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TITLE: **COST CUTTING MEASURES FOR THE MAINTENANCE OF HOSPITAL MEDICAL EQUIPMENT IN THE EASTERN CAPE, SOUTH AFRICA**

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Cost Cutting Measures for the Maintenance of Hospital Medical Equipment in the Eastern Cape, South Africa

By

Bonga Mabentsela

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DECLARATION

I, Bonga Mabentsela, do hereby declare that this mini-dissertation is the results of my original work, research and investigation and that this has not been submitted in part or full for any degree or for any other degree to any other University.

Signed: _____

Date: ____28-01-2020__

CERTIFICATION

This mini-dissertation entitled Cost Cutting Measures for the Maintenance of Hospital Medical Equipment in the Eastern Cape, South Africa meets the regulations governing the award of the degree of Masters of Public Health at the University of Fort Hare and is approved for its contribution to scientific knowledge.

Mr D. Seekoe

Research Co-Supervisor

29/01/2020

Date

Prof. MG Pinkoane

Research Supervisor

28/1/2020

Date

DEDICATION

I dedicate this research report lovingly to the following:

My wife, Thembile

My daughter, Pumelela and

My son, Enzokuhle.

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B. Mabentsela

LIST OF ACRONYMS

BMET:	Biomedical Equipment Technicians
CE:	Clinical Engineering
COSR	cost of maintenance service over acquisition cost ratio
DoH:	Department of Health
HTA:	Health Technology Assessment
MEMP:	Medical Equipment Management Programs
MTTF:	Mean Time to Failure
NHI:	National Health Insurance
PMB:	Prescribed Minimum Benefits
RCM:	Reliability Centred Maintenance
TAT:	Turn Around Time
WHO:	World Health Organisation

ABSTRACT

The Eastern Cape Department of Health is located in Bisho, Eastern Cape Province of South Africa and about 88% of the EC population is serviced by the public health sector. Most of the facilities are situated in remote areas and for the maintenance of medical equipment they rely on the service of the few private equipment vendors that are situated in two cities, East London and Port Elizabeth and in some instances these vendors are located in Gauteng province. The location of vendors makes it difficult and impossible for these medical equipment vendors to render the acceptable service to the Department. This study was undertaken to systematically study the cost cutting measures of medical equipment department of health, Eastern Cape.

A quantitative method approach was used using exploratory and descriptive research design during the 2019-20 financial year (April 2019 to March 2020). The sample for this study was limited to managers who have the ability to provide the information about the acquisition, maintenance and management of medical equipment. The total sample size was 100.

The major finding was that outsourcing is not feasible. The respondents preferred in-sourcing, standardisation of medical equipment and procuring equipment with comprehensive maintenance contracts.

The findings from the study were that the Department will cut costs associated with medical equipment if maintenance of medical equipment is in-sourced, equipment is standardized and equipment is procured with maintenance contracts. The study recommended that the Department should revisit some of its medical equipment maintenance strategies and draw up comprehensive interventions to reduce costs associated with maintenance of medical equipment and improve service delivery in the Department.

KEY WORDS: Medical equipment, maintenance, maintenance contracts, outsourcing

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CHAPTER 1 - INTRODUCTION

1.1 Introduction

This research explores the cost cutting measures for the maintenance of medical equipment at the department of health, Eastern Cape. The background to the problem is discussed; the aims; objectives and the significance of the study is also laid out followed by the literature review and the chosen research methodology and design. A brief format of the study which provides an outline of each chapter is also discussed.

1.2 Background to the study

The mandate that vests the overall responsibility for the maintenance of all health infrastructure assets in the Department of Health (DoH) is legislated in the Constitution of South Africa, and in the National Health Act (Department of Health, 2015). South Africa enshrines the right to access health care for all people in the country. This ultimately mandates the Department of Health to establish and maintain a health delivery system that supports, and meaningfully realises this constitutional right. However, the Constitution takes cognisance of the fiscal challenges that have to be overcome ahead of this enshrined universal healthcare provision being fully realised. South Africa, taking into account the obligations imposed by the Constitution, sets as one of its objectives, the protection, promotion, and fulfilment of the rights of the people of South Africa to the progressive realisation of the constitutional right of access to health care services (Terence, 2014). Indicated under Section 47, it legislates that all health establishments must comply with the quality requirements and standards prescribed therein which may relate to human resources, health technology, equipment, premises, the delivery of health services, business practices, and the manner in which users are accommodated and treated. Clearly, a crucial and vital component of this health delivery system comprises the infrastructure and health technology equipment which enables and facilitates health care delivery to occur. Provincial departments of Health and public sector hospitals are being sued billions of rands and this is a result of a mix of too many reasons, sick patients, human resource constraints, lack of equipment, non-functioning equipment and recurring shortages of supplies (Pelton, 2014).

The Eastern Cape Province has about 1100 health facilities with most of these situated in remote areas. These health facilities rely on the service of the few private equipment vendors that are situated in two cities, East London and Port Elizabeth and in some instances these vendors are located in the Gauteng province. The location problem makes it difficult for these medical equipment vendors to render the acceptable service to the Department. Some hospitals have Clinical Engineering departments, but without dedicated resources. Studies have been conducted in the country and in the Province and it has been found that the medical equipment or healthcare technology assets are not able to support the delivery of healthcare services adequately and this is due to the fact that the maintenance of these technologies are not conducted optimally.

1.3 The Research Problem

This research explores the cost cutting measures for the maintenance of medical equipment in Eastern Cape Department of Health. The Eastern Cape Department of Health is faced with huge maintenance back log of medical equipment. There is a severe problem with the maintenance of medical equipment .There are virtually no Clinical Engineering services available to perform maintenance of medical equipment in health facilities. In most cases the maintenance budget is used to replace equipment that is far from reaching its end of lifecycle and requires minor repairs or maintenance. The function of Clinical Engineering services is outsourced to private vendors that do not have enough capacity to service the province. This results in inefficiencies, equipment downtime which then result in clinicians being unable to provide better services. Thus, the purpose of this research is to investigate the cost cutting measures in the maintenance of medical equipment in the Eastern Cape health facilities. The results of the study will provide Eastern Cape Department of Health with an indication of how medical equipment maintenance cost can be reduced.

1.4 Aim of the Study

The aim of the study is to explore cost cutting measures in the maintenance of hospital medical equipment in the Eastern Cape

1.5 Research Objectives

- Determine if insourcing or outsourcing of medical equipment maintenance contribute to saving cost.
- Examine if standardization of medical equipment has a contribution to saving cost.
- Investigate if medical equipment maintenance contracts assist in saving cost.

1.6. Research Questions

- How does insourcing or outsourcing of medical equipment maintenance contribute to cost saving?
- How does standardization of medical equipment contribute in cost saving?
- Which medical equipment maintenance contracts assist in cost saving?

1.7 Significance of the Study

The results from this study will allow a reappraisal of the competing theories of medical equipment maintenance strategies. The study will assist the Eastern Cape Department of Health in developing the health technology maintenance strategies. This issue is one of the most important topics, not only in the Eastern Cape ,but nationally and most of the developing countries, as testified by the number of papers, books and international conferences on this subject that have taken place over the last few years. Therefore it is anticipated that this project will generate a great deal of interest, not only among medical equipment users, but also among the decision makers, healthcare technology managers, finance managers, national department of health and other provinces as they can begin to benchmark from Eastern Cape. The other provinces could begin to review and implement the results of this study. On completion of the study recommendations will be provided to the Department of Health as to how can the department benefit from the cost cutting measures identified in this research.Based on the recommendations made the Department will develop medical equipment maintenance policy that can be implemented across the province. The department will have a clear information about the maintenance strategies that can be implemented in order to cut medical equipment maintenance costs and improve services.

1.8 Format of the Study

The contents of each chapter of the dissertation is described below where a brief description about each chapter is outlined. This will be the format of the study.

Chapter 1 is the Introduction which gives information about the research that is being undertaken. The chapter also provides a roadmap for what the rest of the study entails.

Chapter 2 is the Literature review which provides an analysis and evaluation of the existing knowledge pertaining to each research problem that this research seeks to study.

Chapter 3 is the Research methodology where information about the chosen research methodology is discussed. A description and justification of the research design, method as well as ethical considerations that is followed in this research is discussed.

Chapter 4 is the Results, discussion and interpretation of the findings. The purpose of this chapter is to present the findings of this study. The chapter present and provide the analysis of the data obtained from participants. This is done to achieve the study's aim.

Chapter 5 is the Conclusions and recommendations which consists of an introduction and conclusion. The main aim of this chapter is to make a summary of the findings of the study conducted. The chapter first provides a summary of the findings from literature. It then provides a summary of the findings from the primary research. Recommendations are also suggested to enable a more effective and efficient way of implementing the medical equipment cost cutting measures.

1.9 Conclusion

This chapter describes a brief overview of the research process, the research questions, objectives and methodology. Chapter two presents the literature analysis and evaluation of the existing knowledge relevant to the research problem.

CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

In this section, the status of research on maintenance of medical equipment is assessed. The section provides an outline of the importance of medical equipment in hospitals. It also covers the insourcing versus outsourcing of medical equipment maintenance; standardisation of medical equipment; as well as medical equipment maintenance contracts. Reduction of costs associated with medical equipment maintenance as well as strategies that can be employed in cutting the high maintenance cost is discussed. A reflection on the legislation that governs medical equipment maintenance will also be reviewed.

The maintenance and care of the medical equipment available in public hospitals is in accordance with section 38(1) (d) of the Public Finance Management Act 1 of 1999 as amended which states that “the accounting officer for a department, trading entity or constitutional institution is responsible for the management, including the safeguarding and the maintenance of the assets of the department” (South Africa, 1999). Based on this Act, public hospitals must keep inventory an asset registers, procurement and maintenance plans for the effective and efficient management of medical equipment available in public sector hospitals.

Although hospitals spend a significant amount of financial resources for the purchase and maintenance of medical equipment as well as procurement of consumables for these equipment, no formal study has been done in South Africa to document this. This study is planned as a first step to address the knowledge gap in this important area.

2.2 Theoretical Statements

Medical device means any instrument, apparatus, implement, machine, appliance, implant, reagent for in vitro use, software, material or other similar or related article, intended by the manufacturer to be used, alone or in combination, for human beings, for one or more of the specific medical purpose(s) of:

- diagnosis, prevention, monitoring, treatment or alleviation of disease,
- diagnosis, monitoring, treatment, alleviation of or compensation for an injury,
- investigation, replacement, modification, or support of the anatomy or of a physiological process,
- supporting or sustaining life,
- control of conception,

- disinfection of medical devices,
- providing information by means of in vitro examination of specimens derived from the human body; and does not achieve its primary intended action by pharmacological, immunological or metabolic means, in or on the human body, but which may be assisted in its intended function by such means (WHO 2011).

Medical equipment is the Medical devices requiring calibration, maintenance, repair, user training and decommissioning – activities usually managed by clinical engineers. Medical equipment is used for the specific purposes of diagnosis and treatment of disease or rehabilitation following disease or injury; it can be used either alone or in combination with any accessory, consumable or other piece of medical equipment. Medical equipment excludes implantable, disposable or single-use medical devices. (WHO 2011)

Cost-cutting measures are initiatives that focus on reducing expenses through methods such as lowering salary costs, conserving necessary resources, or consolidating office spaces to decrease facilities expenses in order to improve the financial health of an organization (http://www.businessdictionary.com/)

Maintenance is a combination of both technical and administrative actions which are aimed at keeping the components of an equipment in the most appropriate condition for effective use (Egolum, Oladejo, and Umeh 2015).

Corrective maintenance (CM) is a process used to restore the physical integrity, safety and or performance of a device after a failure (WHO 2011).

Inspection and preventive maintenance (IPM) refers to all the scheduled activity necessary to ensure a piece of medical equipment is functioning correctly and is well maintained. IPM therefore includes inspection and preventive maintenance (PM) (WHO 2011).

2.3 Insourcing or Outsourcing Medical Equipment Maintenance

Medical devices are assets that directly affect human lives. Medical technology are seen as assets that have an effect on the lives of citizens. Governments are investing in medical technology and the cost of investing and maintaining such technologies is high. Bearing this in mind, it is vital to ensure that the provision of medical technology is prioritised and maintained such that the costs are reduced. Maintenance of medical equipment is the function of Clinical Engineering Department. This function is also

performed by medical equipment vendors. According to WHO (2013), maintenance strategy includes procedures for inspection, as well as preventive and corrective maintenance. Health facilities may choose to insource or outsource maintenance of medical equipment.

Tiwari and Tiwari (2014) points out that, players in the health industry have been outsourcing maintenance of medical equipment and this has become commonplace. The advantages of outsourcing are that there is increased operational efficiency, the suppliers in the private sector have technical expertise and there is also the spread of risk amongst the stakeholders. However, it should be noted that outsourcing can also come up with its costs. In order to keep risk to a minimal it is necessary to measure the operational efficiency of those who would be providing the services and they must be monitored and evaluated to ensure that they provide the desired outcomes (Tiwari and Tiwari, 2014).

Currently the trend in South Africa is that equipment maintenance is outsourced to the private vendors with no intentions of strengthening the in-house Clinical Engineering departments. Equipment is procured with five year maintenance contract. The equipment vendors are required to keep the spare parts in order for them to respond to the equipment breakdown within a short period of time. A study done by Haugan, Miguel-Cruz, and Rios-Rincón (2014) provided evidence which showed that outsourcing of spare parts brought significant effects on the overall performance of governance systems. This shows that outsourcing can have an impact on the government activities. In contrast with outsourcing of medical equipment maintenance, Mkalaf (2015) argue that, the effectiveness of a maintenance strategy will depend on the type of maintenance service used by the healthcare organisation. Maintenance services can be classified into three types: using an in-house biomedical engineering service department, outsourcing all the maintenance services to independent companies and mixing in-house with outsourced services. In support of the arguments Mkalaf (2015), points out the advantages and disadvantages of insourcing medical equipment maintenance.

Advantages:

- Fast response possible for breakdowns.

- Technical staff can work closely with professional users;
- On-site repairs can lead to short down times.
- Often less costly than an outside organisation for a given level of service (Mkalaf 2015).

Disadvantages:

- Special tools and test equipment may not be available or may need additional costs (for example, calibration by the manufacturer).
- Hard to maintain adequate stocks of spare parts across a wide range of devices.
- Training costs high and manufacturers are sometimes reluctant to provide.
- In-house staff are typically generalist rather than specialist (Mkalaf, 2015).

According to (Wang et al. 2006) cited by Mkalaf (2015), maintenance management strategies fall into two categories. The first involves unplanned activities such as repair and replacement. The second involves planned activities which include proactive and reactive strategies. Proactive activities include scheduled replacement, predictive (or on-condition) maintenance and scheduled discard. Reactive activities include failure-finding tasks, recalibration, and redesign.

