technicians can do these tasks to some extent, much of the work involves the integration of much equipment into working systems. On the strength of this, it is often advantageous (especially in the larger high technology hospital) to employ biomedical engineers who can assure that the equipment, facilities, people, and policies are melded together. These engineers could then assess the engineering impact due to the introduction of new technology into the hospital and establish criteria for equipment selection; develop the drawings, specifications, and procedures to make, install, and checkout new and modified equipment hardware and software systems; design operating and maintenance procedures that reflect local conditions, the mistakes of others, and the required performance indications and threshold levels; design in-services and the visual and teaching aids that make the in-services more meaningful; and ensure the systems are being used and are operating as designed; this is applicable especially for incident investigations and the identification of potentially harmful equipment malfunctions and user errors.

Contract management services are also available to do these functions and are increasingly in demand. Nearly 50 percent of hospitals now use these services (Souhrada 1991). A hospital with its own ability to evaluate designs, however, will no doubt have a better background for implementing its technology assessment, computer technology, quality improvement, and in-service programs as described below.

2.6.2.7 Technology Assessment

Technology assessment at the hospital level is aimed at determining whether a new technology is worth implementing; as a consequence, it precedes the equipment selection process. Emphasis is on its clinical value, optimal level of quality, affordability, and financial and operational risks (Millenson&Slizewski 1986). Based on their training, biomedical engineers should be able to contribute to the assessment by evaluating such engineering elements.

Clinical value may be reflected by such intangible outcomes as faster or easier procedures. Often a new technology breakthrough is merely first generation equipment, and more time will be required for it to attain a practical form (Samuel 1986). Searches in the biomedical engineering literature may reveal the experiences and opinions of others.

The optimum level of quality can be impacted by the hospital resources that need to be provided or modified. Facility requirements may involve buildings, power, air conditioning, heating, radiation shielding, lighting, water, drainage, storage, communications, and other such services. Similarly, maintenance personnel may have to be hired, organized, and trained, and procedures integrated for operation and service of the new equipment. Provision of facility specifications and of preliminary layout and installation diagrams should help architectural decisions and determine whether to provide a new building or just modify an old one. Operations research and queuing theory techniques may provide insight into space utilization and patient flow through the facility (Shaffer & Shaffer 1991).

Affordability can be based on expected system costs that may include facility additions or modifications, amortization of capital equipment based on lifetime estimates and salvage values, and operating expenses. The difference between the costs and income provides a measure against which the intangibles can be evaluated. Some consideration needs to be

given to the fact that diffusion of a new technology occurs gradually, and often without a concomitant decrease in the older, outmoded services.

In considering risk, biomedical engineers will probably have little to contribute with regard to the financial risk of new technology. However, they can help evaluate the operational and liability risks by investigating the approval status of the new technology equipment. Other operational risks can be evaluated by human-factor techniques and single-point failure analyses. These, together with liability risks, may be determined by again seeking out the experience of others. The Food and Drug Administration's National Center for Devices and Radiological Health and the Emergency Care Research Institute are two potential sources for this information. Other sources may include the professional engineering literature and the technology vendor's engineers with whom there could be commonality of language, training, and outlook.

2.6.2.8 Computer Applications

Developments in the use of computers in hospitals during the last ten years have enabled decentralized system structures to evolve on three levels: the hospital-level mainframe; department-level personal computers that handle special department statistics, billing, and other such applications that require quick reaction to change and equipment-level "embedded" computers that are incorporated in instrumentation to support their data acquisition, processing, and display functions. In some cases, these computers work with programmable personal computers to provide the special calculations, displays, and records desired by particular clinicians.

The system structure has thus progressed from a horizontally aligned centralized system based on functional applications to a vertically stratified decentralized system based on size and complexity. This now allows hospital computer personnel to be more easily assigned to a

particular level in accordance with the expertise needed. It also reduces communication gaps by placing assigned personnel closer to the actual users.

Proper implementation and maintenance of both the department and embedded-level systems require not only a knowledge of software, but also of the hardware, communications, and clinical practices, a combination characteristic of biomedical engineering training.

At the department level, programming by enthusiasts, volunteers, and part-timers can create problems due to the lack of uniformity of programming style and documentation, continuity for program changes, and coordinated knowledgeable supervision. As an alternative, program packages are available from over 200 vendors (Packer, 1989). There are advantages to both the "make or buy" (produce versus purchase) (Shaffer et al., 1991); regardless, support should be available to help expand current computer usage to include special applications as needed; plan, format, and program the required displays; provide inter-level and intra-level data transfer; develop unanticipated new displays that help clinical departments better manage their affairs; train the clinician staff to use the programs; and install, test, and maintain the system.

At the equipment level, the support may comprise the usual technology management functions of equipment selections: assuring the interfaces are standard whereby the equipment can work with other levels, selecting manufacturer options that produce the required input and output formats, and negotiating beneficial maintenance arrangements. Programming effort at this level is mostly limited to changes in report formats.

2.6.3 Quality Improvement

The hospital’s quality improvement activities may be helped by technical support for some of W. Edwards Deming’s principles (Walton, 1986) which are as follows:

1. Evaluate new equipment through the techniques of technology assessment and the opinions of knowledgeable associates (Deming point 4)

2. Improve constantly productivity and service by participation in the various improvement teams' activities (Deming point 5)

3. Assist in in-service training in the proper use of equipment (Deming point 6)

4. Assist in formal education and re-training in technology (Deming point 13)

With their design training, biomedical engineers should be able to contribute to the improvement of a team's activities by using their computer experience for formulating flow, cause-and-effect (Ishikawa 1985), and other required diagrams (Chaufournier, Grassel, & Shaffer 1991); defining and setting up the measurement systems; designing and implementing the data processing; and applying operations research techniques to the analysis of flow restrictions, traffic loading, and so on.

Generation of a flow diagram illustrates the sequential steps that have to be made in a time-based process. The cause-and-effect diagram identifies the process's variables based on such categories as people, procedures, policies, equipment, materials, environment, and information, but without reference to time or the steps to which they apply in the process. This reference may be achieved by constructing Shafournier diagrams (Chaufournier, Grassel, &Shaffer, 1991) that integrate on one display the sequential steps of the flow chart, the process variables in each decision that has to be made, and the measurements located with reference to both the steps in the flow and the process variables that have to be measured.

2.6.4 Staff Selection

Clearly, there is a trade-off depending upon the competency of the biomedical engineering in-house staff, the needed outside support, the available quality of that support, and the business

situation. In any event, a hospital should have a good idea as to what its in-house staff is qualified to do safely.

Biomedical engineering staff can fall into three general categories according to their level of formal education: (1) vocational school graduates, who demonstrate a wide range of proficiency according to the school's commitment; (2) associate degree technicians, who have had two years of academic training in a community college or technical institute; and (3) bachelor's degree technicians, who have attended a four-year program that offers a bachelor degree (Carr& Brown, 1993).

2.6.5 Research Gap

Individual access to health care is critical (Roosevelt, 2008). Therefore, reforming the delivery of health care to improve patient safety, eliminate waste, and provide equitable and effective care is essential (Crossing, 2001; Roosevelt, 2008). In the design of health care, there is a service gap due to the increase in innovation in hospital laboratories and technology, healthcare rules, regulations, knowledge, and skills needed in the delivery of health care (Leibach, 2007a). To be an effective member of an interdisciplinary health care team, biomedical engineers must be equipped with a broader array of skills including the ability to order laboratory tests, analyse test information, review patient records, communicate with patients, and interpret and apply laboratory generated information (Leibach, 2008a).

Advisors in the health care industry continue to review the changing health care needs of society including chronic disease, new and re-emerging infectious disease epidemics (Milo, 2003), and the continued threat of bio-terrorism (Scope, 2001). In addition, medical mistakes, hospital-acquired infections, medication errors, overuse of emergency services, and unnecessary lab tests are costing the health care industry an estimated $760 billion in revenue each year (Roosevelt, 2008). Patients, payers, and providers have a stake in the health care

industry, but patients remain quiet on issues of waste and inefficient care while continuing to pay for quantity and not quality of the health care received (Roosevelt, 2008).

