

**BEST PRACTICES INFLUENCING SUSTAINABLE MEDICAL SOLID WASTE
MANAGEMENT AMONG PUBLIC HOSPITALS. A CASE OF MERU COUNTY,
KENYA**

BY

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REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN
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DECLARATION

I declare that this Research project is my original work and has not been submitted for a degree in any other university or college for examination or academic purposes.

Signature:Date:.....

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L50/5377/2017

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

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DEDICATION

I dedicate this research project to my family for their encouragement and support during the entire period of study.

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ABBREVIATIONS AND ACRONYMS

EEA:	European Economic Area
HIV:	Human Immunodeficiency Virus
MOH:	Ministry of Health
SPSS:	Statistical package for social sciences
SWM:	Solid Waste Management
UNEP:	United Nations Environment Programme
USAID:	United States Agency for International Development
WCED:	Western Cape Education Department
WHO:	World Health Organization

ABSTRACT

Disposal of health care waste, particularly from hospitals and health centers is a burning issue. Health-care solid waste in most hospitals is currently disposed of by burying in the dumpsite without any treatment. The purpose of the study was to assess best practices of sustainable medical solid waste management among public hospitals in Meru County, Kenya. The study was guided by the following objectives; To assess how awareness and training, type of medical waste, availability of medical solid disposal equipment and facilities and appropriate technology influence sustainable management of medical solid waste in public hospitals in Meru County. The study was grounded on the Systems Theory and Systems Thinking, Stakeholder Theory. The study used descriptive research design. The target population comprised of staff involved in management of public hospitals in Meru County. Slovin's formula was therefore used to determine the sample size of 177 management staff drawn from 327 target populations comprising of staff involved in management of public hospitals in Meru County. A sample of public hospitals in Meru County was randomly selected. The process made use of questionnaires, secondary data and interviews. The study involved the use of both quantitative and qualitative methods of data collection. The study used primary data which was collected by use of questionnaires. At the completion of the data collection process, the questionnaires were sorted, coded and analyzed. The Statistical package for social sciences (SPSS) was used to generate the required frequencies and percentages to answer the research questions. Mean and standard deviation were used to analyze the operationalized data. In order to enhance simplicity and ease of understanding, tables were used to present the data. Inferential data analysis was done using multiple regression analysis. Multiple regression analysis was used to establish the relations between the independent and dependent variables. The study added new and relevant knowledge on safe management of health care solid waste to management of public hospitals, health policy makers and researchers and academicians. The study found that awareness and training influences management of medical solid waste management in public hospitals in Meru County greatly and that type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County in a great extent. The study also revealed that availability of medical solid disposal equipment and facilities greatly influence sustainable management of medical solid waste management in public hospitals in Meru County and that appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County in a moderate extent. The study concluded that availability of medical solid disposal equipment and facilities had the greatest effect on sustainable medical solid waste management in Meru County followed by appropriate technology, then awareness and training while type of medical waste had the least effect on the sustainable medical solid waste management in Meru County. The study recommends that technology needs to be at the centre stage of all solid waste management programs of Meru County government as well as other counties in Kenya, that the county should invest in more types of treatment for solid waste management and that public hospitals management should organize educational activities such as the organisation of conferences, seminars and workshops, publication of training manuals, case studies and best practices, and provision of technical and financial assistance should also be conducted.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The health care sector is an important and critical sector for the wellbeing of the population. The sector provides a range of services and contains a number of facilities that use a variety of inputs to produce a wide array of health-related outputs (WHO, 2009). However, similar to facilities that consume resources the generated outputs that are no longer useful become waste. Such waste originating from health-care facilities has been an issue and is of serious concern due to its harmful effect on the natural environment and human health. Worldwide, large quantities of waste are generated on a daily basis from health-care facilities. According to Chaerul, Tanaka and Shekdar (2008), waste fractions from health-care facilities include general waste, infectious wastes, sharps, pathological waste, pharmaceutical wastes etc. The hazardous and contagious characteristics of such waste and its effect on the environment and human health constitute to one of the most hazardous type of waste.