Gupta, Jaltade, Path, and Patil (2015) suggested that actual steps should be taken to reorganize the upkeep and repairs of expensive equipment. Apurva and Ankita (2014) identifies outsourcing of outlying activities to specialized non-hospital establishments in order to safeguard better attention of administration over the main activities as the plan that can be employed. Outsourcing also safeguards increase in functioning efficiency, access to skilled expertise, better risk management, cost-effectiveness, flexible staffing as basic benefits. Hockel and Kintner (2014) argues and say optimising Clinical Engineering (CE) processes can bring high utilisation of equipment and backing realising the organisation's financial aims. To do so you must construct and full leverage a best in-house CE department that carries extreme value to your medical equipment assets. The end result is the removal of large, expensive service contracts, not staff, services or other valuable resources. Ait Kadi, Jamshidi, Rahimi, and Ruiz (2014) agree with and say, when a health care institution lacks the technical skills or specialized assets needed for the maintenance of its medical technology, maintenance should be outsourced. However while outsourcing has grown in popularity, research on maintenance outsourcing for medical devices in academic literature remains scarce. Research into the outsourcing of medical device maintenance services and its

associated risks in hospitals is still in its infancy stages, and that further progress in this field would benefit from additional empirical study grounded in management theory. In the healthcare environment this problem is worthy of study, as healthcare institutions lacking the capacity to deal with these issues may face significantly higher costs

Khalaf et al. (2015) points out that, to safeguard acceptable system dependability and safe operation of medical equipment, a number of tools are used in healthcare services. Maintenance is just one tool, and others include increasing number of equipment, leasing equipment and employing more reliable components. In a study done at Evanston Hospital one of the principal advantages from in-house maintenance cited by Caceress (2012) was the fast response times. Devices could be made operative without disrupting patient flow; night and weekend emergencies could also be resolved speedily. It is essential for any health-care facility, regardless of its size, to implement a maintenance programme for medical equipment. The difficulty of the programme depends on the size and type of facility, its location, and the resources required. However, the principles of a good maintenance programme will be the same if it is in an urban area in a high-income country or a rural setting in a low- to middle-income country (WHO, 2011).

According to Chemweno, Mukhongo, and Mutia (2018), facility managers consider maintenance as unnecessary practice as it delays or obstructs the health service delivery. However, maintenance strategy is the pivot point for the success of health delivery services by the medical equipment in the hospitals. A predictive and intelligent management system customized for in-house decision making computerized maintenance management systems may provide the best maintenance management of medical equipment in the healthcare. A good strategy of maintenance is very much needed, which helps to improve and maintain the productivity, quality and most importantly the operational cost. (Chemweno et al., 2018).

Barkany, Biyaali and Mahfoud (2016) in a study on assessing the status of research tackling preventive maintenance optimization problems of medical devices learnt that not much has been presented in this field of medical equipment and broadened their study with research papers which have demonstrated to a large extent the success of advanced maintenance optimization models on other industries. Aspects determining

a model of maintenance optimization problem were deeply analysed and proposed the following for future studies:

- Instead of merely following standards, regulations, and manufacturer's recommendations, healthcare professionals should deploy evidence-based maintenance to learn from comparative maintenance efficiency studies and make required adjustments to maintenance policies and actions, especially, when many manuscripts have showed how maintenance strategies for medical equipment are extensive and counterproductive.
- Reliability centred maintenance (RCM) and total productive maintenance concepts represent a significant step in getting the most out of medical equipment compared with other industries applications and may help medical equipment maintenance service elaborate evidence based strategies for the betterment of their performance levels.
- Risk-based prioritization methods are widely used only to identify the critical medical devices subject to stringent maintenance program and not for true PM optimization issues. Evidence in the literature points that mathematical modelling is much more flexible than empirical approaches, and medical equipment maintenance would benefit from optimization modelling.
- Hardly any study in medical equipment maintenance has addressed condition based maintenance policy compared with preventive and corrective ones. Further research in this field should measure outcomes of predictive maintenance including prognostics.
- Maintenance resources requirements such as team size and composition, spare parts, outsourcing, and logistics issues should be further included in optimization models for medical equipment to create more pragmatic decision-making structure.

Whether to outsource or insource maintenance of medical equipment, Masmoudi, Houria, Al Hanbali, and Masmoudi (2016) propose that a decision must be based on the existing factors. The decision support procedure to outsource or insource is based on the following:

- availability of maintenance tools
- availability of competent staff
- equipment criticality factor

- maintenance load time and cost
- complexity and frequency of failures
- costs of spare parts

Similarly with the authors cited above Mkalaf (2015) concurs that flexibility needs to be built into maintenance management strategies because medical devices have different characteristics and therefore a variety of maintenance strategies are needed to avoid sudden failure. Some parts of medical equipment may require scheduled inspection and or regular maintenance.

2.4 Standardization of Medical Equipment

According to Kachieng'a (2012), inappropriately procured equipment is normally the beginning of maintenance problems, often rendering the equipment non-functional. Respondents in a study by Kachieng'a (2012), pointed that lack of equipment standardisation, poor management information support (inventory and asset management systems), poor logistics of spare parts and lack of ongoing training compound the problems of maintenance for technical personnel and users. This concurs with the study by the World Bank (1993), which concluded that standardisation could simplify management and maintenance and reduce inventory costs.

The specialists felt that equipment procurement committees and the tender board should give careful attention to special requirements such as equipment calibration, standardisation, and quality control, since few hospitals have certified and qualified staff to provide these services (Kachieng'a, 2012).

Assessing an equipment inventory can help to identify potential benefits in standardizing equipment (World Bank, 1993). Important items that feed into such a decision are the cost of spare parts (discounts for bulk purchases), failure rates of equipment, lack of expertise of equipment users and maintainers due to variability between different pieces of equipment, and the cost of training users and technical maintenance staff. Assessment might show that standardization would lead to lower spare parts prices, lower costs required for training more individuals on one type of technology, and lower costs for tool and equipment purchases (WHO 2011). According to WHO (2011) it is often not possible to provide all maintenance services in-house. In such circumstances, it may be necessary to make use of external service providers for a significant portion of the maintenance activities. In some parts of the world there are many external service providers, which offer the clinical engineering department

manager a wide variety of options. However, in other parts of the world the number of external service providers is much more limited. In some cases these companies find it uneconomical to offer services in remote areas with small inventories of equipment. They are more likely to expand their service areas if it possible to negotiate a contract that covers a large inventory of equipment, especially if that inventory has a reasonable level of standardization in terms of manufacturer and model. In some cases, it may be reasonable to consider liaising with other health-care facilities in order to provide better justification for the external service providers to enter the local market. A study by (National Audit Office, 1999) concurs with WHO but also cautioned that there are risks from relying on too few suppliers of medical equipment. The results of a study by (WHO, 2010) showed that most of adverse events results from misuse of medical devices and, the cause is only indicated as operation related. The study concluded that standardization is a key issue in the field of medical devices, and would reduce the number of accidents. National Audit Office, (1999) maintain that although standardising makes and models reduce costs, organisations must ensure that they have available a range of makes and models of medical equipment to meet clinical needs.

2.5 Medical Equipment Maintenance Contracts

Effective maintenance is essential if medical equipment is to function as intended and to prevent breakdowns that could limit availability of care or be harmful to patients (National Audit Office, 1999).

The effectiveness on performance of medical equipment needs to be managed. Every device has a designed purpose. A device is clinically effective when it produces the effect intended by the manufacturer relative to the medical condition and clinical effectiveness is a good indicator of device performance. Performance, however, may include technical functions in addition to clinical effectiveness and is closely linked to safety. Hence performance and safety of medical equipment are considered together. It is incumbent on the medical device manufacturer to demonstrate that all possible risks associated with the device are identified and adequately addressed. The role of the regulatory authority is to ensure that the manufacturer has effectively implemented the risk management process and fulfilled other regulatory requirements (WHO, 2014). The manufacturer, service vendor and the user are the participants that need to ensure

the safety of the medical device. The government has the responsibility of overseeing that medical devices sold in the country are safe and effective (WHO, 2012).

In their study of Outsourcing versus in-house maintenance of medical devices, Haugan et al. (2014) discusses the limitation of their study and they pointed out the following five areas that still need to be researched or improved in the future studies.

- First, new variables that affect the performance of maintenance service providers should be included in future studies. For example, the type of maintenance tasks that is, corrective versus preventive; the type and features of contractual relationships that is, contract duration, whether the contract is guaranteed, the total quantity of equipment included in the contract, and whether replacements parts are included in the contract; and the capacity of the firm to deliver the services for example, the number of engineers and technicians working on the contract and the total number of contracts managed by the company.
- Second, other types of maintenance performance transactions should be considered, such as Market, Trilateral Governance, Bilateral or Unified Governance Structures.
- Third, future research might focus on which capabilities and characteristics of medical device maintenance providers affect the vertical integration or "make or buy" decisions made by the managers of healthcare institutions
- Fourth, and most importantly, more research is needed to examine how the performance of maintenance service providers affects the quality or performance of medical services in terms of input quality (staffing or equipment), process quality (length of stay of patients, numbers of tests and procedures performed), and output quality (patient mortality or morbidity).
- Finally, the finding that COSR is independent of TAT presents an opportunity to complement this study by investigating the effects of asset specificity, and the impact of uncertainty and transaction frequency on financial performance, all of which are measured by COSR.

Although according to the researcher's knowledge there are no studies conducted in this regard the Eastern Cape. Department of Health has incorporated some of the strategies listed above by Haugan et al. (2014) in their standard tender documents. All

new equipment is procured with a two year warranty, in addition to the warranty is a five year maintenance contract and the department has a choice of procuring the comprehensive maintenance contract of just the preventative maintenance for the period of five years. The evaluation of tenders also includes testing the technical capacity of the service provider required for the maintenance and repairs to equipment for continued operation such that downtime is prevented. This is intended to supports and advances patient care by applying engineering and managerial skills to health-care technology. The locality and the availability of an application specialist to train users on equipment operation, functional set-up and testing, proper application, appropriate handling, cleaning and storage of medical equipment is also a requirement. The service vendor is required to demonstrate if they are going to have access to spare parts from the manufacturer for the duration of the contract. Even though this is not proven as a cost effective measure of maintaining equipment at least there are regulations in place. (Eastern Cape Department of Health, 2016).

Barkany et al. (2016) points out that in addition to maintenance expenditure, and government responsibility of overseeing that medical devices sold in the country are safe and effective, medical equipment is frequently involved in patient incidents such as death or injury. Therefore, a legal obligation is imposed upon healthcare organizations and clinical engineering to ensure high-level safety and reliability of their medical devices as well as checking maintenance strategies efficiency.

A frequent comment from the specialists was that maintenance contracts were generally negotiated by personnel of hospitals' administration or financial departments, who do not have the technical capacity to assess consequences and technical implications of the contracts Kachieng'a (2012).

It was generally felt that state hospitals should use their 'market purchasing power' to negotiate for better maintenance contracts from external equipment maintenance service providers Kachieng'a (2012). Equipment specialists felt that equipment manufacturers and suppliers control equipment maintenance through service contracts, and that they limit information about their products by providing poorly written service manuals. This lack of co-operation, from manufacturers, they felt, hinders cost-effective management of technology. Some suppliers also practice "sell and run" philosophy, where they do not provide after-sales back-up services. These

practices impede effective transfer of health technology from industrialised countries to African countries Kachieng'a (2012).

2.6 Equipment Management

Al-Bashir, Al-Tawarah, and Jawwad, (2017) concurs with WHO and points out that medical equipment needs to be managed competently and wisely from the first step of procurement until being damaged. This includes obtaining procedure, functioning procedures and the upkeep guidelines used in this regards. Handling the upkeep of medical equipment is energetic for the patient, medical doctors and for the hospital itself. One of the foremost difficulties in healthcare sector today is the accessibility of medical equipment, which is mostly affected by downtime abnormality needed to repair the medical equipment.

Referring to the same problem of the obtainability of medical equipment, Khalaf, Djouani, Hamam, and Alayli (2015) argue that, the determination of upkeep in general is to advance the operational obtainability and to prolong equipment lifespan or to increase the mean time to failure (MTTF) where, in the case of medical equipment, it assists another important purpose. An important feature that distinguishes medical equipment maintenance from analogous activities in other businesses is healthcare interference and patient safety, which are vital constituents of quality healthcare services. Satisfactory clinical results, in addition to other clinical factors, need a high level of operational accessibility of medical equipment. This makes the case for medical inattention entitlements and answerability when found that there was a failure to offer the essential and acceptable equipment for the treatment (David, Maltzahn, Neuman, and Bronzino, 2015) argues that, through old-fashioned assets administration plans, medical equipment can be broadly managed by clinical engineering staffs. First, the administration should contemplate a full range of plans for equipment technical support. Plans may contain use of a combination of equipment service providers such as manufacturers, third-party service groups, shared services, and hospital-based (in-house) engineers and biomedical equipment technicians (BMETs).

2.7 Maintenance Cost

In 1997, Al-Zubaidi (cited in Egolum et al., 2015) saw that the key aim of maintenance is to reduce related operating costs. Gupta et al. (2015) point out that, as equipment is

part of health care provision in hospital, it is essential to have well scheduled and managed equipment upkeep system in the organization. Gupta et al., (2015) further uphold that, planning and categorisation for the maintenance by precautionary maintenance of medical equipment not only increase the due capability of the devices, but also lessen repair costs and increase the efficiency and competence of the equipment. Maintenance cost must be accomplished sparingly. Over the last three decades, several actions dealing with efficiency and cost-effectiveness of Clinical Engineering have been endeavoured (Khalaf et al. 2015). According to Al Hanbali et al. (2016) the sophistication and the costs of medical equipment that continue to escalate, governments have implemented new reforms to control costs and improve the efficiency and the quality. Hospitals are becoming interested in minimizing the total operational cost, by optimizing healthcare production planning and their support activities. Al Hanbali et al. (2016) argue that hospital managers need to reorganize the medical equipment maintenance service as a priority in order to reduce the cost and the dependency on external parties while ensuring that the medical devices are safe, accurate, and operating at the required level of performance.

Gupta et al. (2015) argue that, equipment administration is supervision and control of equipment from obtaining to disposal, controlling equipment in an optimum manner at a minimum cost. A number of areas have been selected for fast track improvement in health care. All managers at all levels are expected to ensure that the standards meet National Core standards (2011). The documents clearly state how these standards would be measured by pointing out the domain, sub-domain, standard and criteria. The following standards refer to Health Care Technology sub-domain:

- Medical equipment for safe and effective patient care is available and functional
- Staff are trained in the correct use of medical equipment
- Medical devices are maintained to ensure safety and functionality. National core standard (2011)

Indeed the cost of delivering healthcare is a challenge in South Africa. The recently approved National Health Insurance (NHI) document points out that, the current environment of Prescribed Minimum Benefits (PMBs) has contributed to rising costs in the private health sector. The cost of PMBs is mainly driven by amongst others:

(i) Lack of healthcare technology assessment resulting in uncontrolled introduction of new healthcare technology. This leads to cost increases without an improvement in the quality of care. National Health Insurance for South Africa (2017).

(ii) Health Technology assessment and procurement systems must ensure that access is improved whilst also delivering healthcare services affordably, based on scientific-evidence and cost effectively. National Health Insurance for South Africa (2017).

Chemweno et al. (2018) point out that Organizations are faced with challenges on choosing the most efficient and effective strategies to enhance the operational capabilities continually, to reduce the maintenance costs and to achieve competitiveness in the industry in question.