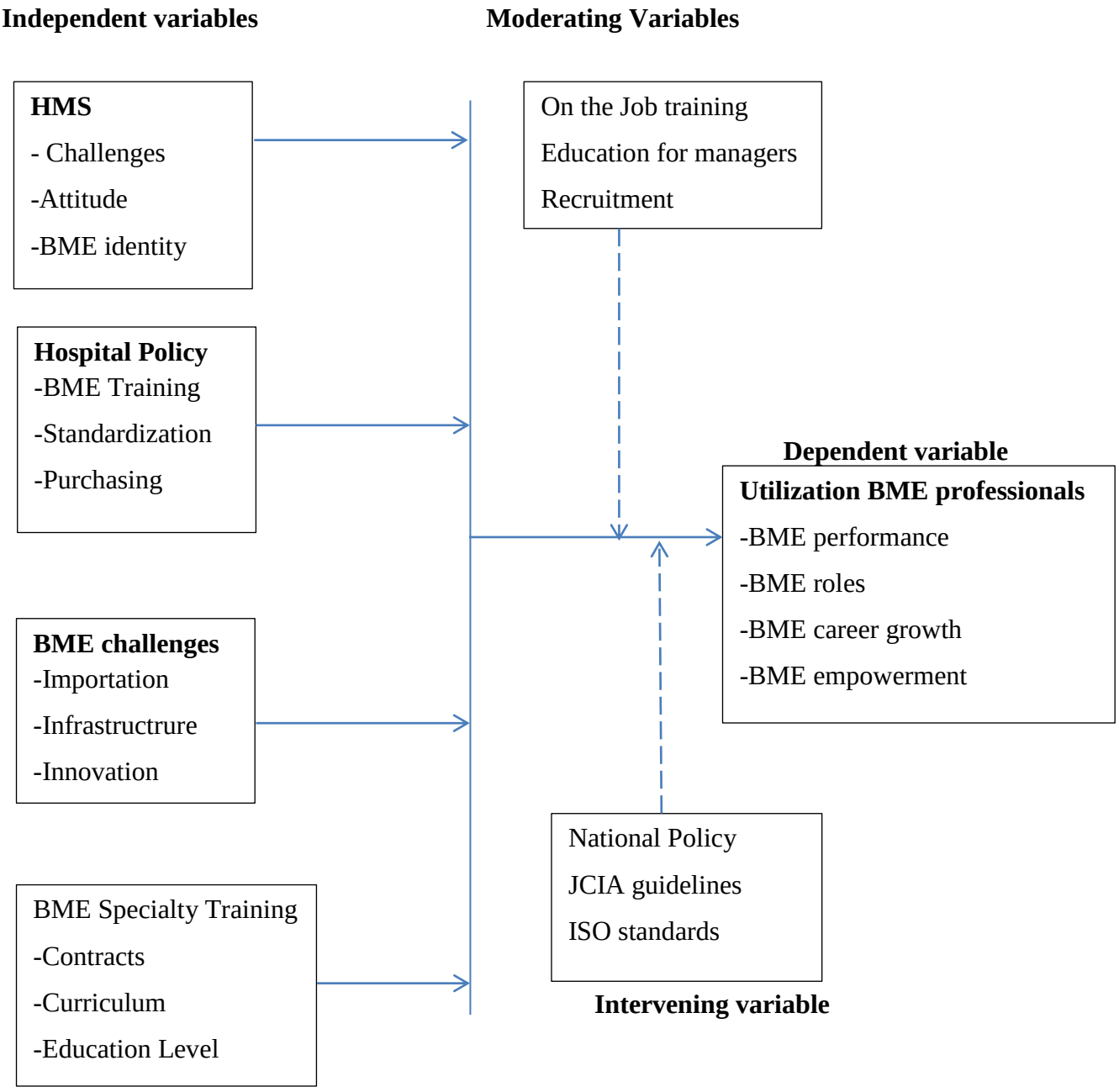
Health care professionals agree the health care system has been poorly organized (Crossing, 2001). For years, health care was a commodity while cost reduction was the prevailing strategy (Porter, Teisberg, & Wallace, 2008). The answer is not simply universal health insurance (Roosevelt, 2008); and transferring the responsibility from employer or individual to the government is not acceptable (Porter et al., 2008). Other health care professionals argue for redefining health care according to specific diseases and treatments rather than according to health insurance plans, networks, or hospital groups (Weisman, 2004).

In 2000, professionals from the Institute of Medicine envisioned the ideal health care delivery system as safe, patient centered, effective, efficient, timely, and equitable (Cowen, Halasyamani, McMurtrie, Hoffman, Polley, & Alexander, 2008). The new design for effective health care includes a focus on an interdisciplinary health care team, which delivers patient care, improves the transfer of information, and connects with operational leadership (Cowen et al., 2008). The medical staff, nursing, clinical laboratory science professionals, and other allied health professionals must work to implement and sustain the new design (Cowen et al., 2008).

2.7 Conceptual Frame work

This study was guided by the following conceptual framework;

Figure 2.2: Conceptual Framework



This Figure 2.1 shows the conceptual framework for this research. It indicates the independent and dependent variables as well as the moderating and intervening variables. The dependent variable is influenced by the independent variables thereforeaffects its outcome. Moderating variable is a variable that changes (increases or decreases) the otherwise established effect of the independent variable upon the dependent variable. An **intervening variable** facilitates a better understanding of the relationship between the independent and dependent variables when the variables appear to not have a definite connection.

2.8 Summary of Literature

As biomedical engineers job is not to better *their own*world, it is to better *the* world. By being fully utilized in the private hospitals i.e designing something new, they can change how people live in Kenya. The formal definition of a biomedical engineer is a professional who "builds on scientific understandings of a disease to design new healthcare technologies" .

Although there are endless demands for biomedical engineers, I feel that private Hospitals In kenya especially in Nairobi County are in the most urgent need. By concentrating our efforts in the Nairobi County and utilizing BME codes of ethics,(AMEK 2014)we can find potent solutions to the overwhelming health problems. According to Engineering Board of Kenya ,2000' code of ethics, engineers have "a direct and vital impact on the quality of life for all people" . Additionally, it states that engineers "should hold paramount the safety, health, and welfare of the public. This code of ethics needs to be taken into broader terms and realize that BME professionals must be fully utilized in all the private Hospitals In Kenya. Without following these codes of ethics, many treatments can lead to negative effects on those who are sick and on the public community. Another dynamic of increasing the availability and usefulness of BME professionals in Kenyan Private Hospitals is to incorporate the study of this kind of work into the content of undergraduate curriculums. In

educating future BMEs about the importance and proper ways of aiding Kenya as a country , we would be taking a huge step to bring more scholars into this field of work and educate them on how to properly apply their knowledge in different areas in the Hospital. By taking a course like this, engineers would gain a global perspective on how they can make a change and how their work could improve the quality of life of millions in Private Hospitals in Nairobi County . It would be very beneficial to offer something that would teach young BME why they should help developing areas and how to utilize their career in their work. By following having proper standards to follow in Private Hospitals in Kenya ,BME will have to take many things into consideration when dealing with the issues plaguing Private Hospitals in Nairobi County which will allow for improved results. It is vital for more biomedical engineers to put their time and skills towards those suffering from inadequate medical support and integrate optimum utilization in their work to guarantee positive results .

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methodology of the study and it comprises the research design, population, study techniques, data collection, pilot study and data analysis. The chapter addresses the actual methodologies to be used in the research process from inception to the end. The role of both primary and secondary data in the process of addressing the various research questions were addressed and the manner in which data would be collected and later analyzed to reach a reliable conclusion.