The World Health Organization notes that typical health-care waste generated in Latin America and the Caribbean per day is 3 kg/bed while in North America it is alarmingly around 7-10 kg/bed as compared to 3-6 kg/bed in Western Europe. Even though 3 kg/bed is minimal in comparison to the other regions, if not managed through environmentally sound methods, the consequences would be severe (United States Agency for International Development (WHO, 2009). The quantity of waste produced per day depends on a number of factors such as the type of service, number of beds (in-patient capacity), the hazardous content and infectious nature and the level of waste management. Quantification of waste is crucial for proper management and it is even more vital in developing countries. Cost related to disposal and proper disposal methods can be challenging for these countries (Chaerul, Tanaka & Shekdar, 2008).

Given its special characteristics poor disposal practices can lead to the release of pollutants directly into the air, water, and soil (Hassan, Ahmed, Rahman and Biswas, 2008). The largest fractions, 75% to 90%, of total waste by volume produced from health-care facilities are considered as general waste such as paper, food, packaging etc. with no serious environmental consequences. The rest, 10-25%, if not treated with care and managed in an environmentally

sound way, can cause serious harm to human health and environment due to its infectious and hazardous nature (WHO, 2009). Direct risks to human health involve the transmission of deadly infections such as Hepatitis B and C as well as the Human Immunodeficiency Virus (HIV). These infections are commonly spread by needle-stick injuries resulting from poor handling of needles and sharps. The risk of infection can also propagate downstream the waste chain to waste handlers, waste pickers and wider community as a result of poor waste management practices. In 2000 alone the WHO estimated worldwide, 21 million cases of Hepatitis B and 2 million cases of Hepatitis C of which 32% and 40% respectively were new infections caused by infected needles. Additionally, 5% of new infections relating to HIV resulted from contaminated needles increasing the number for that period to 260,000 (WHO, 2005).

Waste management is the organised systematic channelling of waste through practically appropriate recovery disposal routes, consistent with acceptable public health and environmental safeguards. It entails: storage, collection, transportation and disposal. The objective of waste management is the development of a fully or partly containerized storage, collection and transport services, which does not allow the waste material to pollute the environment (UNCHS Habitat, 2014). Health-care waste management can be a challenge for developing countries including Kenya. On one hand there is the need to provide foremost adequate health care for the population and on the other hand, protecting human health and the environment, which is essential, given the lack of environmentally sound waste management practices due to limited resources (WHO, 2009). In a survey conducted by the WHO in approximately 22 developing countries in 2002, it was concluded that 18% to 64% of health care facilities in these countries lack adequate disposal methods for disposal of waste (Chartri, 2012).

Approximately half of the world's population (47 per cent) lives in urban areas, a figure which is expected to grow by 2 per cent per year during 2000–15 (United Nations Population Division, 2001). The accumulation of people, their consumption patterns, travel behaviour and their urban economic activities have a large impact on the environment in terms of resource consumption and waste discharges. There is a strong correlation between economic growth and waste generation, especially waste from urban-based consumption. In the European Union, waste generation per capita from health activities, which constitutes only part of the total amount of municipal waste, already exceeds the target of 300 kg per capita per year set in the European

Union's fifth environmental action plan (EEA, 2014) by 100 kg. Most European countries have recycling schemes, particularly for paper and glass although this development has been only a partial success because the generation of waste paper and glass has also increased. Sludge from urban wastewater treatment plants is estimated to have increased in the EU from 5.2 to 7.2 million tonnes dry solids during 1992–98, and further growth is expected (EEA, 2014).

Such volumes are increasingly difficult to absorb through incineration, dumping in landfills and recycling in agriculture. The problem is being compounded by the fact that sludge is often contaminated with heavy metals and other toxic chemicals, which even in minute concentrations can affect human health (Hall & Dalimier, 2010). Consequently infectious and hazardous waste is often dumped in open, uncontrolled areas accessible to the general public and mixed with municipal waste. In many of these countries, disposal methods for health care waste include open unlined pits either close to the water table or other water bodies, open burning, indiscriminate dumping, or incineration with no emission control. Often these countries lack the resources and technical capabilities to adequately manage waste originating from health care facilities particularly hospitals (Brent, Rogers, Ramabitsa-Siimane & Roher, 2009).