Many countries conduct the PM according to the manufacturers' specifications. A study by Ait Kadi et al. (2014) discovered that there is still a serious debate on preventive maintenance (PM) intervals that is taking place among clinical engineering (CE) practitioners on various levels and in professional journals. The debate is focused on the standard requirements by regulating authorities and accreditation organisation in many countries that (PM) intervals should follow the equipment manufacturer's recommendations. Some devices that appear to be very similar in their function and design have manufacturer-recommended intervals that vary by a factor of two or more. The question has been raised about the credibility of these recommended intervals and whether it is based on meaningful test data. According to Ridgway cited by (Ait Kadi et al., 2014) PM does have some impact on the reliability of some items and therefore it does have some beneficial impact on equipment uptime. However, the discussion about what value properly executed PM brings to the facility's maintenance program requires considering the impact of eliminating or increasing the intervals for some or all of the PM-related tests and results achieved: increased safety, reduced downtime and fewer expensive repairs. Khalaf et al. (2014), concurs and say fixed maintenance intervals is the most frequently used approach in the maintenance of medical equipment. Although there are newer maintenance strategies such as reliability centred maintenance (RCM) or conditional based maintenance, these are not considered for application in the maintenance of medical equipment anywhere in the world. Khalaf et al. (2014), argue that component and equipment deterioration and

condition improvement by maintenance are quantitatively linked and can determine the effect of maintenance on reliability of medical equipment. Implementation of strategies such as RCM or conditional based maintenance are capable of describing actual processes more realistically and also enable optimisation for greatest reliability or minimal costs. Barkany et al. (2016) concur with other studies reviewed above and point out that, even though many medical equipment management programs (MEMPs) have been well planned and executed in healthcare organizations for more than 30 years, very few studies investigate the effectiveness of these programs in providing an optimized PM considering reliability, cost, and safety for service delivery.

Some tertiary hospitals outsource the maintenance of sophisticated healthcare equipment to service providers who specialise in them but this has also met with failure in the absence of close monitoring and supervision. Some other tertiary hospitals outsource their facilities maintenance to reduce cost or to cut down on the financial burden of employing qualified maintenance staff (Egolum et al., 2015).

2.8 Conclusion

In conclusion the similar studies and the legislation cited above came to similar findings. They all concur to the fact that medical equipment needs to be managed and maintained. This study seeks to recommend strategies that are suitable for the Eastern Cape environment. Furthermore there is a cost associated with management and maintenance of medical equipment that needs to be managed. Flexibility needs to be built into maintenance management strategies because medical devices have different characteristics and therefore a variety of maintenance strategies are needed to avoid sudden failure. The recently released NHI document points out that there are still gaps in the field of Healthcare Technology Management. The practice of Health Technology Assessment (HTA) is still at its infancy stage. The regulatory authority needs to ensure that the manufacturer has effectively implemented the risk management process and fulfilled other regulatory requirements with regards to medical equipment. Also, government has the responsibility of overseeing that medical devices sold in the country are safe and effective. Most of the literature review pointed gaps in the research that has been conducted with regards to the maintenance of medical equipment. The research on maintenance outsourcing for medical devices in academic literature remains scarce. The literature reviewed came to similar conclusions that, research into the outsourcing of medical device maintenance services and its

associated risks in hospitals is still in its infancy stages, and that further progress in this field would benefit from additional empirical study grounded in management theory. In the healthcare environment this problem is worthy of study, as healthcare institutions lacking the capacity to deal with these issues may face significantly higher costs. PM is the most widely used medical equipment maintenance strategy. Despite the fact that PM is widely used in organisations, there is substantial variation in the activities it is used for and there are opposing ideas about its efficiency and effectiveness.

CHAPTER 3 - RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

In the previous chapter, literature with regards to the cost cutting measures for the maintenance of medical equipment was reviewed. This chapter deals with a detailed description and justification of the research method, design as well as ethical considerations that is followed in this research.

3.2 Research Method

Lewis, Saunders and Thornhill (2016) define method as the techniques and procedures used to obtain and analyse research data. In this section, the research method which was used for this study is elaborated upon and justified hereunder.

3.3 The Research Design

The research design was exploratory, descriptive and quantitative in nature, Descriptive study attempts to describe systematically a situation, problem, phenomenon, service or programme, or provide information or describe attitudes towards an issue (Kumar 2014). According to Lewis et.al (2016) the purpose of descriptive research is to gain accurate profile of events, persons or situation. For this research quantitative data was collected.

3.4 Setting of the Study

The study was conducted in the Department of Health Eastern Cape. The Eastern Cape Department of Health is located in Bisho, Eastern Cape Province of South Africa and about 88% of the Eastern Cape population is serviced by the public health sector. It serves a population of 7,130,480 with the following resources-: 92 Hospitals, 28 Community Health Centres, and 711 clinics. Furthermore the province is still haunted by objective condition of two worlds in one with 64% of the population in rural areas facing conditions of poverty, illiteracy and lack medical facilities.

Most of the facilities are situated in remote areas and for the maintenance of medical equipment they rely on the service of the few private equipment vendors that are situated in two cities, East London and Port Elizabeth and in some instances these vendors are located in Gauteng province.

3.5 Target Population

Gray et al. (2017) define target population as the entire set of individuals or elements meeting the sampling criteria. The total population of this study are officials that were working for the Eastern Cape Department of Health at the time the study was conducted, responsible for acquisition, maintenance and management of medical equipment in the Eastern Cape Department of Health. The population comprised Finance managers, Health Technology Managers, Hospital Unit managers, Clinic managers and Facilities managers.

3.6 Sampling

According to Kumar (2014) it is impossible to collect all the data available due to the limitations of resources such as money and time. Therefore the process of selecting a few from a bigger group as the basis for estimating or predicting the prevalence of an unknown piece of information , situation or outcome regarding the bigger group called sampling was used (Kumar, 2014). The sampling choice and size are described hereunder.

3.6.1 Sampling Method

For this study to sample population, a probability systematic sampling technique was used. According to Burns and Grove (2017), the goal of sampling for quantitative studies is to obtain data from a subgroup of a population that is statistically representative of the population, to allow the findings to be generalized to the population. The sampling technique is chosen as all the elements in the population have equal chances of being selected resulting in results that represent the entire population.

The selection was done according to the following set criteria. The participants are;

- willing to participate in the research and give written informed consent after being informed about the reasons and procedures of the research;
- Employees of Eastern Cape Department of Health;

- involved in the acquisition , maintenance and management of medical equipment;
- practising in one or more of the three areas, namely Provincial, Tertiary ,Regional Hospital;
- practising in one or more of the three units, namely Health Technology, Finance, and Administration ;
- are willing to complete the self-administered questionnaire.

3.6.2 Sample Size

The total sample size was 100 managers who meet the inclusion criteria. This size was chosen in order to limit the sampling error. The larger the sample within reason, the smaller the sampling error and the higher the representativity of the sample (Beck and Polit 2017).

3.7 Data Collection

The data collection method, as well as a role of a researcher is discussed hereunder.

3.7.1 The Research Instruments

Beck and Polit (2017) explain that there are two most widely used data collection methods, interview schedule and a questionnaire or a self-administered questionnaire. In an interview schedule, questions are asked orally in a face to face or telephone interview while in a questionnaire the respondents complete the instruments themselves, either in a paper format or on a computer. The self-administered questionnaire can be distributed in person, by mail on a tablet, or over the internet (Beck and Polit, 2017). In a self-administered questionnaire, there is no interviewer to ask the questions; instead the respondents must read each question themselves and answer the questions themselves (Bryman (2012). Panneerselvan (2009) points out that data is the basic input to any decision making in a business and can be classified into primary and secondary data. The different methods which are used for primary data collection are observation method, personal interview, telephone interview and mail survey. The secondary data are collected from sources which have already been created for the purpose of first time use and future uses.

For this study self-administered questionnaire was used to collect quantitative data where questionnaires were issued to consenting participants. This was chosen as it is less costly as compared to interviews, and it offers the possibility of complete anonymity and there is no interviewer bias (Beck and Polit, 2017). The questionnaire contained specific investigative questions to research objectives for which data needed to be gathered. Data was collected using self-administered questionnaire that were delivered and collected from the consenting participants. Written consent was obtained from all the participants.

3.7.2 Questionnaire Construction

The questionnaire consisted of two sections:

Section A questions seek to understand the demographics of the respondents

Section B contained questions which seek to determine the cost cutting measures for the maintenance of hospital medical equipment at the department of health, Eastern Cape.

The first five questions of Section B seek to determine if insourcing or outsourcing medical equipment maintenance contribute in saving cost.

The second six questions seek to examine if standardization of medical equipment contribute in saving cost.

The last five questions of section B seek to investigate if medical equipment maintenance contracts assist in saving cost.

The questions in section B were closed ended questions where respondents were given options from which to choose the one that most closely matches the appropriate answer. Questions in section B were rank-order questions using a 5 point scale below, where: 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree.

3.7.3 Pilot Study

According to Offredy and Vickers (2013) a pilot study is usually preliminary to a main study and as such should follow the design of the main study as closely as possible or rather, the main study should fully follow the pilot study. Offredy and Vickers (2013) also points out the reason for running a pilot study is that it serves as a testing ground for your data collection instruments, sample and method of analysis so that if mistakes are made in any part of your research design, it will not be unduly costly in terms of

money or time, because problems can be sorted out before moving to the main study. For this research ten respondents were targeted for the pilot study and their comments served to amend the final questionnaire. Two errors were identified and corrected. The first error was in the numbering, where one of the subheadings in section B of the questionnaire was numbered as if it was a question. The second correction was the grouping of the questions according to the research questions.

3.7.4 Administration of Questionnaires

The questionnaires were administered by email to all the participants together with letter of a permission to conduct a study, covering letter, and informed consent. This method was chosen as it is cost-effective for reaching geographically dispersed respondents (Beck and Polit, 2017).

3.7.5 Collection of Questionnaires

Data was collected in June 2019. All the respondents were asked to return the completed questionnaires before 30 June 2019. Completed questionnaires were sent back to the researchers email address, stored in one folder and printed for analysis after the 30 June 2019. Reminders were sent to the non-respondents to complete and return their questionnaires before this date.

3.8 Data Analysis

This section summarises how the data that was collected using the questionnaires was analysed. Lewis et.al (2016) point out that quantitative data in a raw form convey very little meaning to most people. Data therefore needs to be processed in order for it to be useful, that is to turn data into information. According to Beck and Polit (2017) researchers use statistical analysis to organise, interpret and communicate numeric information. Statistical tests that can be used to address the research questions include descriptive and inferential statistics. Descriptive statistics are used to describe and synthesise data for example as a percentage. Inferential statistics are based on the laws of probability and allow researchers to make inferences about a population based on data from a sample (Beck and Polit 2017). For this research, categorical and numerical data was collected. SPSS was used to process the data. Descriptive

statistics was used to present the data. Graphs, tables and frequencies were used to present the findings.

3.9 Validity and Reliability in Quantitative Research

3.9.1 Construct Validity

The questionnaire designed focused on the three areas, first relates to the wording of the questions, second, to the planning of issues with regards to the how the variables were categorised, scaled and coded after receipt of the responses and lastly pertained to the general appearance of the questionnaire.

3.9.2 Internal Validity

The research remained objective throughout the study. This was achieved by the use of the data collection tool. Bougie and Sekaran (2013) points out that all three are important issues in questionnaire design as they minimise bias in research.

3.9.3 External Validity

Section A of the questionnaire asked the respondents demographic questions and gender neutral words were used in this section. Whether results can be generalized back to the population from which the sample was obtained.

3.9.4 Statistical Conclusion Validity

The sample represented sufficient size and correct statistical tests were used in consultation with statistician.

3.10 Limitations of the Study

Time and money was saved by selecting a sample to be studied rather than attempting to study the entire population of Eastern Cape Department of Health managers who are responsible for the maintenance and management of medical equipment. Obtaining data from the population of managers as well as analyzing and interpreting vast amounts of data would be impossible to accomplish within the time constraints and with the limited financial resources available for conducting this research.

3.11 Ethical Considerations

Access and ethics are critical aspects for the conduct of the research (Lewis et al. 2016). According to Lewis et al. (2016) irrespective of the data collection techniques, there are a number of ethical principles that a researcher needs to adhere. In this section a summary of how this research abides to the ethical considerations principles is highlighted. This research is contextual.

3.11.1 Informed Consent

According to Lewis et al. (2016), informed consent refers to the importance of informing the participants of the nature of the research study. The researcher ensured that all participants were aware of having a choice to choose whether to participate in research. After a full explanation of the nature of the study, participants were asked to give written consent of their willingness to participate in the study.

3.11.2 No Harm versus Harm/ Risks

Gray, Grove and Sutherland (2017) point out that researchers should conduct their studies to protect participants from harm such as physiological, emotional, social or economic in nature. The study was conducted in a way that ensured and maintained the confidentiality and dignity of all participants (Lewis et al. 2016).This was achieved by not asking participants' questions about their personal views, weaknesses, or fears.

3.11.3 Confidentiality and Anonymity

The researcher should ensure nondisclosure of participant's identity (Lewis et al. 2016). In this study, anonymity was achieved by not putting names on the questionnaire.

3.11.4 Permission to Conduct the Research

Negotiating access is important and necessary in gaining entry to the organisation and developing cognitive access to allow the researcher to collect the necessary data (Lewis et al., 2016). Also approval process of the research proposal involved must be considered and approved by a research ethics committee (Lewis et al., 2016). The research proposal was presented and approved by the University of Fort Hare's Research Ethics Committee. In addition, the permission to conduct the study was obtained from the Eastern Cape Department of Health. The research then

commenced after obtaining approval from the Research Ethics Committee and the Eastern Cape Department of Health.

3.11.5 Termination

Subjects may discontinue participation in, or may withdraw from, a study at any time without penalty or loss of benefits (Rubin, 2014).The researcher explained this right of participants to withdraw from the study at any time. The participants were then requested to sign the consent forms.

3.12 Conclusion

This chapter described and gave justifications of the chosen research design, methodology and the ethical considerations that the researcher used in this research. In the following chapter results, discussion and interpretation of findings will be dealt with.

CHAPTER 4 - PRESENTATION ANALYSIS AND DISCUSSION OF RESULTS

4.1 Introduction

This chapter presents the results from the primary data collected during the research and discusses the findings and associated interpretations. The chapter aims to present the findings that were obtained in the data gathering process. The study is quantitative in nature and the study used frequencies, tables and percentages to present its findings.

The response rate was as follows:

Table 4.1: Response rate

Distributed questionnaires	100
Returned questionnaires	98
Response rate	98%

Table 4.1 shows that 100 questionnaires were distributed and 98 questionnaires were returned. This shows that the response rate was reasonably high; it was 98%.

4.2 Demographic Analysis

This section presents the demographics. The section shall look at the gender composition, years of experience, occupational level and educational qualifications.

Table 4.1: Gender

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	55	56.1	56.1	56.1
	Female	43	43.9	43.9	100
	Total	98	100	100.0	

Results from Table 4.1 show that 56% of the respondents were males and 44% of the respondents were females. This shows that there were more males in the study than females. However, the difference was not significant.

Table 4.2: Years of experience

Years of Experience in the public sector					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 4 years	29	29.6	29.6	31.9
	4-6 years	12	12.2	12.2	45.1
	7-9 years	11	11.1	11.1	49.5
	10-12 years	12	12.2	12.2	62.6
	More than 12 years	34	34.7	37.7	100.0
	Total	91	92.9	100.0	
Total		98	100.0		

Results show that most (37.7%) of the participants had an experience of more than 12 years. This was followed by the less than 4 years category which had 30%. The 4-6 years and 10-12 years category had 12.2% respectively and the 7-9 category had 11%.

Table 4.3: Occupational Level

Occupational Level					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Senior Manager	12	12.2	12.2	12.2
	Manager	29	29.6	29.6	41.8
	Employee	57	58.2	58.2	100.0
	Total	98	100	100.0	

Results show that most of the respondents were junior managers or employees. The employees category constituted 58% of the total respondents. The manager category was second on the list and it had 30% of the total respondents. The senior manager category has 12% of the respondents.