3.2 Research Design

The study employed a descriptive survey research design as it portrays an accurate profile of situations (Cooper, 1999). This is designed to describe the characteristics of a particular phenomenon in a situation. It was used to obtain information concerning the current determinants of the utilization of biomedical engineers in private Hospitals in Kenya, a case of Nairobi county. The design helped the researcher obtain information concerning the determinants of utilization of biomedical engineers in private Hospitals in Kenya, Nairobi County and thus relate it to the objectives of the research and therefore make it relevant to the research questions (Schindler, 2003).

3.3 Target Population

Population refers to the entire group of individuals, events or objects having common observable characteristics. It is the aggregate of all that conforms to a given specification. The study specifically focused on those hospitals registered under the Kenya Association of Private Hospitals (KAPH) in the Nairobi County. The total number of registered private hospitals in Kenya is 32 (KAPH, 2015). The study population comprised 120 senior

management staff and Biomedical Engineers with focus on 10 major private hospitals in Nairobi County. The targeted Hospitals were those with a bed capacity of 60 and above, which are well established in terms of equipment and skilled manpower. These are important as they can key indicators and a justification of the employment of a biomedical engineer hence the determinants of their utilization. The respondents were the head of finance, head of information technology, head of procurement, Director of Nursing, Director of Medical, head of customer care, biomedical engineers, chief pharmacist and head of human resources, Head of Facilities, Head of Qualities; Head Radiology These are the groups from which the sample was be drawn.

3.3.1 Study population

The study population consisted of the following correspondence Medical Director 10, Director Nursing 10,Finance manager 10,Human Resource manager 10,Head of customer care 10,Head of Information Technology 10,Procurement officer 10,Chief pharmacist 10,head Facilities 10,Head of Radiology 10, and Biomedical Engineers 20.

Source: Human Resources Department from Private Hospitals

3.4 Sampling Method and Sample Size

This section describes the sampling procedure and sample size

3.4.1 Sample Procedure

Stratified sampling was used to select the sample of the study; the method assured the researcher that the sample would be representative of the population in terms of certain critical factors that have been used as a basis for stratification. Stratified sampling as noted by Kothari, (2004) is a method applied if the population from which a sample is to be drawn and does not constitute an identical group, and hence requires comparisons between various sub-groups. The study design involved completing a structured questionnaire.

3.4.2 Sample Size

Mugenda and Mugenda (2003) define sampling as a method of selecting some part of a group to represent the entire population. This study employed Krejcie and Morgan (1970) formula presented below to determine sampling size. According to Krejcie and Morgan (1970): $S = X^2NP(1-P)/ d^2(N-1) + X^2P(1-P)$

Where S = required sample size, and

X^2 = the table value of chi-square for one degree of freedom at the desired confidence level

N = the population size

P = the population proportion (assumed to be .50 since this would provide the maximum sample size)

d = the degree of accuracy expressed as a proportion (.05)

Given a population of 120 people the sample size according was determined as 92 people. The researcher then used stratified random sampling to get respondents from each category of staff as shown in Table 3.1.

Table 3. 1 Sample Size

Population Categories	Populatio	Sample Size
Medical Director	10	8
Director of Nursing	10	8
Finance Managers	10	8
Human resource Managers	10	8
Head of customer care	10	8
Head of information technology	10	8
Procurement officer	10	8
Chief pharmacist	10	8
Head of Facilities	10	8
Head of Radiology	10	8
Biomedical Engineers	20	15
Total	**120**	**92**

3.5 Data Collection Instrument

The study used a questionnaire to collect both qualitative and Quantitative data from primary sources. Questionnaires guarantee confidentiality as respondents act without any fear or embarrassment. Advantages of questionnaires is that they are cheap and do not require a lot of effort from the researcher. They also have standard answers that make it simple to compile data. A questionnaire was preferred because it is simple to administer and convenient for collecting data within a short time (Kothari, 2003). The questionnaire was administered through email, drop and pick or by personal administration depending on which method is convenient to the specific respondents. A questionnaire is preferred because it is simple to administer and convenient for collecting data within a short time.

3.5.1 Pilot Test

Mugenda and Mugenda, (2003) asserted that, the accuracy of data to be collected largely depends on the data collection instruments in terms of validity and reliability. A pilot study was conducted to check validity and reliability of the questionnaire. The instruments were pilot tested among 10 respondents randomly selected sample participants in the Private Hospitals in Kenya, Nairobi county, which were not included in the actual data collection. The pilot study took 10 days after which data was analyzed and corrections done on the instrument. This enhanced the reliability of the instrument. In this study, reliability was ensured by pre-testing the questionnaire. The pre-test was conducted by both the principal researcher and the research assistants to enhance clarity of the questionnaires.

3.5.2 Validity of the instrument

Validity as noted by Kothari, (2004) is the degree to which the results obtained from the analysis of the data actually represents the phenomenon under study. Validity will be ensured by having objective questions included in the questionnaire. This will be achieved by pre-testing the instrument to be used to identify and change any ambiguous, awkward, or offensive questions and techniques as emphasized by Cooper and Schindler, (2003).

Validity is the degree to which results obtained from the analysis of the data actually represent the phenomena under study (Mugenda & Mugenda, 2003). According to Taylor, Sinha and Ghoshal (2006), validity is the success of a method in probing or assessing what it sets out to probe or assess. To enhance validity in this study, content related validity of the questionnaire on schedule will be determined by the help of experts, such as the research supervisor. The supervisor will provide guidance to ensure that the instruments are well constructed, so that the research instruments address the information sought by the research objectives.

3.5.3 Reliability of the instrument

Reliability on the other hand refers to a measure of the degree to which research instruments yield consistent results (Mugenda & Mugenda, 2003).Reliability, according to Mulwa (2006), is the extent to which a measuring device or a whole research project would produce the same result if used again on a different occasion with the same objective of the study.

Reliability of the instruments will be ascertained for internal consistency using split half reliability method. The questionnaires will be administered once to the same individuals and then split into two equal parts. The parts are scored and the scores correlated using SPSS program. The instrument were considered reliable after attaining reliability coefficient of 0.88.

3.6 Data Collection Procedure

Data Collection exercise commenced on approval from University of Nairobi to proceed with the research. The researcher sought permission to collect data from Private Hospitals approved by KAPH In Nairobi County The researcher took the letter of authorization to the Director Kenya Association of Private Hospitals In Kenya who shall provide consent to conduct the study in the Registered Private Hospitals. Then the researcher shall brief Heads of Private Hospitals of the research and schedule appointments for data collection. Necessary arrangements were made for the identified respondents to fill the questionnaire at venue and time of convenience.

3.7 Data Analysis Technique

The data obtained was coded appropriately and analyzed using Statistical Package for Social Scientists (SPSS version 21). The results were presented in tables using descriptive statistics (frequency counts and cross tabulations). Inferential statistics (chi-square test and correlation analysis) were used to show the determinants of Utilization of BME professionals in Private Hospitals in Nairobi County, Kenya.

3.8 Data Analysis

The collected data were examined and checked for completeness and comprehensibility. The data was then be summarized, coded and tabulated. Descriptive statistics such as means, standard deviation and frequency distribution were used to analyze the data. Data presentation was done by the use of pie charts, bar charts and graphs, percentages and frequency tables. The collected data was analyzed using both quantitative and qualitative techniques. Quantitative techniques were used to analyze the closed-ended questions where a computer program (SPSS software) was used. Qualitative techniques were used to analyze the open-ended questions. Content analysis will be used to categorize common answers according to their commonality.

CHAPTER FOUR

DATA ANALYSIS AND PRESENTATION OF FINDINGS

4.1 Introduction

This chapter analyzes the data collected from the respondents, presents and interprets it. This section presents the participants background information, hospital management system, hospital policy, challenges faced by biomedical engineering professionals and specialty training of biomedical engineers.

4.2 Response Rate

The response rate for the questionnaires was worked out as shown in table 4.1.