Wastes generated from hospitals originate from various sources within the hospital such as the offices, kitchen, operating rooms, various wards, laboratories and diagnostic centres, pharmacies (Chaerul, Tanaka & Shekdar, 2008). A large number of the population reside in outlying, rural areas requiring the government to establish programmes to provide health services through health centres and health posts. However, environmentally sound disposal methods are often not in widespread practice at these facilities. These countries will continue to generate large quantities of waste in relation to population size from hospitals and health centres because of the general lack of adequate systems to regulate and manage such wastes. Thus, there is a high risk of an increase in the generation of health-care waste in the future.

Population growth and the lack of adequate management further exacerbate the environmental and health related issues (Chaerul, Tanaka & Shekdar, 2008). Given the severity of the issues highlighted, it is imperative to find ways to reduce the impact on the environment and human health. Policy intervention and environmentally sound management through waste minimization, the reuse and recycling of materials and technologies to treat waste before disposal are possible

measures that can be applied to reduce the quantity of waste generated and risk associated with this hazardous waste stream.

In India, Private participation in the provision of public hospitals Solid Waste services has existed since 1985 whereby the Municipalities have employed private contractors for secondary transportation from the communal bins or collection points to the disposal sites. In New Delhi the capital city of India, segregation and storage of Municipal Solid Waste decomposable and non-decomposable wastes are often disposed of at a common communal dustbins or disposal centre. New Delhi has increasingly resulted to the use of private contractors for collection, transportation and disposal and private capital to supplement the mechanization or improvisation process over the years. Also, the engagement of private sector participation has increased from short term contracts to long-term partnership, close to long-term Build Operate-Transfer concessions being awarded to the private sector to manage solid waste (Chartri, 2012).

A good example that highlights the challenges in solid waste management in Africa is Freetown in Sierra Leone; this town is a major port city with a total area of 357 square kilometers in the western area of the country. Freetown has a population of 772873 (Sierra Leone, 2006). This harbour is capable of receiving ocean going vessels and handles Sierra Leone's main port. Health institutions have duly increased the population of Freetown with a corresponding increase in the quantity of solid waste. The problems of solid waste in Freetown can be traced far back as the 60s when the management has been under variable organizations; both private and public. Unfortunately, each change further deteriorated the system, bringing it on the verge of collapse (Wilson et al. 2009).

The problem of increased population in public hospitals was further compounded in the mid-1990s when Freetown served as a safe haven for thousands of people from the provinces during the war and suffered a corresponding increase in the rate of generation of waste with very little management facilities as skip trucks, containers were vandalized or completely destroyed. The Freetown Waste Management Company, the current authority, is struggling to manage the wastes under tight budgets, limited trained but inexperienced man power, and little or no legislative authority and experience in solid waste management. Given the lack of education and awareness, and coupled with the very weak penalties (if any) for non-compliance, the public at large is also generally non-cooperative.

Many previous studies have examined problems of public hospitals solid waste in both developed and developing countries. These studies analyzed the problems of solid waste in different countries, sharing data and allowing for evaluation of the state-of-the-art in terms of waste generation, collection, transportation, disposal, recycling, attitudes and perceptions of the people towards sanitation issues, inadequate funding, insufficient tools and equipment. In Freetown the problem is acute as the disposal facilities have not been able to keep pace with the quantum of solid waste being generated. It is common to find large heaps of garbage lying in a disorganized manner at every nook and corner of the city. In developing countries, there is no formal waste collection system (Wilson et al. 2009).

In most developing countries, typically one to two thirds of the solid waste generated is not collected. As a result, the uncollected waste is dumped indiscriminately in the streets and in drains, contributing to flooding, breeding of insect and rodent vectors and the spread of diseases. Public hospitals waste management is drawing increasing attention, as citizens observe that too much garbage is lying uncollected in the streets, causing inconvenience and environmental pollution, and being a risk for public health. Although government authorities apply all the means at their disposal, the piles of wastes only seem to grow from day to day. Such means as by laws and arresting tools in an era of shrinking municipal budgets and a restriction on the scope of municipal government jurisdiction, the problem is likely to intensify unless alternate approaches can be developed (Chartri, 2012).