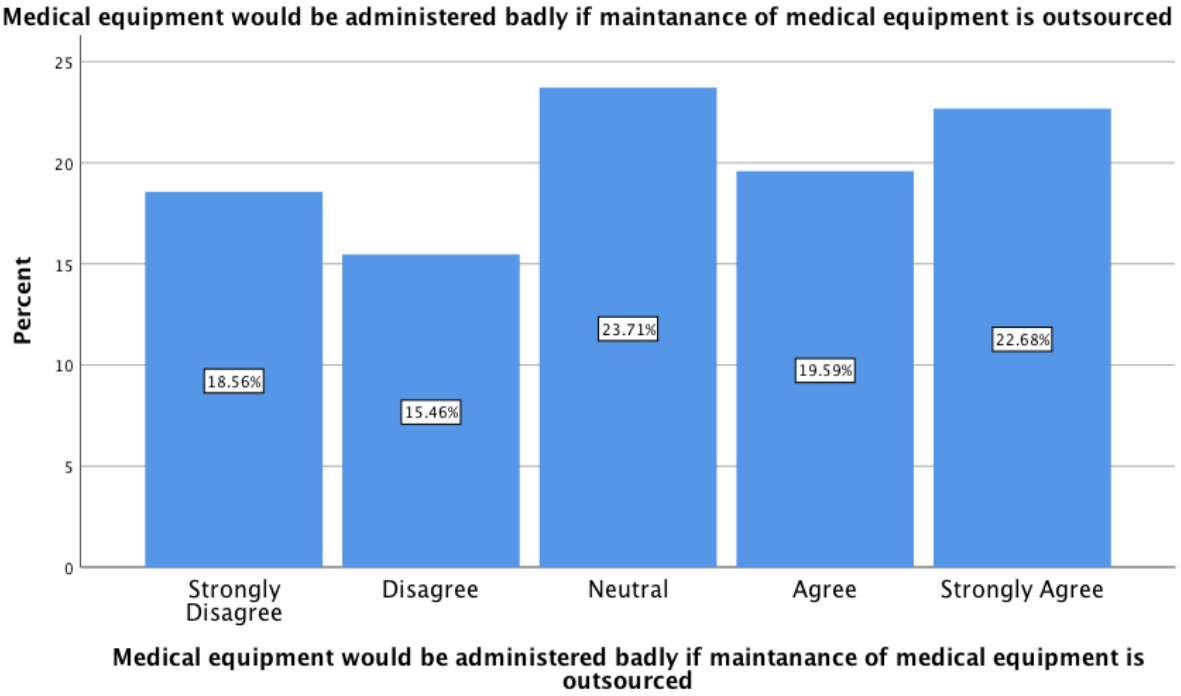
Table 4.4: Highest Educational qualification

Highest Educational Qualification					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Secondary school	3	3.3	3.3	3.3
	Professional Certificate	14	14.2	6.7	10.0
	Diploma	35	38.9	38.9	48.9
	Undergraduate Degree	17	18.9	18.9	67.8
	Postgraduate Degree	29	32.2	32.2	100.0
	Total	98	91.8	100.0	

Results show that most of the participants had a diploma (39%). The postgraduate category was second on the list (32%). This was followed by the undergraduate category (19%), then the professional certificate category (14%) and the secondary school category (3%).

4.3 Primary Findings

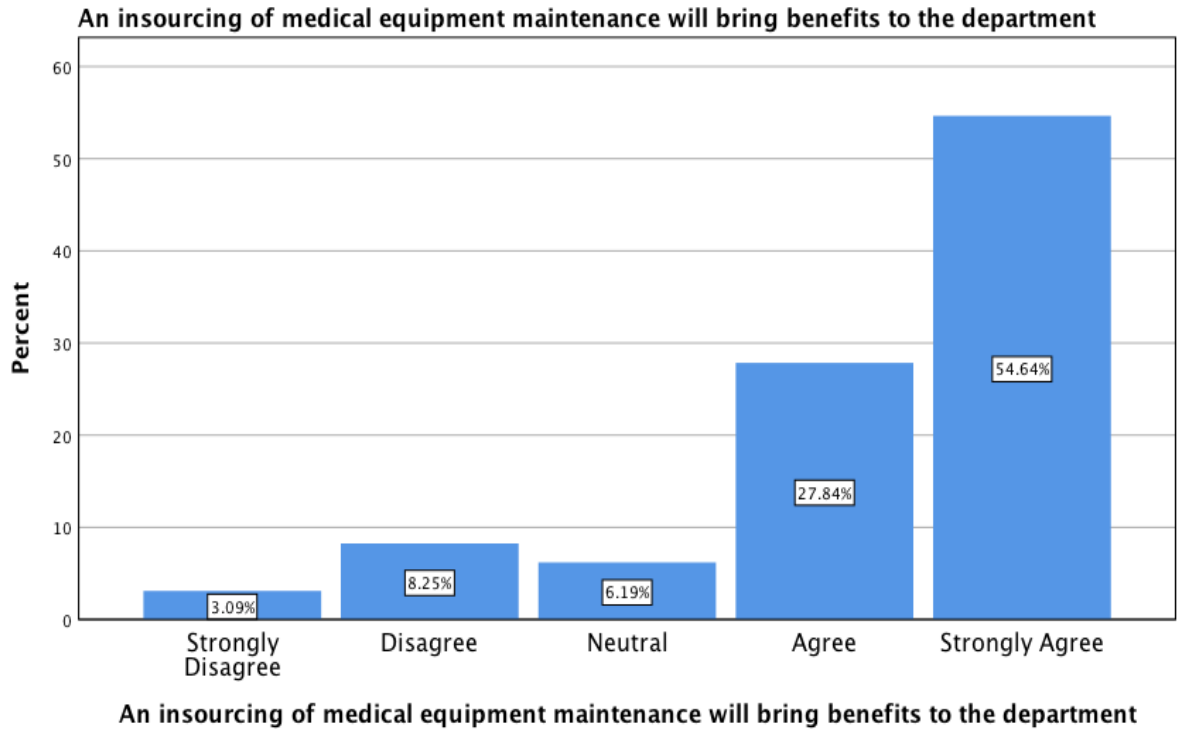
Figure 4.1: Medical equipment would be administered badly if maintenance of medical equipment is outsourced



The results as shown in figure 4.1 indicate that most participants either agreed or strongly agreed that medical equipment would be administered badly if maintenance of medical equipment is outsources. Those who agreed constituted 20% and those who strongly agreed constituted 23% of the respondents. Those who disagreed were 15% and those who strongly agreed to the statement were 19%. The responses may be in line with empirical literature. The Institute of Leadership and Management (2019) states that as a developmental concept within the public service outsourcing has lost a great deal of credibility and public trust has been tarnished by a culture of embedded impunity and corruption involving influential companies and some ill-disciplined public officials (Institute of Leadership and Management, 2019). However, literature also supports the issue of outsourcing. Medical devices outsourcing is the process of contracting a third party for business purposes, which includes manufacturing, product designing, prototyping, and supply chain management. This process enables the

original equipment manufacturers to reduce the labour cost and production time-scale, thus increasing its demand in the market. Outsourcing mainly allows companies to focus on core activities, which results in industrial development.

Figure 4.2: An insourcing of medical equipment will bring benefits to the department

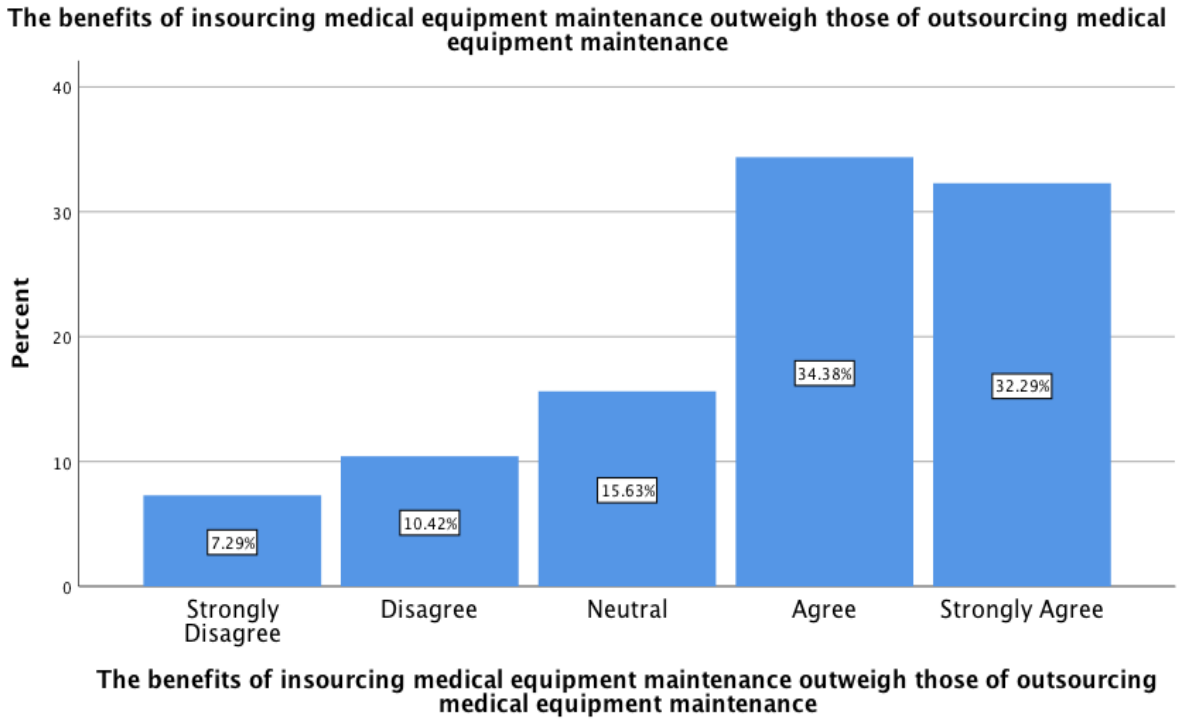


The results as shown in figure 4.2 indicate that most of the participants either agreed or strongly agreed that an insourcing of medical equipment will bring benefits to the department. Approximately 55% of the participants strongly agreed to this while 28% agreed to this, making those in agreement to be in the majority. Only 8% and 3% respectively disagreed. This may suggest that an insourcing of medical equipment will bring benefits to the department. Insourcing is providing the means for local councils to look at services and how they contribute to much wider strategic aims; not just to save money on the often more expensive outsourced contracts but to be able to direct resources where they are needed the most, rather than the often rigid delivery apparatus used in an outsourced environment (Association for Public Service Excellence, 2018). Mkalaf (2015) argue that, the effectiveness of a maintenance strategy will depend on the type of maintenance service used by the healthcare organisation. Maintenance services can be classified into three types: using an in-house biomedical engineering service department, outsourcing all the maintenance services to independent companies and mixing in-house with outsourced services. In

support of the arguments Mkalaf (2015), points out the advantages of insourcing medical equipment maintenance as:

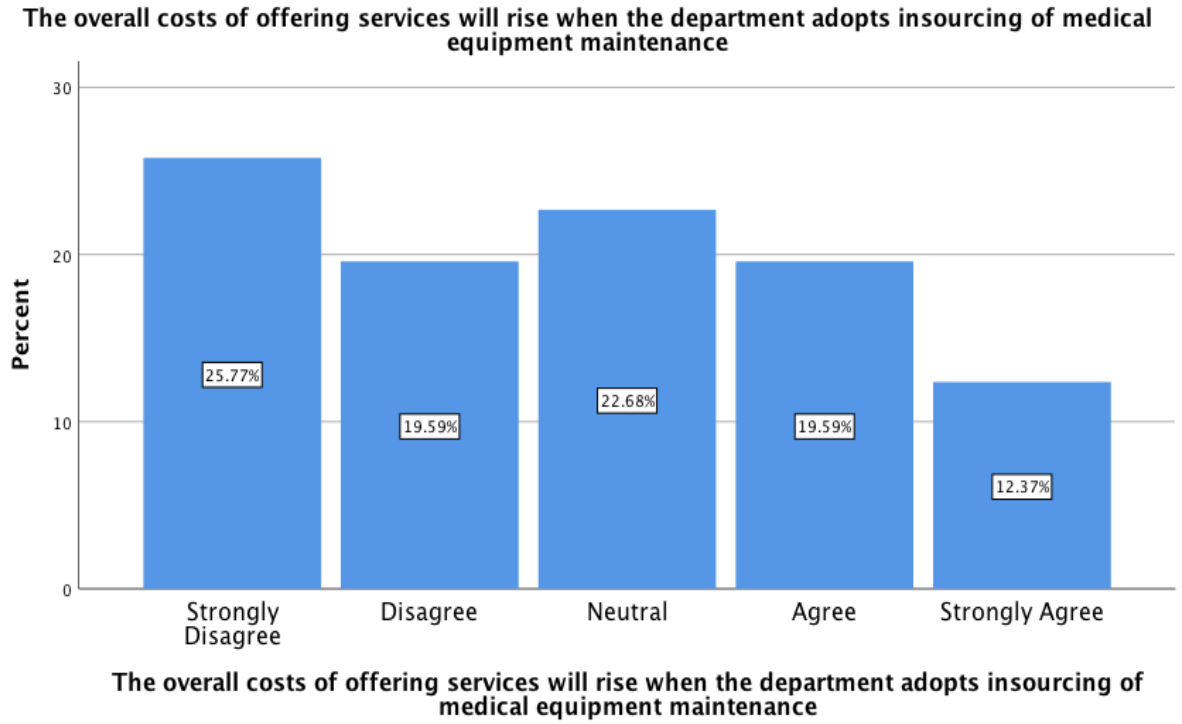
- Fast response possible for breakdowns.
- Technical staff can work closely with professional users;
- On-site repairs can lead to short down times.
- Often less costly than an outside organisation for a given level of service.