Table 4.1: Response Rate

Sample size	Respondents returning questionnaires	Percent
92	81	88.04%

Out of the 92 respondents in the sample, 81 were reached and their questionnaires completed for analysis. This represented a response rate of 88.04%. This was considered very good for analysis. The high response rate was attributed to the continuous follow ups and call backs on the respondents. A response rate of 50% is considered adequate for analysis and reporting, 60% is good and that of 70% and above is very good (Mugenda & Mugenda, 2003).

4.3 Participants background information

This section analyses and presents the findings on the following variables: Gender, level of education, designation, number of biomedical engineers in the hospital, in charge/overseer in biomedical engineering department, where the in charge reports to, average retainance of biomedical engineers in respective hospitals and the cause of BME turnover.

4.3.1 Gender of the respondent

The respondents were asked to state their gender, the results were as shown in Table 4.2

Table 4.2 Gender of the respondent

Gender	Frequency	Percent
Male	39	48.1
Female	42	51.9
Total	**81**	**100.0**

Of the respondents, 42(51.9%) were females and 39(48.1%) were males. Thus more female respondents than male were interviewed in the study. Table 4.1 depicts the respondent's gender. In this study there was no significant association between gender and the utilization of the BME professionals (*p value=0.446*).

4.3.2 Level of education

The respondent were asked to state their level of education, the results were as shown in Table 4.3

Table 4.3: Level of education

Level of Education	Frequency	Percent
Diploma	13	16.0
Degree	47	58.0
Masters	18	22.2
Ph.D.	3	3.7
Total	**81**	**100.0**

Majority of the respondent were degree holders which stood at 47(58%), 18(22.2%) of the respondents stated they had masters, 13(16%) on the other hand stated they were diploma holders while 3(3.7%) stated that they had Ph.D. A Chi square p-value was further computed to determine the relationship between the level of education and utilization of BME professionals, there was no significant association found between level of education and utilization of BME professionals (*p value=0.421*).

4.3.3 Designation of the respondents

The respondents were asked to state the designation, the results were as shown in Table 4.4

Table 4.4: Designation of the respondents

Designation of Respondents	Frequency	Percent
Medical Director.	8	9.9
Director Nursing	6	7.4
Finance manager	7	8.6
Human Resource manager	6	7.4
Head of customer care	7	8.6
Head of Information Technology	6	7.4
Procurement officer	8	9.9
Chief pharmacist	7	8.6
Head Facilities	6	7.4
Head of Radiology	6	7.4
Biomedical Engineers	14	17.3
Total	**81**	**100.0**

Of the respondents, 14(17.3%) stated they were biomedical engineers, 8(9.9%) stated they were medical directors. A similar percentage also cited that they were procurement officers, 7(8.6%) stated they were finance managers with a similar percentage citing head of customer care and chief pharmacists. An equal number of respondents cited directors of nursing, human resource managers, head of information technology, head of facilities and head of radiology which stood at 6(7.4%).There was no significant association between designation of the respondents and utilization of BME professionals. (*P value=0.246*).

4.3.4 Number of biomedical engineers.

The respondents were asked to state the number of biomedical engineers in the hospital. Table 4.5 depicts the number of biomedical engineers.

Table 4.5: Number of biomedical engineers

No. of Biomedical Engineers	Frequency	Percent
1	28	34.6
2	33	40.7
3	20	24.7
Total	**81**	**100.0**

It was popular among the respondents to state the number of biomedical engineers as 2 which stood at 33(40.7%). The number of respondents who stated the number of biomedical engineers as 1 stood at 28(34.6%) while 20(24.7%) stated the number of biomedical engineers as 3. A Chi square p-value was worked out to determine the relationship between number of biomedical engineers and utilization of BME professionals. There was statistical significant association between the number of biomedical engineers and utilization of BME professionals. (*P value=0.017*).

4.3.5 Presence in charge/overseer in the biomedical engineering department

The respondents were asked to state whether there is an in charge/overseer in the biomedical engineering department, the results were as shown in table 4.6

Table 4.6: Presence of in charge/overseer in biomedical engineering department

Presence of biomedical Incharge	Frequency	Percent
Yes	56	69.1
No	25	30.9
Total	**81**	**100.0**

Of the respondents, 56(69.1%) stated that there is an in charge/overseer in the department while 25(30.9%) said that there was no in charge/overseer in the department.Chi square test showed no significant relationship between presence of an in charge/overseer in biomedical engineering department and utilization of BME professionals (*P value=0.193*).

4.3.6 Reporting line for biomedical engineering

The respondent were asked to state to whom the in charge of biomedical engineering department reports to, the results were as shown in Table 4.7

Table 4.7: Reporting line for biomedical engineering

	Frequency	Percent
Head of Facility Management Systems	77	95.1
Not Sure	4	4.9
Total	**81**	**100.0**

Majority of the respondents at 77(95.1%) stated that the in charge reports to the head of facility management systems while 4(4.9%) stated that they were not sure what position the in charge reports to. In this study there was no significant association between where the respondents reported to and the utilization of BME professionals. (*P value=0.370*).

4.3.7 Average retainance of biomedical engineer professionals

The respondents were asked to give their opinion on the average retainance of biomedicalengineer professionals. The findings are as shown in table 4.8

Table 4.8 Average retainance of biomedical engineer professionals

	Frequency	**Percent**
Good	21	25.9
Average	50	61.7
Bad	10	12.3
Total	**81**	**100.0**

Of the respondents, 50(61.7%) rated the retainance of the biomedical engineers professionals as average, 21(25.9%) on the other hand rated the retainance of biomedical engineers as good while 10(12.3%) rated the retainance of biomedical engineers as bad. In this study there was a significant relationship between average retainance of biomedical engineers and utilization of BME professionals. (*P value= 0.022*).The study finding is supported by the assertion by Loo and Thorpe (2004) and Savage and Scott (2004) that many Private hospitals have problems retaining BME professionals.

4.3.8 Cause of BME turnover.

Respondents were asked to state the main causes of BME turnover. The results are as depicted in table 4.9

Table 4.9: Cause of BME turnover.

	Frequency	Percent
Motivation for higher pay	44	54.3
Feeling undervalued	13	16.0
Growth opportunity unavailable	11	13.6
They are poorly managed	9	11.1
Organizational Instability	4	4.9
Total	**81**	**100.0**

It was popular among respondents to state motivation for higher pay as the main cause for BME turnover which stood at 44(54.3%). 13(16.0%) stated feeling undervalued as the main cause of BME turnover, 11(13.6%) on the other hand stated growth opportunity unavailable as the main cause while 9(11.1%) and 4(4.9%) stated they are poorly managed and organizational stability respectively and the main cause. It was also established that there was a strong significant relationship between the main causes of BME turnover cited and utilization of BME professionals. (*P value<0.000*).

4.4 Influence of Hospital management system (HMS) on utilization of BME professionals

This section addresses the first objective of the study; To determine the extent by which Hospital Management system influences the utilization of BME professionals.

4.4.1 Hospital Management System

The respondents were asked questions concerning hospital management and the results were as shown in Table 4.10

Table 4.10: Hospital management system.

Statement	YES	NO	P-VALUE
Hospital management has challenges on utilization of BME professionals	13(16%)	68(84%)	0.485
BME department has a role to play in other departments	75(92.6%)	6(7.4%)	0.034
BME professionals are clinical staff	29(35.8%)	52(64.2%)	0.487
Hospital management has negative attitude towards BME professionals and their utilization	12(14.8%)	69(85.2%)	0.023
Hospital has enough BME professionals	50(61.7%)	31(38.3%)	0.045
BME have descriptive job description like other cadres	77(95.1%)	4(4.9%)	0.001
Recommendation on utilization of BME in your hospital	48(59.3%)	33(40.7%)	0.455
BME professionals are aware of their role	70(86.4%)	11(13.6%)	0.002
BME empowered to execute their duties	61(75.3%)	20(24.7%)	0.007

Respondents were asked to state if hospital management has challenges in utilization of BME professionals, majority at 68(84%) responded no while 13(16%) responded yes. There was no significant relationship between the challenges faced by hospital management in utilization of BME professionals and utilization of BME professionals. (*P value=0.485*)

Respondents were further asked to state if the BME department had a role to play in other departments. Majority of the respondents at 75(92.6%) responded yes while 6(7.4%) responded no. In this study there was a significant relationship between the role of BME professional in other departments and utilization of BME professionals. (*P value=0.034*)

Respondents were asked to state if BME professionals are clinical staff. Of the respondents, 29(35.8%) responded yes while 52(64.2%) responded no. the researcher also did a Chi square analysis which showed no significant association between whether BME professionals were clinical staff and utilization of BME professionals. (*P value=0.487*).The findings of this study supported by the argument by Dopson (1996) argues that Biomedical Engineers not clearly identified as either Non clinical or clinical staff ,a point of divergent comes in when Dopson argued that the non-classification BME as clinical staff results into underutilization. This study establishes an insignificant relationship between two variables.