Solid Waste Management (SWM) is a major public health and environmental concern in many developing countries. The situation in Africa, particularly in the large hospitals is severe. The public sectors in many countries are unable to deliver services effectively, regulation of the private sectors is limited and illegal dumping of medical solid waste is a common practice. Local authorities charged with the responsibility of providing services have found it increasingly challenging to play this role (UNEP, 2010).

According to Wilson et al., (2010) one-third to one-half of public hospitals solid waste generated within most cities in low and middle income countries, of which Sierra Leone is no exception are not collected. They usually end up as illegal dumps on streets, open spaces and waste lands (Wilson et al., 2009). Banga et al., (2011) points out that many cities in developing countries, like Kenya, are facing increasing generation of waste and accompanying problems associated

with waste collection and disposal. Begum et al., (2007) agrees that this is mainly due to increase in population growth and rapid economic expansion. The problem of solid waste in Eldoret town has been contributed by a high waste generation, lack of disposal sites, inadequate waste collection by the concerned parties, and individual poor disposal habits. In many parts of the town, there are uncontained generation of solid waste and disposal, worsened by poor collection services. All these as discussed by Jin et al. (2006) and Afroz et al., (2009) have posed a great threat to environmental quality and human health.

According to Obirih (2002), waste management is one major area in urban environment which has a major impact on urban livelihoods and people's health with disastrous consequences as such as diseases and bad odours. Doan (1998) further adds that throughout history cities and towns have struggled with how to collect and dispose of the refuse generated by their population. In Eldoret, urban authorities have failed to devise effective response mechanisms to mitigate the problem of waste collection and disposal. In Eldoret, especially in health centers the sanitation companies have not efficiently and effectively provided waste management services because of an increase in urban population and an influx of informal settlements. This has made waste management even harder.

In Moshi Tanzania, waste collection services are provided by the Moshi Municipal Council (MMC), a private contractor on a pilot basis, and community based organizations (CBOs). The private contractor provides services in one of three wards in the central business district (of 15 intotal in Moshi). The arrangement is that private contractors collect both waste and fee and pay three per cent of the total fee collected to the county government (Oberlin, 2012).

Medical solid waste situation, which could be taken to generally represent Kenya's status, is largely characterized by low coverage of solid waste collection, pollution from uncontrolled dumping of waste, inefficient public services, unregulated and uncoordinated private sector and lack of key medical solid waste management infrastructure. Health care waste is a major challenge in the country due to increased amounts of waste produced and the lack of proper capacity to manage. Data indicates that for every patient admitted in hospital in the country 0.5kg of waste is produced; 20 percent of this waste is potentially infectious. In Kenya the main mode of medical waste management is incineration, open pit burning and burying. The most

important limitations that are currently hampering the proper management of HCW is inadequate resources, lack of trained manpower and lack of affordable HCWM technologies.

In Kenya, according to Ikiara et al. (2014) while poor management of solid waste is a general problem, it is probably worst in public hospitals. This means there is a problem in quantification of solid waste management from other towns in Kenya like Eldoret. Indiscriminate disposal of public hospitals solid waste in dumpsites has proved to be a problem to residents. In most developing towns, Eldoret is no exception, open dumps can pose major public health threats and environmental effects.

1.2 Statement of the Problem

There are a number of Solid Waste Management (SWM) projects that have been done in the developing countries. Many of these projects are often funded; hence once the funding are completely depleted these projects fail since they are not able to self-fund themselves hence there is a risk of un-sustainability of such projects. In Nairobi Kenya, most of industrial waste is deposited at Dandora dump site and most of the adjacent areas are quite disadvantages due to the many operations that are undertaken at the dumpsite. The existence of this dumpsite has led to several issues like poor infrastructure, including roads and drainages, unending dumping of industrial waste, medical and house hold waste. In addition, the dumpsite has posed significant pollution of adjacent rivers, air and soil pollution is also exhibited. The dumpsite has also posed risk on the health of people and domestic animals living around there (Muniafu & Otiato, 2010).