Figure 4.3: The benefits of insourcing medical equipment maintenance outweigh those of outsourcing medical equipment maintenance



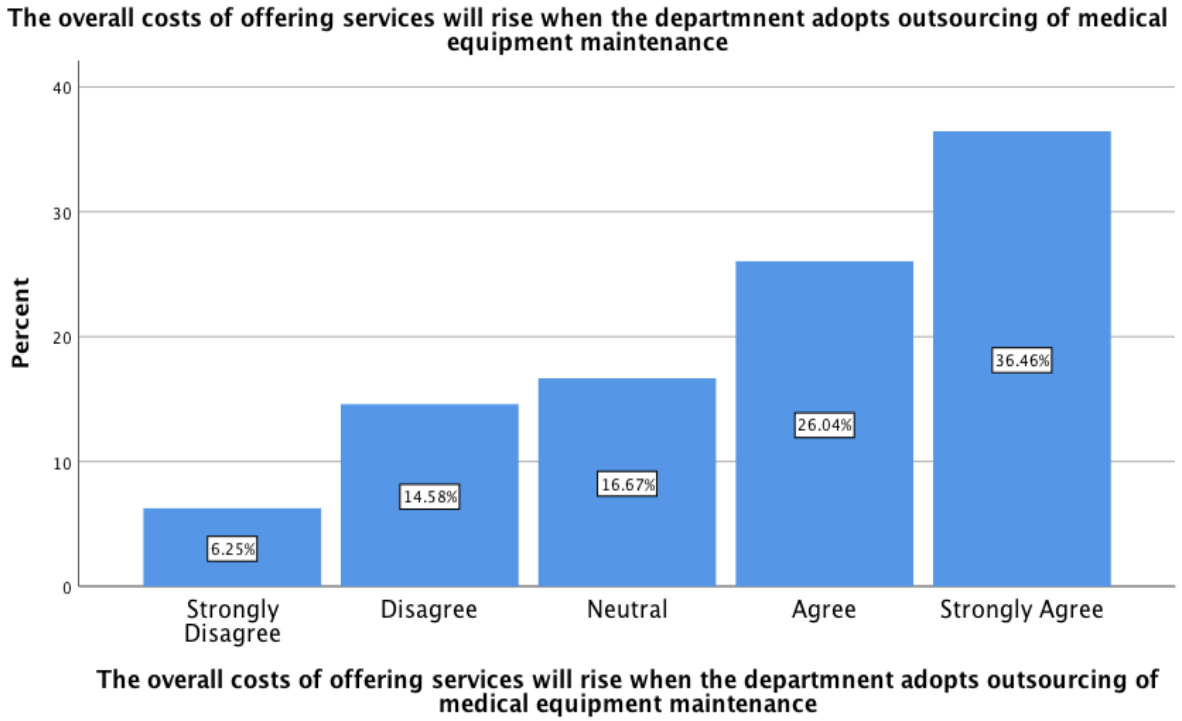
According to the result as show in the figure 4.3, most (32%) respondents strongly agreed (32%) that the benefits of insourcing medical equipment maintenance outweigh those of outsourcing medical equipment maintenance. Those who strongly disagreed were 7%. This may suggest that the benefits of insourcing medical equipment maintenance outweigh those of outsourcing medical equipment maintenance. This is consistent with what other have found in literature. For instance, public sector procurers require flexibility, rather than being locked into long-term contractual arrangements that are costly to change (Association for Public Service Excellence, 2019). Councils need to be confident that whoever delivers services to communities is fully accountable and financially robust. And they need to be able to retain control over services, offer local training and employment opportunities and prevent public funds leaking out of local areas in the form of profits to shareholders.

Figure 4.4: The overall cost of offering services will rise when the department adopts insourcing of medical equipment maintenance



The results as shown in figure 4.4 indicate that most respondents strongly disagreed (26%) and (12%) strongly disagreed that overall cost of offering services will rise when the department adopts insourcing of medical equipment maintenance. This may suggest that the overall cost of offering services will not rise when there is outsourcing. Potrafke (2018) notes that efforts by private providers to reduce costs may well decrease the quality of the services supplied. This may not be the case when there is insourcing. The government may not increase costs when offering services as opposed to the private sector. Hockel and Kintner (2014) concurs by saying optimising in-house Clinical Engineering (CE) processes can bring high utilisation of equipment and backing, realising the organisation's financial aims. To do so organisations need to construct and full leverage a best in-house CE department that carries extreme value to medical equipment assets. The end result is the removal of large, expensive service contracts, no staff, services or other valuable resources.

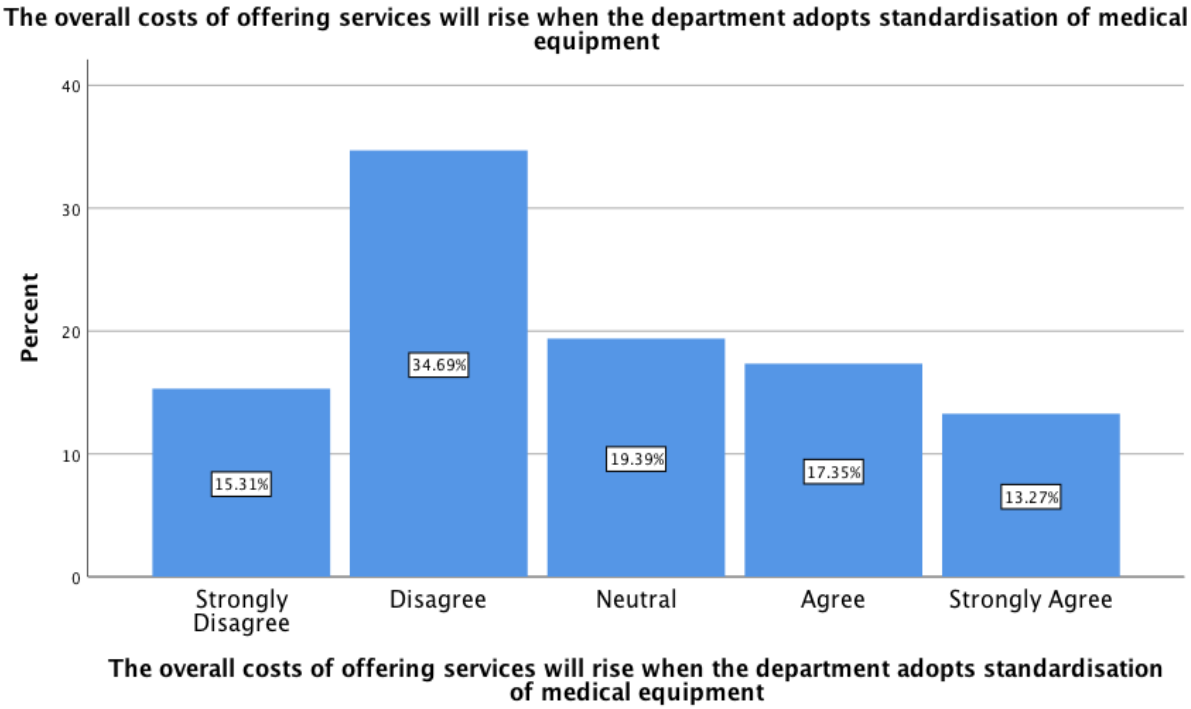
Figure 4.5: The overall costs of offering services will rise when the department adopts outsourcing of medical equipment maintenance



The results as shown in figure 4.5 indicate that most participants strongly agreed (36%) and (6%) strongly disagreed that overall costs of offering services will rise when the department adopts outsourcing of medical equipment maintenance. There were a few strongly disagreed (6%) and disagreed (15%) to the statement that overall costs of offering services will rise when the department adopts outsourcing of medical equipment maintenance. This is in line with previous literature. Insourcing is providing the means for local councils to look at services and how they contribute to much wider strategic aims; not just to save money on the often more expensive outsourced contracts but to be able to direct resources where they are needed, rather than the often rigid delivery apparatus used in an outsourced environment (Association for Public Service Excellence, 2018). Tiwari and Tiwari (2014) points out that, players in the health industry have been outsourcing maintenance of medical equipment and this has become commonplace. The advantages of outsourcing are that there is increased operational efficiency, the suppliers in the private sector have technical expertise and

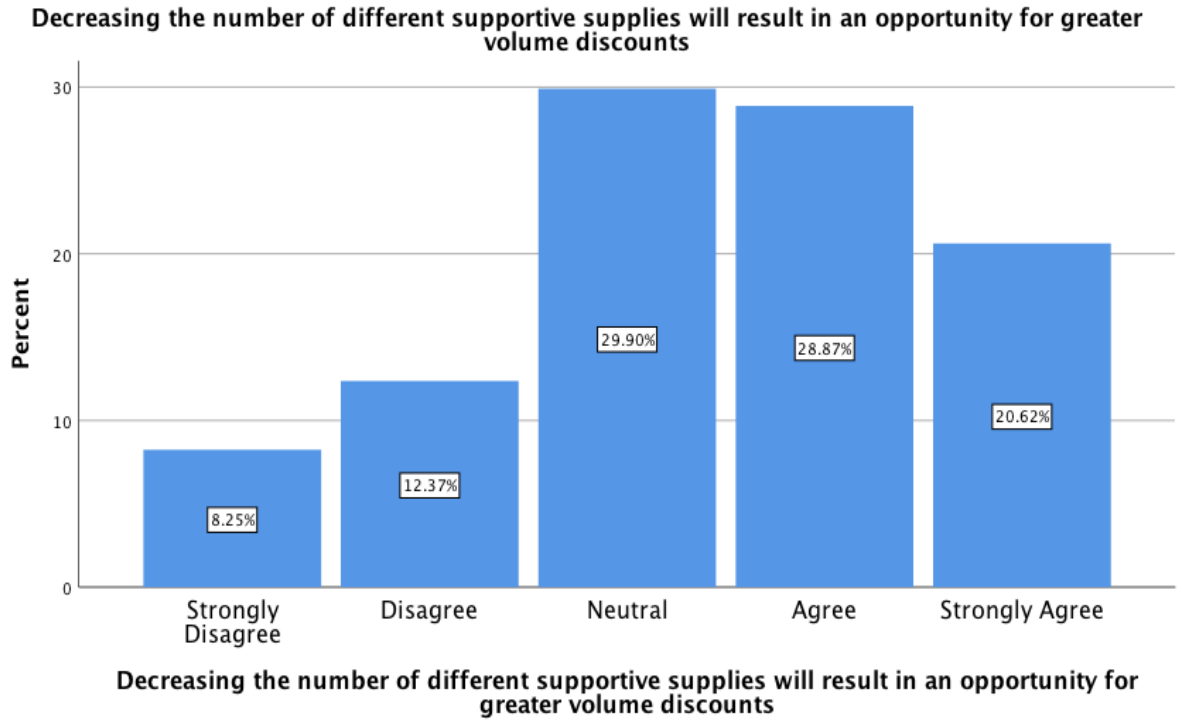
there is also the spread of risk amongst the stakeholders. However, it should be noted that outsourcing can also come up with its costs.

Figure 4.6: The overall costs of offering services will rise when the department adopts standardization of medical equipment.



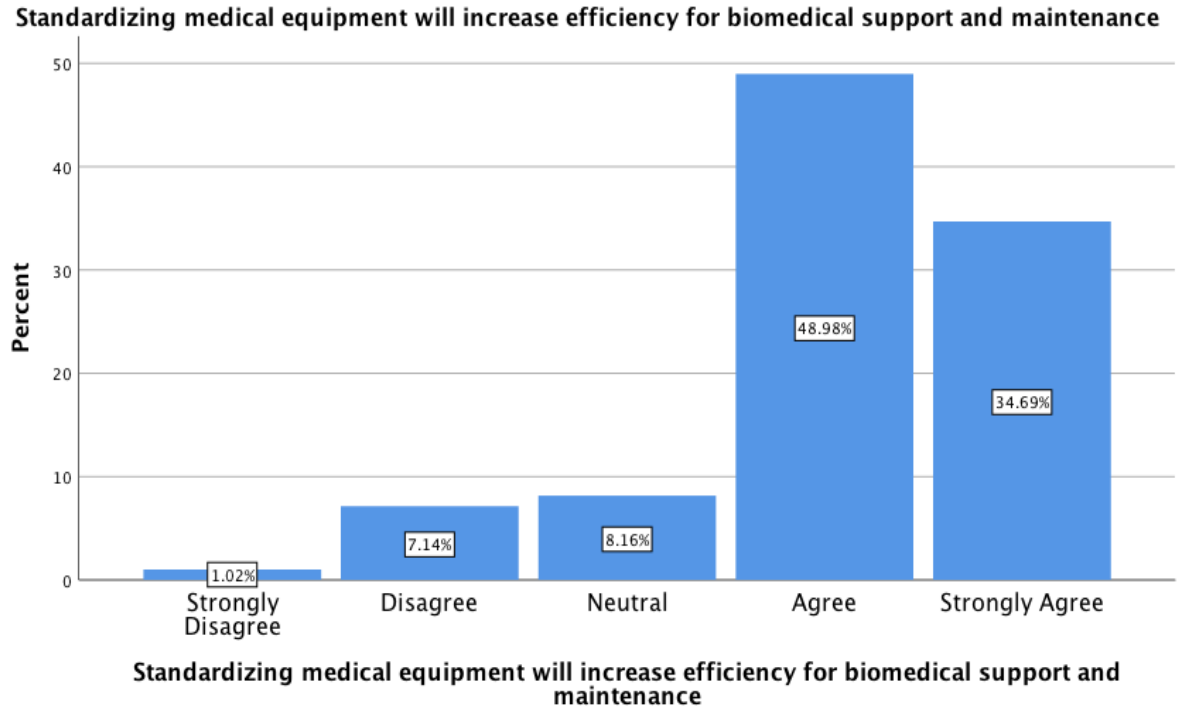
In figure 4.6 the results show that the majority disagreed (35%) and strongly disagreed (15%) to the statement that overall costs of offering services will rise when the department adopts standardization of medical equipment. Those who agreed were 17% and those who strongly agreed were 13%. This may suggest that the respondents believed that the overall costs of offering services will not rise when the department adopts standardization of medical equipment. This is in line with literature. A primary way that hospitals and their administrators support the program is through controlling operating costs while maintaining or improving the quality of patient care. Equipment procurement is an area that provides an opportunity to address both. By standardizing on the same equipment brand and model when purchasing for new construction, expansion or remodelling projects, workflows can be streamlined with reduced costs and improved quality (CME, 2016). A study by the World Bank (1993), concluded that standardisation could simplify management and maintenance and reduce inventory costs.

Figure 4.7: Decreasing the number of different supportive supplies will result in an opportunity for greater volume discounts



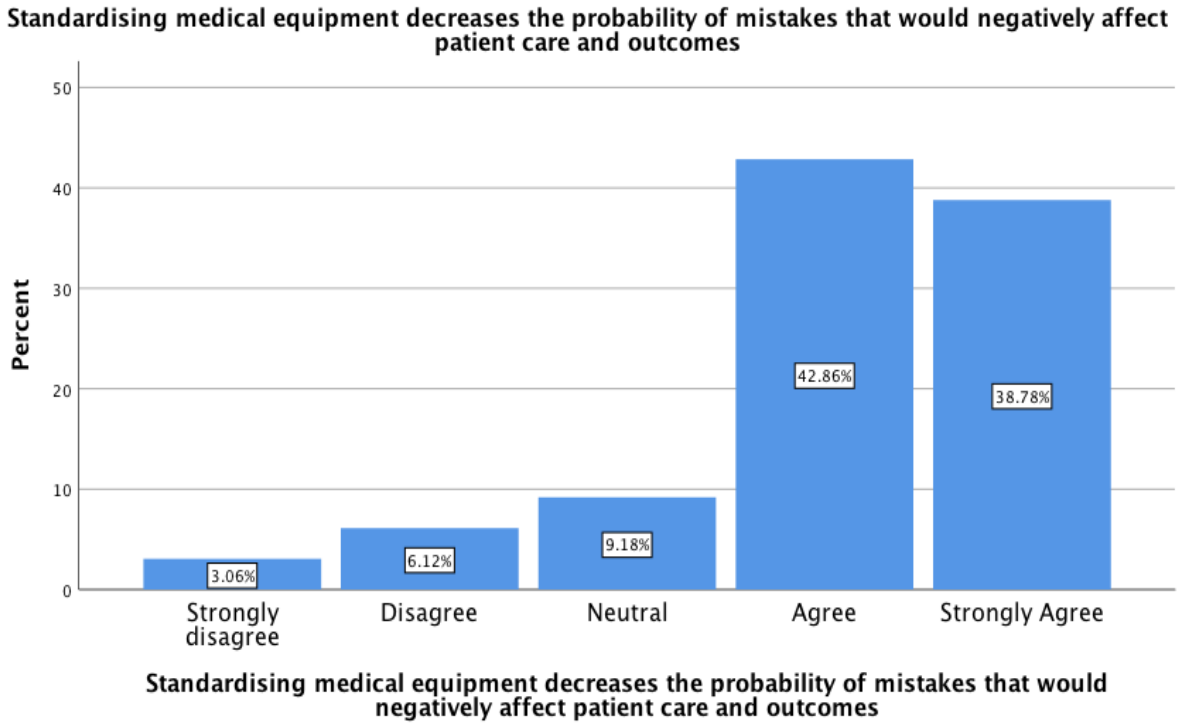
In figure 4.7 the results show that the majority agreed that the number of different supportive supplies will result in an opportunity for greater volume discounts. Those who agreed were 29% and those who strongly agreed were 21%. Product standardization also helps when purchasing supportive medical supplies. Working with a single equipment manufacturer decreases the number of different supportive supplies that are required for proper operation and increases the opportunity for greater volume discounts (CME, 2016). Contracts often require a set percentage of purchases happen with defined manufacturers in order to obtain the discount. Other contracts establish a sliding scale that increases your discount as your percentage increases. Standardizing equipment purchases so that they comply with the GPO contract ensures that you get the cost savings you're looking for with the relationship. Purchases made outside of the GPO contract can also benefit from manufacturer standardization. Just as the GPO gets better pricing through volume purchases, you can get better pricing though volume purchases of particular items and through negotiations on secondary purchases. Manufacturers regularly give discounts on product B when you're already purchasing product A.