With regard to whether the hospital management has negative attitude towards BME professionals and their utilization, majority at 69(85.2%) responded no while 12(14.8%) responded no. in this study there was a significant relationship between whether the hospital management had negative attitude towards BME professionals and their utilization and the utilization of BME professionals. (*P value=0.023*).This finding converge with those of Preston and Loan-Clarke 2000 negative perception of Private hospital management presents several challenges to BME professional Utilization.

Respondents were asked to state whether the hospital has enough BME professionals. Majority at 50(61.7%) responded yes while 31(38.3%) responded yes. in this study there was a significant relationship between whether the hospital has enough BME professionals and utilization of BME professionals. (*P value=0.045*).These findings diverge with those of Loo

and Thorpe (2004) and Savage and Scott (2004) that many private hospitals have problems in recruiting enough appropriately skilled BME professionals and also Retaining them.

Concerning whether BME professionals have descriptive job description like other cadres, majority at 77(95.1%) responded yes while 4(4.9%) responded no. there was a significant relationship between whether the BME professionals have descriptive job description like other cadres and utilization of BME professionals. (*P value=0.001*). Loo and Thorpe 2004; Savage and Scott (2004) noted that BME professionals also feel their role lacks definition compounded by the lack of definitive job description, this is contrary to the findings of this study.

Respondents were asked to state whether they would give Recommendation on utilization of BME in your hospital. 48(59.3%) responded yes while 33(40.7%) responded no. in this study there was no significant relationship between whether they would give their recommendation on utilization of BME in your hospital and utilization of BME professional. (*P value=0.455*).

Respondents were asked to state whether BME professionals are aware of their role, majority at 70(86.4%) responded yes while 11(13.6%) responded no. The researcher further conducted a chi square test which showed a significant relationship between whether BME professional are aware of their role and utilization of BME professionals. (*P value=0.002*).The findings of the study diverge with those of Dopson (1996) that Private Hospital Managers struggle to understand BME professional identity in that their roles are not understood.

Respondents were asked to state whether BME professionals were empowered to execute their duties. Majority at 61(75.3%) responded yes while 20(24.7%) responded no. In this study there was a significant relationship between whether BME professionals are empowered to execute their duties and utilization of BME professionals. (*P value=0.007*).The findings of the study diverge with those of Biomed Essence (2015) that

Biomedical Engineering Professionals are not fully empowered to execute their duties in Private Hospitals in Kenya as most of the Equipment are maintained on contractual basis.

4.4.2 Minimum number of years of experience that BME professionals get employed

Respondents were asked to state the minimum number of years of experience that BME professionals get employed in the respective hospitals. Table 4.11 depicts the results.

Table 4.11: Minimum number of years of experience that BME professionals get employed.

	Frequency	Percent
2	2	2.5
3	45	55.6
5	27	33.3
7	5	6.2
10	2	2.5
Total	**81**	**100.0**

It was popular among respondents to state 3 as the minimum number of years of experience that BME professionals get employed which stood at 45(55.6%), 27(33.3%) cited 5 years, 5(6.2%) cited 7 years while 2(2.5%) cited 10 years with a similar percentage citing 2 years. The finding diverge with what Amek (2010) established that many BME professionals are given Jobs in private Hospitals without having had any prior field experience hence not vey conversant with current technology therefore limited utilization. This meant that a scenario like the one which reported in the Doctors essence newsletter, 2014 at Maria Nursing Hospital where a child was completely burnt in an Incubator because unexperienced BME

staff use space heater elements to replace with Special asbestos element meant for Incubator is less likely to occur.

Table 4.12: Correlation test between hospital management system and utilization of MBE professionals

			Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal	by	Spearman	.794	.050	18.556	.000
Ordinal		Correlation				
		N of Valid Cases	81			

The Spearman correlation test between hospital management system and utilization of MBE professionals revealed a strong positive relationship ($r=0.794, p<0.000$).This means that better hospital management system will results into better utilization of BMEs in private hospitals.

4.5 Influence of Hospital policy on Utilization of BME Professionals

This section analyses the second objective; to examine the level at which Hospital policy contributes to the Utilization of BME professionals.

4.5.1 Hospital Policy

The respondents were asked questions concerning hospital policy and the results were as shown in Table 4.13

Table 4.13: Hospital policy

Statement	YES	NO	P-VALUE
Hospital has a policy governing medical equipment management	78(96.3%)	3(3.7%)	0.001
Hospital has a training schedule for BME professionals	75(92.6%)	6(7.4%)	0.423
Hospital has a standardization on equipment range	57(70.4%)	24(29.6%)	0.028
Hospital has an equipment disposal policy	70(86.4%)	11(13.6%)	0.05
Hospital has a centralized budgeting and purchasing policy	68(84%)	13(16%)	0.522

Respondents were asked to state if their respective hospitals have a policy governing medical equipment management. Of the respondents, 78(96.3%) responded yes while 3(3.7%) responded no. the study also found a significant relationship between whether the hospitals had a policy governing medical equipment management and utilization of BME professionals (*P value=0.001*). It is evident that the hospitals are aware of WHO healthcare Policy (2015) which noted that the Private Hospital Policy on Healthcare technology procurement, use, maintenance, and management policy is a serious issue. ECRI(2013) also observes that most

private hospitals have policies to ensure that these devices are used correctly to ensure the safety of the patient; indeed, there is evidence that patients are sometimes harmed or die because devices are not used correctly.

Respondents were asked to state if the hospital has a training schedule for BME professionals 75(92.6%) responded yes and 6(7.4%) responded no. There was no significant relationship between whether the hospital has a training schedule for BME professionals and utilization of BME professionals (*P value=0.423*).Respondents were further asked to state the frequency of the training. Majority at 48(59.3%) said it was quarterly, 20(24.7%) said it was done semi-annually, 11(13.6%)said it was done monthly while 2(2.5%) said it was done annually. Since there are a number of equipment and trainings are largely done on a quarterly basis, it therefore means that the concerns of ECRI (2013) also apply in this study in that the variety of equipment makes it difficult to ensure BME professional training is carried out on all devices. Therefore, many private Hospitals also make a policy to only train on the highest risk devices that can harm or kill (in the event of misuse).

With regard to whether the hospital has a standardization on equipment range, majority at 57(70.4%) responded yes while 24(29.6%) responded no. there was a significant positive relationship between whether the hospital has a standardization on equipment range and utilization of BME professionals (*P value=0.028*).The study findings are supported by those of AMEK(2010) that the only way to improve BME professional utilization , and thereby reduce the risk of harm to patients in private Hospitals, is to have a policy on medical equipment standardization; standardizing devices to a single equipment type from a single supplier for each type of medical technology application.

Respondents were asked to state whether the hospital has equipment disposal policy. Majority at 68(84%) responded yes while 11(13.6%) responded no. there was a significant

relationship between whether the hospital has equipment disposal policy and utilization of BME professionals (*P value=0.05*).