Figure 4.8: Standardizing medical equipment will increase efficiency for biomedical support and maintenance



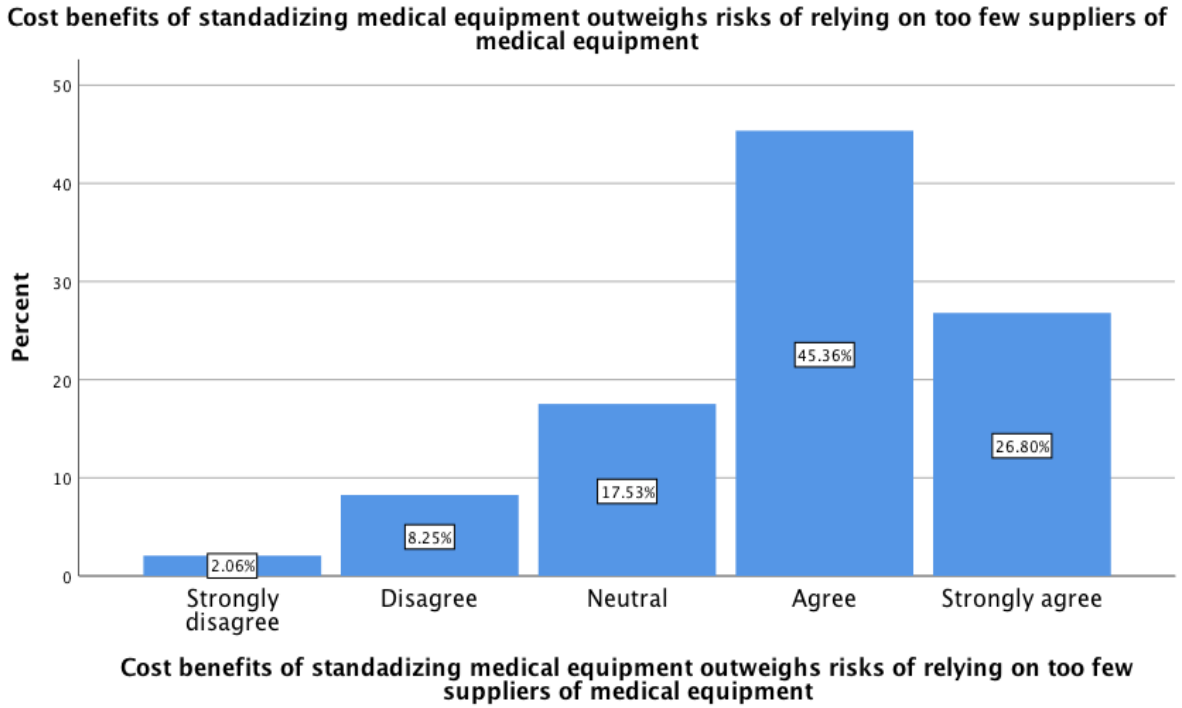
The results as shown in figure 4.8 indicate that most respondents agreed that standardizing medical equipment will increase efficiency for biomedical support and maintenance. Those who agreed were 49% and those who strongly agreed were 35%. Trinh (2018) another way to increase the reliability of a medical device is to practice the standardization of medical devices. This includes both the standardization of medical devices and processes in the hospital or a clinic. This ultimately can help ensure patient safety as when doctors move across hospitals or clinics, their previous knowledge of such devices does not interfere with their work and the safety of the patient. By using a single manufacturer, you can ensure that the equipment used in all departments is the same. This will decrease the confusion of staff working in different areas of the hospital when using equipment such as infusion pumps and vital sign monitors. You will also decrease the learning curve for staff, which not only improves workflow efficiency, but also decreases the probability of mistakes that would negatively affect patient care and outcomes (Trinh, 2018).

Figure 4.9: Standardizing medical equipment decreases the probability of mistakes that would negatively affect patient care and outcomes



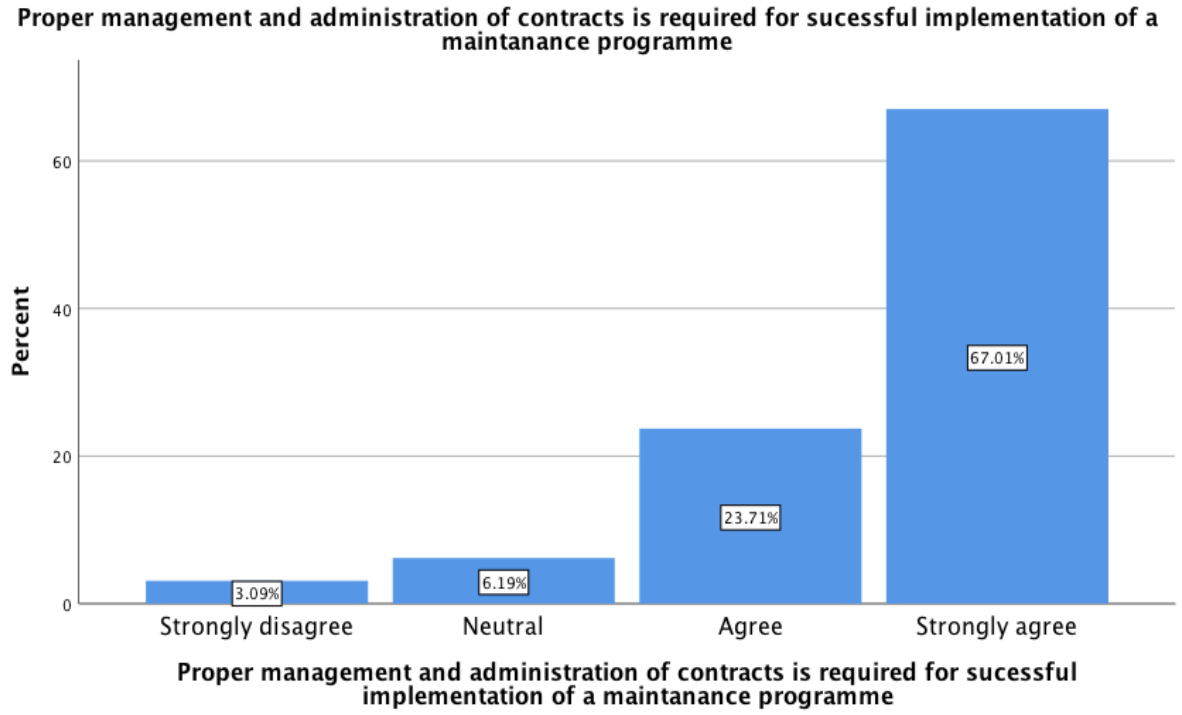
The results as shown in figure 4.9 indicate that most respondents agreed (43%) and strongly agreed (39%) that standardizing medical equipment decreases the probability of mistakes that would negatively affect patient care and outcomes. Trinh (2018) concurs and states that standardization of medical devices and processes in the hospital or a clinic can help ensure patient safety as when doctors move across hospitals or clinics, their previous knowledge of such devices does not interfere with their work and the safety of the patient. Dimitar (2017) notes that another way to increase the reliability of a medical device is to practice the standardization of medical devices. This includes both the standardization of medical devices and processes in the hospital or a clinic.

Figure 4.10: Cost benefits of standardizing medical equipment outweighs risks of relying on too few suppliers of medical equipment



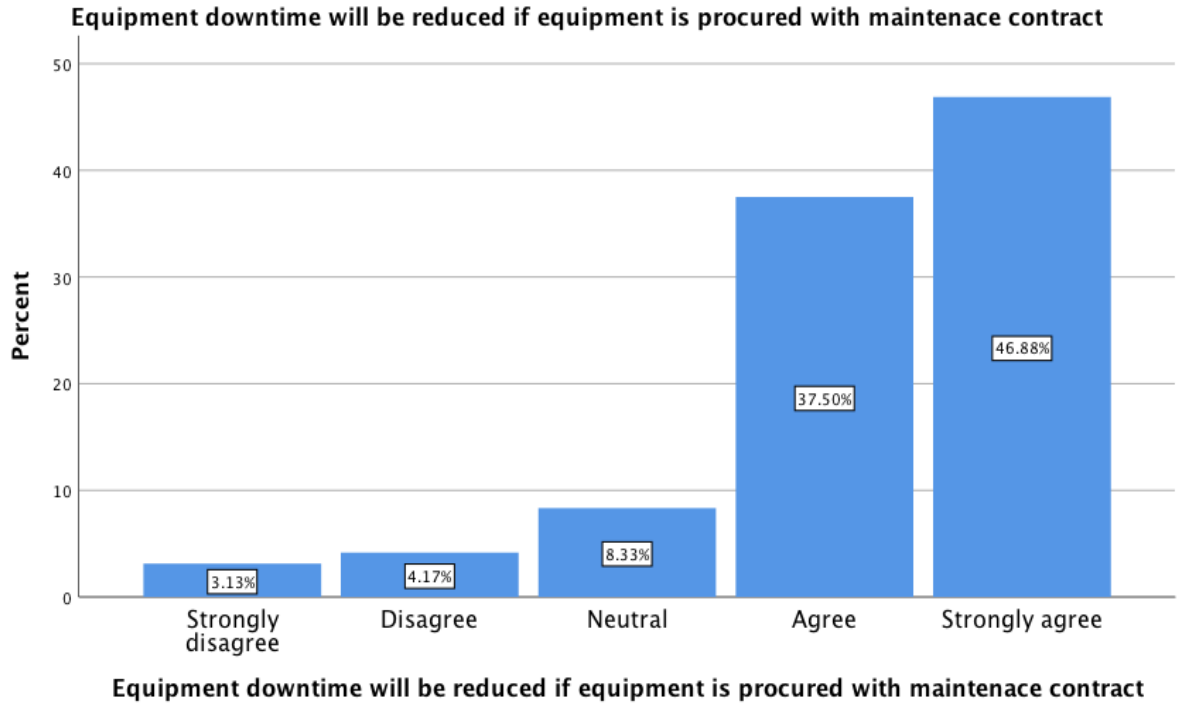
In figure 4.10 the results show that most respondents agreed (45%) and (8%) disagree that cost benefits of standardizing medical equipment outweighs risks of relying on too few suppliers of medical equipment. standardization can help eliminate errors (in the case above, eliminating the error of connecting wrong defibrillator pad). Working with a single equipment manufacturer decreases the number of different supportive supplies that are required for proper operation and increases the opportunity for greater volume discounts (CME, 2016). In summary, standardization can help eliminate errors (in the case above, eliminating the error of connecting wrong defibrillator pad). By standardizing all cable connections with an adapter and standardizing the use of one type of defibrillator pad, these errors can be limited and overall improve patient safety.

Figure 4.11: Proper management and administration of contracts is required for successful implementation of a maintenance programme



In figure 4.11 the results show that most respondents strongly agreed (67%) and only (3%) strongly disagreed that proper management and administration of contracts is required for successful implementation of a maintenance programme. Lynch (2019) states that the goal of contract administration is to ensure proper mechanisms are in place to monitor and evaluate contractors, suppliers and service providers' performance in the fulfilment of their contractual obligations, and to ensure appropriate actions are taken to promptly remedy any deficiencies observed in contract execution or the contract scope, and terms and conditions.

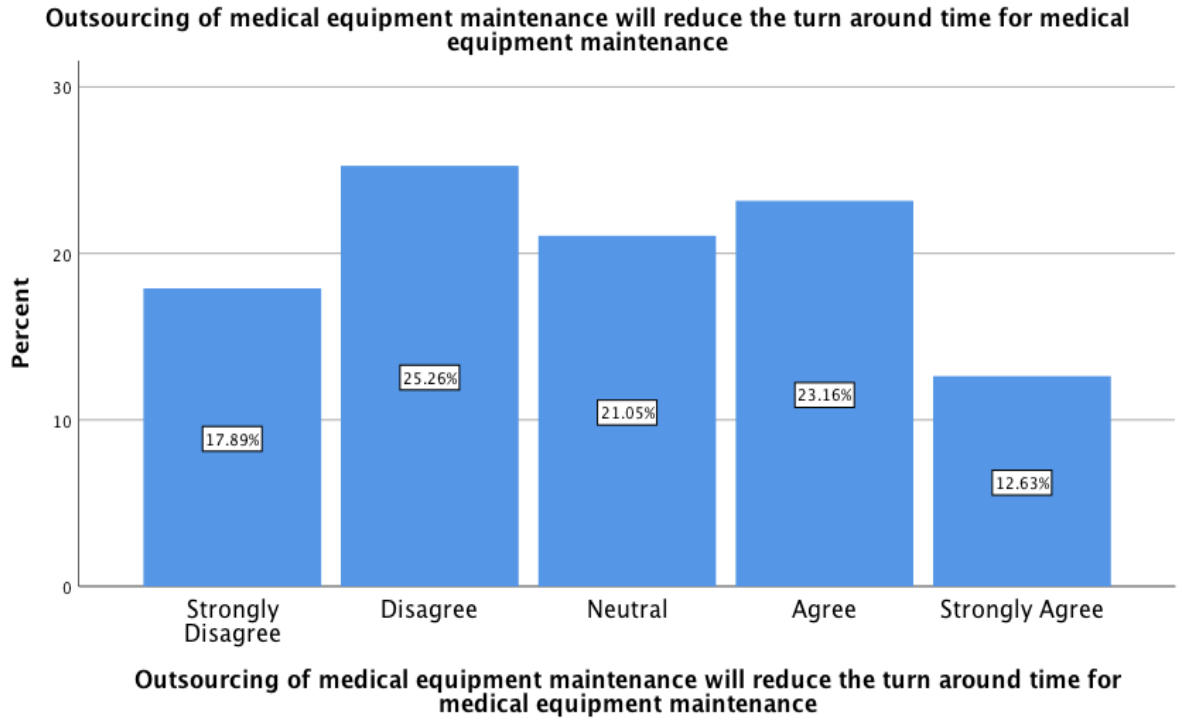
Figure 4.12: Equipment downtime will be reduced if equipment is procured with maintenance contract



In figure 4.12 the results show that most respondents strongly agreed (47%) and only (3%) strongly disagreed that equipment downtime will be reduced if equipment is procured with maintenance contract. This shows that the majority believed that equipment downtime will be reduced if equipment is procured with maintenance contract. Basically all maintenance strategies, besides breakdown maintenance (run-to-failure maintenance), are designed to improve the efficiency and effectiveness of maintenance activities which, in turn, leads to reduced operational expenses. Conducting routine maintenance based on a quality preventive maintenance plan will:

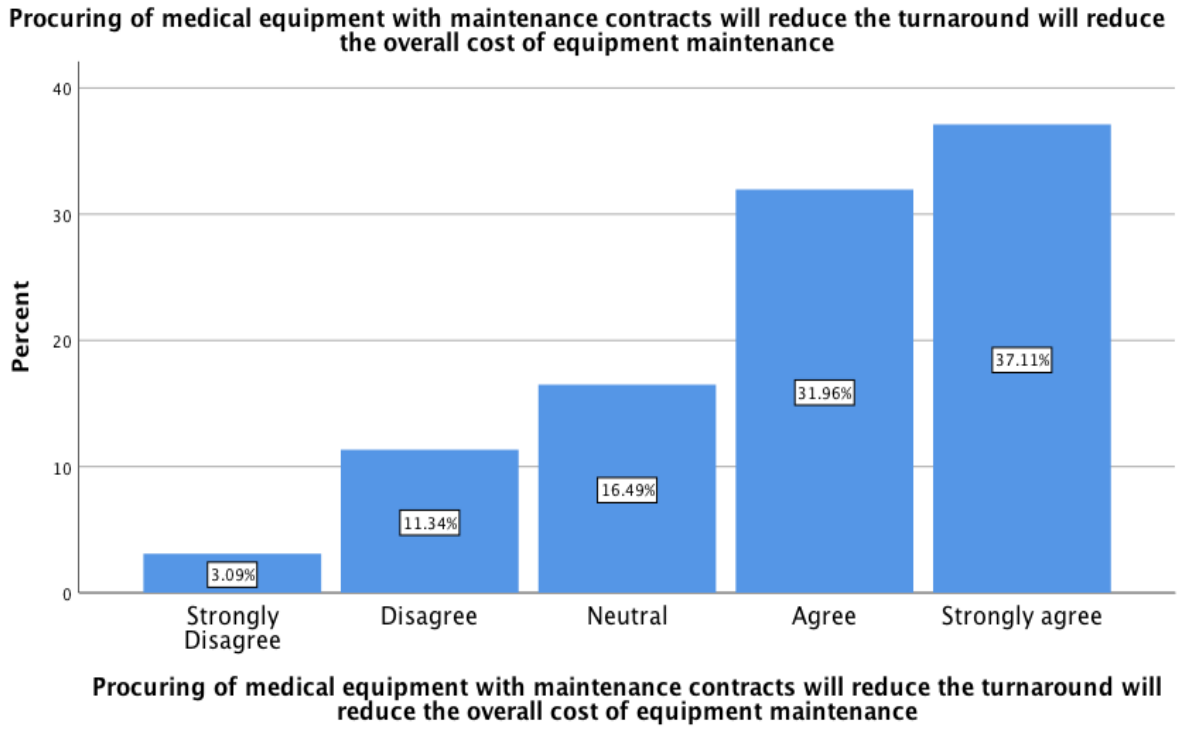
- reduce the number of emergency repairs since problems will be discovered and fixed before a breakdown occur
- reduce overtime labour cost as maintenance technicians will not need to stay late to fix a breakdown of a critical piece of equipment
- increase overall productivity and extend the life of critical equipment (Emeri, 2017)

Figure 4.13: Outsourcing of medical equipment maintenance will reduce the turnaround time for medical equipment maintenance



The results as shown in figure 4.13 indicate that most participants disagreed that outsourcing will reduce the turnaround time for medical equipment maintenance. Those who disagreed were 26% and those who strongly disagreed were 18%. This shows that outsourcing may not help. Insourcing is providing the means for local councils to look at services and how they contribute to much wider strategic aims; not just to save money on the often more expensive outsourced contracts but to be able to direct resources where they are needed, rather than the often rigid delivery apparatus used in an outsourced environment (Association for Public Service Excellence, 2018). It could be more cost-effective or a matter of necessity to contract the maintenance of a portion of the medical equipment in the facility's medical equipment inventory. In those instances when outsourcing is required, contract review will be a responsibility of the clinical engineering department.

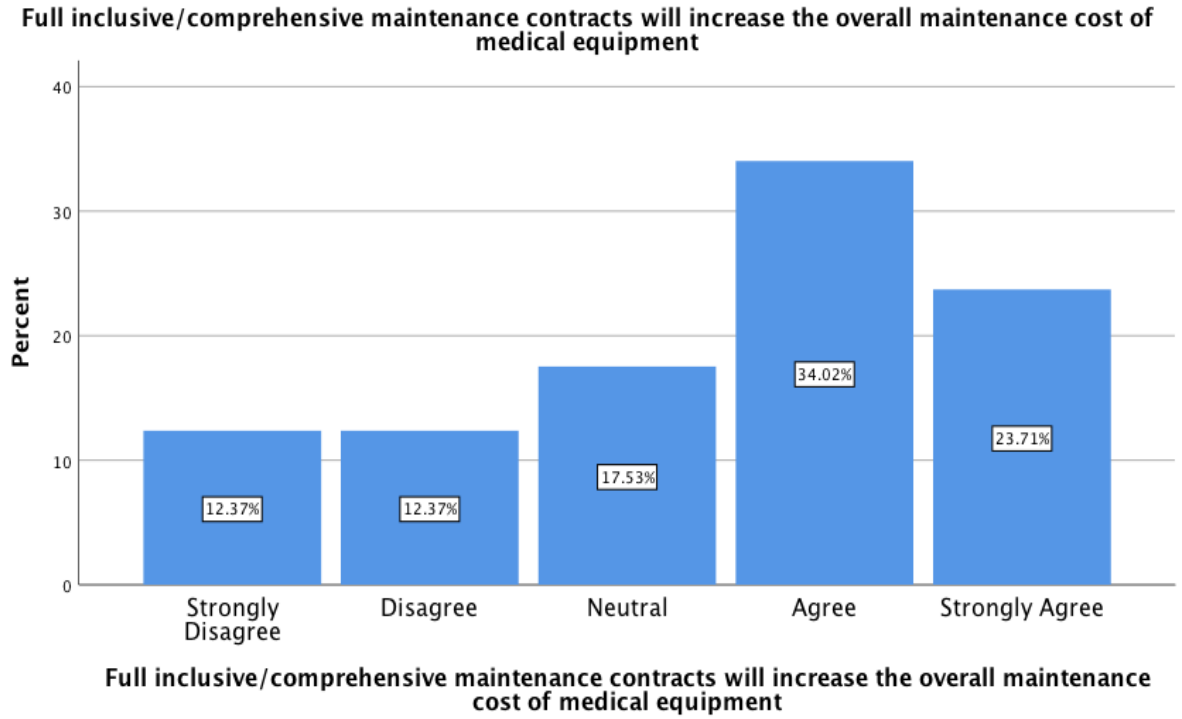
Figure 4.14: Procuring of medical equipment with maintenance contracts will reduce the overall cost of equipment maintenance



In figure 4.14 the results show that most participants strongly agreed (37%) and agreed (32%) that procuring of medical equipment with maintenance contracts will reduce the overall cost of equipment maintenance. Lynch (2019) states that the goal of contract administration is to ensure proper mechanisms are in place to monitor and evaluate contractors, suppliers and service providers' performance in the fulfilment of their contractual obligations, and to ensure appropriate actions are taken to promptly remedy any deficiencies observed in contract execution or the contract scope, and terms and conditions. Conducting routine maintenance based on a quality preventive maintenance plan will:

- reduce the number of emergency repairs since you will be able to discover and fix problems before a breakdown occur
- reduce overtime labour cost as maintenance technicians will not need to stay late to fix a breakdown of a critical piece of equipment
- increase overall productivity and extend the life of critical equipment (Emeri, 2017).

Figure 4.15: Full inclusive maintenance contracts will increase the overall cost of medical equipment



The results as shown in figure 4.15 indicate that respondents believed that inclusive maintenance contracts will increase the overall cost of medical equipment. Those who agreed were 34% and those who strongly agreed were 24%. The goal of public procurement is to award timely and cost-effective contracts to qualified contractors, suppliers and service providers for the provision of goods, works and services to support national and local government, and public services operations, in accordance with principles and procedures established in the public procurement rules (Lynch, 2019). The proper maintenance and care increases the useful life and reduces the annual cost of the equipment. The cost of the maintenance must be considered as part of the decision making process for maintenance on medical equipment. Medical device equipment service life can be extended through careful maintenance, or shortened through carelessness and lack of attention to details.

4.4 Conclusion

This chapter sought to present the study's findings. The chapter made use of descriptive statistics to present the study's findings. A number of findings with regards to outsourcing, standardisation and procurement of medical equipment with maintenance contacts were obtained. However, the major finding was that outsourcing is not feasible. The respondents preferred in-sourcing and standardisation of medical equipment. The next chapter concludes the study.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The main purpose of this chapter is to give a summary of the whole study. The chapter summarises the study's main results from primary data collected. The chapter also offers recommendations based on the findings. Areas for further research are also suggested.

5.2 Findings from the Study

This section presents the summarised findings from the secondary sources that were consulted in the literature review chapter. The section also presents the primary findings that came out from the data collected.

5.2.1 Findings from the Literature Review

Literature was surveyed and it was seen that medical devices are assets that directly affect human lives. Medical technologies are seen as assets that have an effect on the lives of citizens. Governments are investing in medical technology and the cost of investing and maintaining such technologies is high. Bearing this in mind, it is vital to ensure that the provision of medical technology is prioritised and maintained such that the costs are reduced. Maintenance of medical equipment is the function of Clinical Engineering Department. This function is also performed by medical equipment vendors. WHO (2013) points out that a maintenance strategy includes procedures for inspection, as well as preventive and corrective maintenance. Health facilities may choose to insource or outsource maintenance of medical equipment.

Players in the health industry have been outsourcing maintenance of medical equipment and this has become commonplace. The advantages of outsourcing are that there is increased operational efficiency, the suppliers in the private sector have technical expertise and there is also the spread of risk amongst the stakeholders. However, it should be noted that outsourcing can also come up with its costs. In order to keep risk to a minimal it is necessary to measure the operational efficiency of those

who would be providing the services and they must be monitored and evaluated to ensure that they provide the desired outcomes.

Currently the trend in South Africa is that equipment maintenance is outsourced to the private vendors with no intentions of strengthening the in-house Clinical Engineering departments. Equipment is procured with five-year maintenance contract. The equipment vendors are required to keep the spare parts in order for them to respond to the equipment breakdown within a short period of time. A study done by Haugan et.al, (2014) provided evidence which showed that outsourcing of spare parts brought significant effects on the overall performance of governance systems. This shows that outsourcing can have an impact on the government activities. The effectiveness of a maintenance strategy will depend on the type of maintenance service used by the healthcare organisation. Maintenance services can be classified into three types: using an in-house biomedical engineering service department, outsourcing all the maintenance services to independent companies and mixing in-house with outsourced services.

5.2.2 Findings from the Study

(i) To determine if insourcing or outsourcing medical equipment maintenance contribute to saving cost.

The study respondents either agreed or strongly agreed that medical equipment would be administered badly if maintenance of medical equipment is outsourced. This result from the Department or health facilities not being able to realize the advantages of having in-house clinical engineering department Results showed that most of the participants either agreed or strongly agreed that an insourcing of medical equipment maintenance will bring benefits to the department. Results also showed that the benefits of insourcing medical equipment maintenance outweigh those of outsourcing medical equipment maintenance. This is consistent with what others have found in literature. For instance, public sector procurers require flexibility, rather than being locked into long-term contractual arrangements that are costly to change

(ii) To examine if standardization of medical equipment contribute to saving cost.

Results showed that the majority disagreed and strongly disagreed to the statement that overall costs of offering services will rise when the department adopts standardization of medical equipment. Results show that the majority agreed that the number of different supportive supplies will result in an opportunity for greater volume discounts. Product standardization also helps when purchasing supportive medical supplies. The results show that most respondents agreed and strongly agreed that cost benefits of standardizing medical equipment outweigh risks of relying on too few suppliers of medical equipment.

(iii) Investigate if medical equipment maintenance contracts assist in saving cost

Results showed that most participants strongly agreed and agreed that procuring of medical equipment with maintenance contracts will reduce the overall cost of equipment maintenance. Result shows that respondents believed that inclusive maintenance contracts will increase the overall cost of medical equipment.

5.3 Recommendations

The study comes up with the following recommendations:

5.3.1 Recommendations to the Eastern Cape Provincial Health Department

i. Firstly, the Department of Health in-source its medical equipment maintenance. The respondents have shown that it is better to in-source because the costs are much lower than when the Department outsources. Literature also seemed to support this. In-sourcing provides workers with a “liveable” wage, fringe benefits and opportunities which are seen as perks to employment in corporate South Africa. This assists workers to develop and progress out of their circumstances. If done effectively, insourcing assists

organisational stability, projects a positive public image and increases trust between both internal and external stakeholders.

ii. Secondly the Department should standardize its equipment. Results show that the majority agreed that the number of different supportive supplies will result in an opportunity for greater volume discounts. Product standardization also helps when purchasing supportive medical supplies. This will reduce the costs that the Department normally incurs and it will also improve efficiency.

iii. The department should develop a medical equipment procurement strategy that incorporates procurement of medical equipment with comprehensive maintenance contracts.

5.3.2 Recommendations for Further Research

This study was explanatory, descriptive and quantitative in nature. A questionnaire was used as a data collection tool with closed ended questions. Therefore the outcomes of the study were limited to closed ended questions where respondents we unable to support selected choices of their answers. By limiting the study to quantitative method leaves venues open for further research. It is therefore recommended that in order for the Department to get clearer view of the medical equipment cost cutting measures further research should be conducted using qualitative or a mixed method research design.

5.3.3 Recommendations for Hospital Management

i. Hospital management should source and develop the technical skills needed for the maintenance of medical equipment.

ii. Secondly, Hospital management should ensure the availability of maintenance tolls and competent maintenance staff.

iii. The hospital management should standardize on equipment type as fewer number of different supportive supplies will result in an opportunity for greater volume discounts. Product standardization also helps when purchasing supportive medical supplies.

iv. Lastly , the hospital management should procure medical equipment with maintenance contracts

5.3.4 Recommendations for Education of Health Professionals

i. The department should hire qualified medical equipment maintainers.
ii. The department should ensure that maintenance staff is trained on maintenance of medical equipment. This includes scheduling preventive maintenance and equipment repairs resulting to equipment failures.
iii. When equipment is procured with maintenance contracts, health professionals should be trained on the operation of equipment and about the procedures to follow when equipment fails as per the service level agreements.

5.4 Conclusions

This study aimed at exploring cost cutting measures for the maintenance of hospital medical equipment in the Eastern Cape. Medical technologies are seen as assets that have an effect on the lives of citizens. Governments are investing in medical technology and the cost of investing and maintaining such technologies is high. Bearing this in mind, it is vital to ensure that the provision of medical technology is prioritised and maintained such that the costs are reduced.

The researcher in this study identified a number of contributory factors to costs associated with maintenance of medical equipment. Findings from the literature reviewed were that the effectiveness of a maintenance strategy will depend on the type of maintenance service used by the healthcare organisation. Maintenance services can be classified into three types: using an in-house biomedical engineering service department, outsourcing all the maintenance services to independent companies and mixing in-house with outsourced services. The findings from the study were that the Department will cut costs associated with medical equipment if maintenance of medical equipment is in-sourced, equipment is standardized and equipment is procured with maintenance contracts.