Concerning whether the hospital has a centralized budgeting and purchasing policy, it was popular among the respondents to agree which stood at 70(86.4%), 13(16%) on the other hand responded no. the researcher did a chi square test and found no relationship between whether the hospital has a centralized budgeting and purchasing policy and utilization of BME professionals (*P value=0.522*).This is supported by AMEK (2010) assertion that the private hospital should have a policy for planned funding and purchasing from a centralized place to close the Equipment age Gap.

Table 3.14: Correlation test between hospital policy and Utilization of BME professionals

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Spearman Correlation	.523	.087	8.728	.000[c]
N of Valid Cases		81			

The spearman rank correlation test between hospital policy and Utilization of BME professionals revealed that there exists a fairly strong positive relationship between the two variables ($r=0.523$, $p<0.000$).This means that better hospital policy formulation would result into better Utilization of BME professionals among private hospitals.

4.6 Challenges faced by BME professions and their Utilization

This section presents the finding of the third objective; to understand how the challenges faced by BME Professionals influence their utilization.

4.6.1 Challenges faced by Biomedical Engineering Professionals

The respondents were asked questions concerning some of the challenges faced by Biomedical Engineering Professional, the results are as show in Table 4.15

Table 4.15: Challenges faced by biomedical engineering professionals

Statement	YES	NO	P-VALUE
Hospital has sufficient medical equipment to provide quality health care	35(43.2%)	46(56.8%)	0.024
Hospital accepts equipment donations	45(55.6%)	36(44.4%)	0.345
Hospital imports medical equipment	61(75.3%)	20(24.7%)	0.547
Hospital has reliable electricity	77(95.1%)	4(4.9%)	0.001
Hospital has back up power in case of mains failure	81(100%)	0	0.005

Respondents were asked to state whether the hospital has sufficient medical equipment to provide quality health care. 46(56.8%) responded no while 35(43.2%) responded yes. The study found a significant relationship between whether the hospital has sufficient medical equipment to provide quality health care (*p value=0.024*).

Respondents were asked to state whether the hospital accepts medical equipment donations. It was popular among the respondents to state yes which stood at 45(55.6%). 36(44.4%) on the other hand responded no. the researcher also did a chi square test and found no significant relationship between whether hospital accepts equipment donations and utilization of BME professionals. (*P=0.345*).Acceptance of donation poses a challenge, with regards to a study of donations to Columbia from 1974-1979, Pena-Mohr, of the Pan American Health

Organization, points out that five years after donation, "96% of foreign-donated equipment was not working." That same study revealed that 36% of the donations did not work upon arrival due to lack of training, manuals, or accessories. Respondents were further asked to state who oversees the process to ensure only useful equipment are accepted, majority at 51(63%) said they never received donations, 17(21%) stated the BME engineers while 13(16%) stated medical directors as those who oversee the process.

Respondents were asked to state whether the hospital imports medical equipment, majority at 61(75.3%) responded yes while 20(24.7%) responded no. the study found no significant relationship between whether the hospital imports medical equipment and utilization of BME professionals (*p value=0.547*). The findings of the study converge with the assertion by Amek (2009) that in Kenya, over 95% of the medical equipment in public and private hospitals is imported, with virtually no local production. This poses a challenge in that most of the equipment is inappropriate for local needs and unable to be sustained with the lack of local infrastructure.

Respondents were asked to state whether hospital has reliable electricity, 77(95.1%) responded yes while 4(4.9%) responded no, there was a strong significant relationship between whether the hospital has reliable electricity and utilization of BME professionals (*p value*=0.001). The findings converge with those of Malkin and Anand (2001) that unreliable electricity, including spikes and burnouts, make it difficult even for the BME to perform proper Preventive maintenance in their respective private Hospitals in Kenya, hence utilization of BMEs.The respondents were further asked to state whether the hospital has back up power in case of mains failure, all the respondents responded yes which stood at 81(100%). A chi square test was also conducted to determine the relationship between whether the hospital has back up power in case of mains failure and found a strong significant relationship. (*p value=0.005*).

4.6.2 Main cause of equipment lengthened downtime

Respondents were asked to state the main cause of equipment lengthened down time. Table 4.16 depicts the results.

Table 4.16 Main cause of equipment lengthened downtime.

	Frequency	Percent
Lack of spare parts	78	96.3
Lack of expertise	1	1.2
Not useful anymore	2	2.5
Total	**81**	**100.0**

It was popular among the respondents to state lack of spare parts as the main cause of equipment lengthened downtime which stood at 78(96.3%), 2(2.5%) stated it was not useful anymore while 1(1.2%) stated that it was due to lack of expertise. This converges with the assertion of Malkin and Anand (2001) that High-tech Equipment often require expensive replacement parts. Due to the rugged environments in kenya, the equipment fail frequently and access to replacement parts is often difficult and expensive, this results to lengthened downtime.

Table 4.17: Correlation test between Challenges faced by BME Professionals influence their utilization

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Spearman Correlation	-0.014	.074	.204	0.038
N of Valid Cases		81			

A Spearman Correlation test was also done on the Challenges faced by BME Professionals influence their utilization, it was found out that the relationship was a weak negative but

significant (r=-0.014,p= 0.038).This means that elimination of the challenges faced by the MBE professionals would result into improved utilization of BME Professionals albeit to a very small degree.

4.7 Effects of Biomedical Equipment specialty training on Utilization of BME Professionals

This section analyses the findings of the fourth objective; to asses level at which Equipment specialty training affects utilization of BME professionals.

4.7.1 Specialty Training of Biomedical Engineers

The respondents were asked questions about specialty training of biomedical engineers, the results are as show in Table 4.15

Table 4.18: Specialty training of biomedical engineers

Statement	YES	NO	P-VALUE
Biomedical department has specialty trained staff	20(24.7%)	61(75.3%)	0.042
Hospital has contracted companies for specialized equipment	69(85.2%)	12(14.8%)	0.025
Recommendations to specialty trainings for BME professionals	77(95.1%)	4(4.9%)	0.927
Hospital has leased medical equipment	78(96.3%)	3(3.7%)	0.047

Respondents were asked to state whether the biomedical department has specialty trained staff, majority of the staff at 61(75.3%) said no with only 20(24.7%) answering on the affirmative. The study found a significant relationship between whether the biomedical

department has specialty trained staff and utilization of BME professionals (*p value=0.042*). The findings of the study is supported by Leibach (2007) who noted that in Kenya there is no specialty training for BME professionals the curriculumm covers a wide range of equipment making it difficult for a BME professional to have expertise in a given field of Medical technology. Respondents were further asked to state the highest level of education for BME professionals, majority at 40(49.4%) stated degree level, 34(42%) stated diploma level and the least respondents at 7(8.6%) stated they were not sure.

Respondents were asked to state whether the biomedical department has contracted companies for specialized equipment, majority at 69(85.2%) responded yes while 12(14.8%) responded no. the researcher did a chi square test and found a significant relationship between whether the biomedical department has contracted companies for specialized equipment and utilization of BME professionals. (*p value=0.025*).The findings converge with those of Leibach (2007) that private hospitals prefer to contract specialized company to oversee a specialized department than a general Biomedical practioner. The respondents were further asked to state which section is covered by contracted services, 19(23.5%) stated dialysis machines with a similar percentage citing radiology machines. 16(19.8%) stated vent, 12(14.8%) stated glicometers, 6(7.4%) stated laboratory machine, 5(6.2%) stated data scopes and 4(4.9%) stated weighing scales.

Respondents were asked to state whether they would give recommendations for specialty training for BME professionals, majority at 77(95.1%) responded yes while 4(4.9%) responded no. the study found no significant relationship between whether they would give recommendations for specialty training for BME professionals and utilization of BME professionals. (*p value=0.927*).Leibach (2007) also recommended fundamentals for the proposed doctorate in BME profession and the proposed skills needed for successful implementation of full utilization of BME professionals prepared ensuring full participation

on the interdisciplinary health care team. Respondents were asked to state whether the hospital has leased medical equipment, 78(96.3%) responded yes and 3(3.7%) responded no. the study found a significant relationship between whether the hospital has leased medical equipment and utilization of BME professionals. (*P=0.047*).

Table 4.19: Correlation test between Equipment specialty training and utilization of BME Professionals

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Ordinal by Ordinal	Spearman Correlation	0.625	.074	.196	.012
N of Valid Cases		92			

A Spearman Correlation test was also done on equipment specialty training and utilization of BME Professionals, it was established that the relationship was a strong positive and significant one (r=0.625, p=0.012).This means that implementation of equipment specialty trainingwould result into improved utilization of BME Professionals.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter presents the summary of the findings of the main study, conclusions and recommendations.

5.2 Summary of findings

The first objective of the study was to determine the extent by which Hospital Management system influences the utilization of BME professionals. The hospital management did not have challenges in utilization of BME professionals as indicated by the majority at 68(84%).The BME department had a role to play in other departments as indicate by 75(92.6%), only 6(7.4%) had a divergent opinion. Majority 52(64.2%) said that the BME professionals are not clinical staff, 29(35.8%) had a different opinion. The hospital management had a positive attitude towards BME professionals and their utilization at stated by 69(85.2%) respondents. It was established that the hospitals had enough BME professionals at 50(61.7%). It was clear that the BME professionals have descriptive job description like other cadres at 77(95.1%) approval that they were aware of their role at 70 (86.4%) approval. It was also established that the BME professionals were empowered to execute their duties as noted by majority of the respondents at 61(75.3%). It was revealed that there is a strong positive relationship ($r=0.794$, $p<0.000$) between hospital management system and utilization of MBE professionals.

The second objective of the study was to examine the level at which Hospital policy contributes to the Utilization of BME professionals. Majority of the respondents at 78(96.3%) said that there were policies governing medical equipment management. The bulk of the respondents to agreed that the hospital had a training schedule for BME professionals which

stood at 75(92.6%) with the training mostly done on a quarterly basis at 20(24.7%), semi-annually at 11(13.6%) and 2(2.5%) said it was done annually. It was evident that the hospitals had a standardization on equipment range as indicated by majority of the respondents at 57(70.4%). Most hospitals has equipment disposal policies as pointed out by majority of the respondents at 68(84%), in addition it was established that hospital had a centralized budgeting and purchasing policy, this was the view of 70(86.4%) respondents. There was fairly strong positive relationship between hospital policy and Utilization of BME professionals ($r=0.523$, $p<0.000$).

The third objective was to understand how the Challenges faced by BME Professionals influence their utilization. Majority of the respondents at 46(56.8%) had insufficient medical equipment to provide quality health care. Most hospitals accepted medical equipment donations, as shown by 45(55.6%) respondents, the equipment donations were presided over by BME engineers 17(21%) and medical directors while 13(16%) . It was common among the respondents to agree that the hospital imports medical equipment which stood at 61(75.3%). It was evident that most hospitals had stable power supply at 77(95.1%) as well as a back-up power in case of mains failure as indicated by 81(100%) of the respondents. Lack of spare parts was the main cause of equipment lengthened downtime as indicated by 78(96.3%) respondents. It was found out that the relationship between the challenges faced by BME Professionals influence their utilization was a weak negative but significant ($r=-0.014$, $p= 0.038$).

The fourth objective was to assess level at which Equipment specialty training affects utilization of BME professionals. It was established that biomedical department had specialty trained staff, as indicated by all the 81(100%) respondents. It was noted that majority of BME professionals had degree level of education as indicated by 40(49.4%) of the respondents,

34(42%) stated diploma level with 7(8.6%) not being sure. Majority of the hospitals contracted companies for specialized equipment as indicated by 69(85.2%) respondents with 19(23.5%) stated dialysis machines and radiology machines tying, 16(19.8%) stated vent, 12(14.8%) stated glicometers, 6(7.4%) stated laboratory machine, 5(6.2%) stated data scopes and 4(4.9%) stated weighing scales as some of the contracted services. Majority of the respondents would give a recommendation for specialty training for BME professionals at 77(95.1%) responded yes. It was also established that he hospital had leased medical equipment as indicated by 78(96.3%) respondents. It was established that there was a strong positive and significant between equipment specialty training and utilization of BME Professionals, ($r=0.625$, $p=0.012$).

5.3 Conclusion

With regard to the first objective; the researcher concluded that the role of BME professional in other departments, the attitude of hospital management towards BME professionals, the number of BME professionals, job description for BME professionals, awareness of BME professional of their role and the empowerment of BME professionals to execute their duties were important in explaining the relationship to the utilization of BME professionals.

The researcher also deduces that challenges faced by hospital management in utilization of BME professionals, if BME professionals were clinical staff, and whether they would give their recommendation on utilization of BME in the were not important in explaining the variations in utilization of BME professionals.

In respect to the second objective; there researcher conclude that presence of policy governing medical equipment management, whether the hospital has standardization on equipment range and whether the hospital has equipment disposal policy were important in explaining the variations in the utilization of BME professionals. On the other hand, whether

the hospital has a training schedule for BME professionals and whether the hospital has a centralized budgeting and purchasing policy would not explain the utilization of BME professionals.

In relation to the third objective; the researcher concluded that whether the hospital has sufficient medical equipment to provide quality health care, whether the hospital has reliable electricity and whether the hospital has back up power in case of mains failure and utilization of BME professionals were important in explaining utilization of BME professionals. On the other hand, whether the hospital accepts equipment donations and whether the hospital imports medical equipment were not important in explaining utilization of BME professionals.

Pertaining to the fourth objective; the researcher concluded that there is a significant relationship between specialty training of BME professionals and utilization of BME professionals. This was with respect to whether the biomedical department has specialty trained staff, whether the biomedical department has contracted companies for specialized equipment and whether the hospital has leased medical equipment and utilization of BME professionals. However there was no significant relationship with regard to whether they would give recommendations for specialty training for BME professionals.

5.4 Recommendations

Based on the research findings, the researcher made some recommendations that are aimed at enhancing utilization of BME professionals in hospitals.

1. The researcher recommends that the hospital management should ensure that all staff are appropriately recruited, trained, qualified, supervised and competent to practice.
2. The researcher recommends that the hospital policy should incorporate the policy for biomedical engineers to support and complement competence and professional standards for biomedical medical engineers this will in turn contribute to the utilization of the BME professionals.
3. The researcher recommends that the hospital should ensure the good professional practice of individuals, teams and the service are balanced with the needs of the employer and the users of the service.
4. Private hospitals should ensure that there is sufficient medical equipment that can enable the provision of quality and competitive health care.
5. The researcher recommends that the hospital should adopt continuing professional development which assures that they meet the requisite knowledge and skills levels that relate to the evolving scope of the professional practice of biomedical engineers.

5.5 Contribution to knowledge base

Objective	Contribution to body of knowledge
To determine the extent by which Hospital Management system influences the utilization of BME professionals	There is a strong positive and significant relationship between hospital management system and utilization of BME professionals ($r=0.794$, $p<0.000$).
To examines the level at which Hospital policy contributes to the Utilization of BME professionals	There exists a fairly strong positive and significant relationship between Hospital policy and utilization of BME professionals ($r=0.523, p<0.000$)
To understand how the Challenges faced by BME Professionals influence their utilization	It was established that there was a weak negative significant relationship between challenges faced by the MBE professionals and their utilization ($r=-0.014$, $p= 0.038$).
To asses level at which Equipment specialty training affects utilization of BME professionals.	There was a strong positive and significant relationship between equipment specialty training and utilization of BME professionals ($r=0.625$, $p=0.012$).

5.6 Suggestions for further research

There is need to investigate the influence of the involvement of staff on the management decisions on in the Biomedical Department on quality of healthcare.