The findings from this study may help the Department to revisit some of its medical equipment maintenance strategies and draw up comprehensive interventions to

reduce costs associated with maintenance of medical equipment and improve service delivery in the Department.

This study was explanatory, descriptive and quantitative in nature. A questionnaire was used as a data collection tool with closed ended questions. Therefore the outcomes of the study was limited to closed ended questions where respondents we unable to support selected choices of their answerers. By limiting the study to quantitative method leaves venues open for further research. It is therefore recommended that in order for the Department to get more absolute view of the medical equipment cost cutting measures further research should be conducted using qualitative or a mixed method research design.

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APPENDICES

APPENDIX A: ETHICAL CLEARANCE FROM THE UNIVERSITY OF FORT HARE

FACULTY OF HEALTH SCIENCES
Research Ethics Committee

P.O Box 1054
East London 5200
Tel: +27 (0) 43 704 7594
eseekoe@ufh.ac.za

University of Fort Hare
Together in Excellence

ETHICAL CLEARANCE CERTIFICATE
REC-100118-054

Certificate Reference Number:	**Ref # 2019 = 04 = 006 = MabentselaB**
Project title:	**Cost cutting measures for maintenance of hospital medical equipment in the Eastern Cape Province, South Africa**
Nature of Project	Masters of Public Health
Principal Researcher:	Mabentsela B
Student Number:	201716794
Supervisor: Co-Supervisor:	Prof MG Pinkoane Mr D Seekoe

On behalf of the Faculty of Health Sciences Research Ethics Committee (FHREC), I hereby give ethical approval in respect of the undertakings contained in the above-mentioned project and research instruments(s). Should any other instruments be used, these require separate authorization. The Researcher may therefore commence with the research as from the date of this certificate, using the reference number indicated above.

Please note that the FHREC must be informed immediately of

- Any material change in the conditions or undertakings mentioned in the document
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research

The Principal Researcher must report to the FHREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

FACULTY OF HEALTH SCIENCES
Research Ethics Committee

P.O Box 1054
East London 5200
Tel: +27 (0) 43 704 7594
eseekoe@ufh.ac.za

University of Fort Hare
Together in Excellence

Special conditions: Research that includes children as per the official regulations of the act must take the following into account:

Note: The FHREC is aware of the provisions of s71 of the National Health Act of 2003 and that matters pertaining to obtaining the Minister's consent are under discussion and remain unresolved. Nonetheless, as was decided at a meeting between the National Health Research Ethics Committee and stakeholders on 6 June 2003, university ethics committees may continue to grant ethical clearance for research involving children without the Minister's consent, provided that the prescripts of the previous rules have been met. This certificate is granted in terms of this agreement.

The FHREC retains the right to

- Withdraw or amend this Ethical Clearance Certificate if
  - Any unethical principles or practices are revealed or suspected
  - relevant information has been withheld or misrepresented
  - regulatory changes of whatsoever nature so require
  - the conditions contained in the Certificate have not been adhered to

- Request access to any information or data at any time during the course or after completion of the project.
- In addition to the need to comply with the highest level of ethical conduct principal investigators must report back annually as an evaluation and monitoring mechanism on the progress being made by the research. Such a report must be sent to FHREC monitoring@ufh.ac.za.

The Ethics Committee wishes you well in your research endeavours.

Yours sincerely

Professor Eunice Seekoe
Dean of Faculty of Health Sciences
05 April 2019

APPENDIX B: LETTER OF PERMISSION TO CONDUCT THE STUDY

University of Fort Hare
Together in Excellence

6 January 2017

Dr T.D. Mbengashe
Superintended General
Eastern Cape Department of Health
Dukumbana Building
Bisho

Dear Dr Mbengashe

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN HOSPITALS

My name is Bonga Mabentsela currently employed by the Eastern Cape Department of Health as a Deputy Director: Healthcare Technology Projects. I am a Masters: Public Health student at the University of Fort Hare. The research I wish to conduct for my Master's dissertation involves *"Cost cutting measures for the maintenance of hospital medical equipment in Buffalo City Municipality and Chris Hani District Municipality, Eastern Cape"*. This project will be conducted under the supervision of Prof. M. Pinkoane (University of Fort Hare, South Africa).

I am hereby seeking your consent to approach a number of Department of Health officials that are responsible for acquisition, maintenance and management of medical equipment to be participants for this project.

I have provided you with a copy of my dissertation proposal (Annexure: A).

Upon completion of the study, I undertake to provide the Eastern Cape Department of Health with a bound copy of the full research report. If you require any further information, please do

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN HOSPITALS

not hesitate to contact me on 083 541 6556, bonga.mabentsela@echealth.gov.za. Thank you for your time and consideration in this matter.

Yours sincerely,

DATE 16/01/2018

Bonga Mabentsela
University of Fort Hare

DATE 8/2/2018

DR T.D. Mbengashe
SG: EASTERN CAPE DEPARTMENT OF HEALTH
Approved/ not Approved

Comments:

1) I agree that the University Ethics Committee has approved your research
2) The results of the research must be shared with the Dept before published

REQUEST FOR PERMISSION TO CONDUCT RESEARCH IN HOSPITALS

APPENDIX C: COVERING LETTER

Date: ___29 May 2019_____

Dear Participant

My name is Bonga Mabentsela, (student number: 201716794) and I am doing a Master's degree at the University of Fort Hare conducting a research regarding the **Cost Cutting Measures for Maintenance of Hospital Medical Equipment in the Eastern Cape Province, South Africa**. I kindly request you to voluntarily participate in this study. Participation is voluntary and you are not forced in any way to participate in this study. The questionnaire may take you 20 minutes to complete.

Thank you in advance for your co-operation in my research.

Yours sincerely,

Bonga Mabentsela

083 541 6556

APPENDIX D: INFORMED CONSENT

Please understand that you are not being forced to take part in this study and the choice whether to participate or not is yours alone. However, we would really appreciate it if you do share your thoughts with us. If you choose not take part in answering these questions, you will not be affected in any way. If you agree to participate, you may stop me at any time and tell me that you don't want to go on with the interview. If you do this there will also be no penalties and you will NOT be prejudiced in ANY way. Confidentiality will be observed professionally.

I will not be recording your name anywhere on the questionnaire and no one will be able to link you to the answers you give. Only the researchers will have access to the unlinked information. The information will remain confidential and there will be no "come-backs" from the answers you give.

INFORMED CONSENT

I hereby agree to participate in research regarding the **Cost Cutting Measures for the Maintenance of Hospital Medical Equipment in the Eastern Cape Province, South Africa**. I understand that I am participating freely and without any coercion. I also understand that should I choose not to participate in the study the decision will not in any way affect me negatively.

I understand that this consent form will not be linked to the questionnaire, and that my answers will remain confidential.

I understand that if at all possible, feedback will be given to Eastern Cape Department of Health on the results of the completed research.

…….. **Date**:……..

Signature of participant

…….. **Date**:……..

Signature of researcher

APPENDIX E1: QUESTIONNAIRE

SECTION A: DEMOGRAPHIC INFORMATION

1. **Gender**

Male	
Female	

2. **Years of Experience in the Public Sector**

Less than 4 years	
4 – 6 years	
7 – 9 years	
10 – 12 years	
More than 12 years	

3. **Occupational Level**

Senior Manager	
Manager	
Employee	

4. **Highest Educational Qualification**

Secondary School	
Professional certificate	
Diploma	
Undergraduate degree	
Post graduate degree	

SECTION B

Using a 5 point scale below, where: **1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree**, please rate each statement. (Please **Tick** in the Appropriate Box)

	Questionnaire for the Cost Cutting Measures for the Maintenance of Hospital Medical Equipment in the Eastern Cape Province, South Africa	**1**	**2**	**3**	**4**	**5**
	Insourcing or outsourcing medical equipment maintenance					
1	Medical equipment would be administered badly if maintenance of medical equipment is outsourced					
2	An insourcing of medical equipment maintenance will bring benefits to the department					
3	The benefits of insourcing medical equipment maintenance outweigh those of outsourcing medical equipment maintenance					
4	The overall costs of offering services will rise when the department adopts insourcing of medical equipment maintenance					
5	The overall costs of offering services will rise when the department adopts outsourcing of medical equipment maintenance					
	Standardization of medical equipment					
6	The overall costs of offering services will rise when the department adopts standardisation of medical equipment					
7	Decreasing the number of different supportive supplies will result in an opportunity for greater volume discounts.					
8	Standardizing medical equipment will increase efficiency for biomedical support and maintenance					
9	Standardizing medical equipment decreases the probability of mistakes that would negatively affect patient care and outcomes					

10	Cost benefits of standardizing medical equipment outweighs risks of relying on too few suppliers of medical equipment.					
	Medical equipment maintenance contracts.					
11	Proper management and administration of contracts is required for successful implementation of a maintenance programme.					
12	Equipment downtime will be reduced if equipment is procured with maintenance contract					
13	Outsourcing of medical equipment maintenance will reduce the turnaround time for medical equipment maintenance					
14	Procuring of medical equipment with maintenance contracts will reduce the overall cost of equipment maintenance					
15	Full inclusive/ comprehensive maintenance contracts will increase the overall maintenance cost of medical equipment					

= Thank you for your responses =

APPENDIX E2: SAMPLE OF RESPONSES

Appendix D: Questionnaire

SECTION A: DEMOGRAPHIC INFORMATION

1. **Gender**

Male	
Female	X

2. **Years of Experience in the Public Sector**

Less than 3 years	
3 – 6 years	
6 – 9 years	
9 – 12 years	
More than 12 years	✓

3. **Occupational Level**

Director	
Manager	✓
Employee	

4. **Highest Educational Qualification**

Secondary School	
Professional certificate	
Diploma	X
Undergraduate degree	
Post graduate degree	

SECTION B

Using a 5 point scale below, where: **1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree**, please rate each statement. (Please **Tick** in the Appropriate Box)

	Factors that affect the acquisition of an in-house clinical engineering services					
1	There should be proper management to administer in-house clinical engineering				X	
2	Well qualified engineers are needed to operate the in-house clinical engineering					X
3	Technology should be provided to ensure the effectiveness of the in-house clinical engineering					X
4	An in-house Clinical Engineering Department will lead to a shortage of medical equipment	X				
5	Medical equipment would be administered badly if an in-house Clinical Engineering Department is established	X				
6	Medical equipment cannot be administered by an in-house Clinical Engineering Department	X		/		
7	The process of having an in-house Clinical Engineering Department can affect service delivery	X				
8	An in-house Clinical Engineering Department will bring benefits to the department					X
9	The benefits of having an in-house Clinical Engineering Department outweigh those of outsourcing					X
	Effectiveness of an in-house clinical engineering department					
10	An in-house Clinical Engineering Department will improve performance in the department					X
11	An in-house Clinical Engineering Department will sustain better performance in the department					X

	better performance in the department					
12	An in-house Clinical Engineering Department will improve the way services are rendered					X
13	An in-house Clinical Engineering Department will improve service delivery					X
14	An in-house Clinical Engineering Department will reduce sourcing costs					X
15	An in-house Clinical Engineering Department will reduce the turnaround time for medical equipment maintenance					X
16	Service delivery might be compromised when the department adopts an in-house Clinical Engineering Department		X			
17	Service delivery standards will fall when the department adopts an in-house Clinical Engineering Department		X			
18	The overall costs of offering services will rise when the department adopts an in-house Clinical Engineering Department	X				
19	An in-house Clinical Engineering Department will be a burden to the department	X				

= Thank you for your responses =

Appendix D: Questionnaire

SECTION A: DEMOGRAPHIC INFORMATION

1. **Gender**

Male	
Female	✓

2. **Years of Experience in the Public Sector**

Less than 3 years	
3 – 6 years	
6 – 9 years	
9 – 12 years	✓
More than 12 years	

3. **Occupational Level**

Director	
Manager	
Employee	✓

4. **Highest Educational Qualification**

Secondary School	
Professional certificate	
Diploma	✓
Undergraduate degree	
Post graduate degree	

SECTION B

Using a 5 point scale below, where: **1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree**, please rate each statement. (Please **Tick** in the Appropriate Box)

	Questionnaire for the effectiveness of an in-house clinical engineering department in enhancing service delivery at the department of health, Eastern Cape	1	2	3	4	5
	Factors that affect the acquisition of an in-house clinical engineering services					
1	There should be proper management to administer in-house clinical engineering				✓	
2	Well qualified engineers are needed to operate the in-house clinical engineering				✓	
3	Technology should be provided to ensure the effectiveness of the in-house clinical engineering				✓	
4	An in-house Clinical Engineering Department will lead to a shortage of medical equipment		✓			
5	Medical equipment would be administered badly if an in-house Clinical Engineering Department is established	✓				
6	Medical equipment cannot be administered by an in-house Clinical Engineering Department	✓				
7	The process of having an in-house Clinical Engineering Department can affect service delivery				✓	
8	An in-house Clinical Engineering Department will bring benefits to the department				✓	
9	The benefits of having an in-house Clinical Engineering Department outweigh those of outsourcing				✓	
	Effectiveness of an in-house clinical engineering department					
10	An in-house Clinical Engineering Department will improve performance in the department				✓	

11	An in-house Clinical Engineering Department will sustain better performance in the department				✓	
12	An in-house Clinical Engineering Department will improve the way services are rendered				✓	
13	An in-house Clinical Engineering Department will improve service delivery				✓	
14	An in-house Clinical Engineering Department will reduce sourcing costs				✓	
15	An in-house Clinical Engineering Department will reduce the turnaround time for medical equipment maintenance				✓	
16	Service delivery might be compromised when the department adopts an in-house Clinical Engineering Department		✓			
17	Service delivery standards will fall when the department adopts an in-house Clinical Engineering Department		✓			
18	The overall costs of offering services will rise when the department adopts an in-house Clinical Engineering Department		✓			
19	An in-house Clinical Engineering Department will be a burden to the department	✓				

= Thank you for your responses =

APPENDIX F: LETTER TO THE STATISTICIAN

14 May 2019

Dr C. Mlambo
University of Fort Hare
Alice

Dear Dr Mlambo

REQUEST FOR ASSISTANCE WITH RESEARCH DATA ANALYSIS

My name is Bonga Mabentsela student number (201716794) currently studying Masters: Public Health at the University of Fort Hare. As part of the Degree fulfilment I'm required to conduct research. The proposal has been submitted and approved by the University and Department of Health. My topic is "Cost *cutting measures for the maintenance of hospital medical equipment in the Eastern Cape"*. This research is conducted under the supervision of Prof. Pinkoane (University of Fort Hare, South Africa).

I am hereby seeking you to assist me with data analysis for my research once data has been collected.

I have provided you with a copy of my research proposal (Annexure: A), data collection tool, as well as a copy of the approval letter/ email which I received from the University's Research Ethics Committee (Annexure: B).

If you require any further information, please do not hesitate to contact me on 083 541 6556, bonga01@webmail.co.za. Thank you for your time and consideration in this matter.

Yours sincerely,

_____ DATE...14.../...05.../2019

Bonga Mabentsela

APPENDIX G: LETTER FROM THE STATISTICIAN

Mangosuthu
University of Technology

26 November 2019

Dear Sir/Madame

Ref: Confirmation of statistical analysis

This letter serves to confirm that I, Courage Mlambo, independently coded and analysed Mr Bonga Mabentsela's data. The analysis was quantitative (involving descriptive statistical aspects).

Yours faithfully,

Courage Mlambo
PhD, Economics (University of Fort Hare)
Masters Certificate in Health and Environmental Economics (Vrijie University, Netherlands)
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