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APPENDICES

APPENDIX I: INTRODUCTION LETTER

MILLICENT ALOOH

P.O BOX 27185-00100

Nairobi

Dear Sir/Madam,

RE: REQUEST TO COLLECT INFORMATION

I am a student at the University of Nairobi, pursuing a Master of Arts degree. I am undertaking a study that seeks to investigate the ***"*DETERMINANTS OF UTILIZATION OF BIOMEDICAL PROFESSION IN PRIVATE HOSPITALS IN KENYA A CASE OF NAIROBI COUNTY*".***

The purpose of this letter, therefore, is to seek your permission to collect the relevant data within your area of jurisdiction. The information obtained will be treated with utmost confidentiality and will be used only for the intended purpose.

Thanking you in advance.

Yours faithfully,

MILLICENT ALOOH

APPENDIX II: QUESTIONNAIRE

QUESTIONAIRE FOR UTILIZATION OF BME PROFESSIONALS IN PRIVATE HOSPITALS IN KENYA, NAIROBI COUNTY

The researcher is a student of the University of Nairobi, undertaking Masters of Arts degree in Project Planning and Management. The purpose of this questionnaire is to obtain information on the Utilization of Biomedical Engineering profession In private Hospitals In Kenya Nairobi which is my area of study***". A***ll responses will be confidential and will only be used for the purposes for academic purposes..

SECTION A: BACKGROUND INFORMATION

Please tick appropriately.

1. Your gender. Male ( ) Female ( )
3. Your level of education

   Diploma ( )

   Degree ( )

   Masters ( )

   PhD ( )
4. What is your Designation?

   (a) Biomedical Engineer

   (b) Human Resource Manager

   (c) Doctor

   (d) Nurse

   (e) Pharmacist

   (f) Finance manager

   (g) IT Manager

   (h) Procurement Manager

   (i)
5. How many Biomedical Engineers does your hospital have?

_____

6. What is the name of your Hospital?_____

7. Does your Biomedical Engineering department has an overseer/Incharge ? _____

8. To what position does the in charge of Biomedical Engineer report to ?

9. What is the average retainance of Biomedical Engineer professionals in Your Hospital?

10. What's the main Cause of BME staff turnover?

SECTION B – HOSPITAL MANAGEMENT SYSTEM

11. Do think your hospital management has challenges on utilization of BME professionals? YES ( ) NO ( )

12. (a) Does BME department has a role to play in your department ? YES ( ) NO ( )

(b) If yes, which Role do they play?

13 (c) Are BME Professionals Clinical staff? YES ( ) NO ( )

(b) If Yes/No, please explain?

14. (a) Does your Hospital Management has Negative attitude towards BME professionals and their utilization? YES ( ) NO ( )

(b) If yes explain

15. (a) Do you think your Hospital has enough BME professionals ? YES ( ) NO ( )

(b) If no explain why?

(c) Does Your BME professionals have Descriptive Job description like other cadres? YES ( ) NO ( )

16. (a) Would you recommend any change on utilization of BME in your hospital ? YES ( ) NO ( )

(b) If yes explain?

17. (a) Are BME professionals in your hospital aware of their role? YES ( ) NO ( )

(b)Are the BME professionals in your Hospital empowered to execute their duties? YES ( ) NO ( )

18. What is the Minimum number of years of experience that BME professionals get employed at your Hospital?

SECTION C – HOSPITAL POLICY

19. (a) Does your Hospital have a policy governing medical equipment management ?

YES ( ) NO ( )

(b) If yes what is the policy statement

20 (a) Does your Hospital have any training schedule for BME professionals?

YES ( ) NO ( )

(b) If yes, what are the equipment targeted for training?

(c) What is the frequency of the training?

21. Do you have any standardization on equipment range?

YES ( ) NO ( )

22. (a) Do you have an Equipment disposal policy? YES ( ) NO ( )

(b)Which department is the custodian of the Policy?

23. Do you have centralized Budgeting and purchasing policy? YES ( ) NO ( )

24. Explain how the new equipment inspection policy in your hospital?

SECTION C – CHALLENGES FACED BY BIOMEDICAL ENGINEERING PROFESSIONALS

25. (a) Do you have sufficient Medical Equipment to provide quality healthcare in your hospital? YES ( ) NO ( )

(b) If No, which section of the Hospital is underequipped with Medical Equipment?

26.(a) Do you accepts equipment Donations ? YES ( ) NO ( )

(b) If yes, who oversees the process to ensure only useful equipment are accepted?

27. Do you import your Medical equipment?

28. (a) Do you have reliable Electricity in Your Hospital? YES ( ) NO ( )

(b) Do you have any back up power incase of mains failure? YES( ) NO ( )

29. (a) What is the main cause of equipment lengthened downtime in your hospital? Please Tick appropriately

(a)Lack of spare parts

(b)Lack of expertise

(c)Not useful anymore

(d)Other please specify

SECTION D – SPECIALTY TRAINING OF BIOMEDICAL ENGINEERS

30. (a) Does Biomedical Engineering Department have specialty trained staff ?

YES ( ) NO ( )

(b) If yes, what are the specialty trainings for?

31. (a) What is the highest level of Education for the BME professionals in your Hospital

32. (a) Do you have contracted companies for specialized equipment? YES ( ) NO ( )

(b) Which section is covered by Contracted services?

33. (a) Would you recommend specialty trainings for BME professionals? YES ( ) NO ( )

(b If NO? Explain

34. Do you have leased Medical Equipment? YES ( ) NO ( )

35. Explain how the leased medical equipment are maintained in your Hospital?

APPENDIX III: DATA COLLECTION PERMIT

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION
KISUMU CAMPUS

The Secretary
National Council for Science and Technology
P.O Box 30623-00100
NAIROBI, KENYA

27th May, 2016

Dear Sir/Madam,

RE: MILLICENT ALOOH - REG NO: L50/77012/2014

This is to inform you that **Millicent Alooh** named above is a student in the University of Nairobi, College of Education and External Studies, School of Continuing and Distance Education, Kisumu Campus.

The purpose of this letter is to inform you that **Millicent** has successfully completed her Masters Course work and Examinations in the programme, has developed a Research Proposal and submitted before the School Board of Examiners which he successfully defended and made corrections as required by the School Board of Examiners.

The research title approved by the School Board of Examiners is*: "Utilization of Biomedical Engineering Profession in Private Hospitals: A Case of Nairobi County".* The Project is part of the pre-requisite of the course and therefore, we would appreciate if the student is issued with a research permit to enable her collect data and write a report. Research project reflect integration of practice and demonstrate writing skills and publishing ability. It also demonstrates the learners' readiness to advance knowledge and practice in the world of business.

We hope to receive positive response so that the student can move to the field to collect data as soon as he gets the permit.

Yours Faithfully

Dr. Raphael O. Nyonje, PhD
SENIOR LECTURER & RESIDENT LECTURER
DEPARTMENT OF EXTRA-MURAL STUDIES
KISUMU CAMPUS

APPENDIX IV: LETTER OF DATA COLLECTION

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION

Our Ref.: UON/CEES/KSM/1/16

University Of Nairobi Plaza
Oginga Odinga Street
P.O. Box 825,
KISUMU. Kenya

Telephone: Kisumu 057-2021534

27th May, 2016

TO WHOM IT MAY CONCERN

RE: MILLICENT ALOOH - REG NO: L50/77012/2014

This is to inform you that the above named **Millicent Alooh** is a student at the University of Nairobi, College of Education and External Studies, School of Continuing and Distance Education, Department of Extra Mural Studies pursuing **Masters in Project Planning and Management**.

Millicent has completed her course work and examinations successfully and she is now undertaking her Research Project which is a pre-requisite for the course. The Project is entitled: ***"Utilization of Biomedical Engineering Profession in Private Hospitals: A Case of Nairobi County "***The purpose of this letter therefore is to request you to allow the student to access the data or information she may need for purpose of this study. The data is required for her academic purposes only and not for any other reasons.

We would appreciate any assistance that may be given to enable her carry out the study.

Yours faithfully,

27 MAY 2016
P.O. Box 057 - 2021534
KISUMU CAMPUS

Dr. RAPHAEL O. NYONJE, PhD
RESIDENT LECTURER
KISUMU CAMPUS

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APPENDIX V: MAP OF STUDY AREA