The management of health-care waste is of serious concern in Kenya. Waste is generated both from public and private hospitals as well as out-patient centres and community health centres. The quantity of waste generated by these facilities depends on the services provided. Separation of waste at source, even though a recent phenomenon, has been affected by a number of factors such as the availability of equipment (bin liners). The potential health risk and related environmental impacts from health-care waste will therefore vary along the waste chain. The degree of impact downstream of the chain depends highly on the level of separation that occurs at the point of generation of waste. Handlers are placed at risk in the absence of protective equipment when handling, collecting and transporting solid wastes (Chaerul, Tanakam & Shekdar, 2008).

Disposal of health care waste, particularly from hospitals and health centres is a burning issue. Health-care solid waste in most hospitals is currently disposed of by burying in the dumpsite without any treatment. Waste from hospitals is mixed with animal carcasses and abattoir waste. The disposal site has no lining, soil cover or gas control (WHO, 2004) thus there is a potential risk of ground water contamination. Waste is disposed of by either open burning or incineration in the outlying regions of the country. Emissions released directly into the atmosphere from burning affect the surrounding population since these facilities and the location of the burnt boxes or incinerators, are upwind of residences. Further, burning of such waste is known to emit toxic pollutants such as dioxins, furans as well as heavy metals (lead, mercury) either directly in the air or from burying of the ash (Emmanuel, Hrdinka, Gluszyński, Ryder, McKeon, Berkemaier & Gauthier, 2014).

In Meru County, for instance, medical solid waste is seen as a mounting problem. The situation relating to health-care waste management in Meru County is complicated by the lack of awareness and training that is sustainable, variation in solid wastes, inadequacy of medical solid disposal equipment and facilities and challenges in adoption of appropriate technology to manage solid waste. In recent times, there have been numerous press statements of medical waste being disposed of in an incorrect manner. The incineration of medical waste has also caused much concern.

Some studies such as Ochoro (2016) established strategic factors affecting sustainable industrial waste management in Kenya a case study of Nairobi Bottlers Limited. Muniafu and Otiato (2010) studied solid waste management in Nairobi, Kenya, a case for emerging economies. It is estimated that about 45% of health care waste generated in the county alone, for instance cannot be accounted for, indicating that it is being illegally dumped, buried or burnt somewhere, thus affecting the health of the people and the environment (MOH, 2009). Medical solid waste management is a fundamental prerequisite in ensuring sustainable environment. Rapid patient population growth and increased waste generation have transformed solid waste into a major health and environmental concern in Meru County. Medical solid waste management is tough and very expensive especially tough to the low level hospitals who cannot afford the services and hence left to deal with waste disposal on their own. There is often the lack the capacity to properly dispose of huge amounts of medical solid waste being generated. A huge gap therefore

exists when it comes to waste management since knowledge about its full scope and also on how to correctly handle and dispose waste in an environmental friendly manner is limited. This led to a gap in the best practices of sustainable medical solid waste management among public hospitals.

1.3 Purpose of the Study

The study investigated best practices influencing sustainable medical solid waste management among public hospitals in Meru County, Kenya.

1.4 Objectives of the Study

The study was guided by the following objectives: -

- i. To assess how awareness and training influence sustainable management of medical solid waste management in public hospitals in Meru County;
- ii. To examine how type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County;
- iii. To determine how availability of medical solid disposal equipment and facilities influence sustainable medical solid waste management in public hospitals in Meru County;
- iv. To establish how appropriate technology influence sustainable management of medical solid waste in public hospitals in Meru County.

1.5 Research Question

The study was guided by the following research questions:-

- i. To what extent does awareness and training influence sustainable management of medical solid waste management in public hospitals in Meru County?
- ii. To what level do type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County?
- iii. What is the influence of availability of medical solid disposal equipment and facilities on sustainable medical solid waste management in public hospitals in Meru County?
- iv. How does appropriate technology influence sustainable management of medical solid waste in public hospitals in Meru County?

1.6 Significance of the Study

Management of Public Hospitals

The study adds new and relevant knowledge to the available collection of literature on safe management of health care solid waste. Further it fits well within the current global trend of environmental problems. To the healthcare workers, the study may be of great importance as it may provide information on how to manage medical solid waste effectively in Kenya.

Health Policy Makers

The study provides valuable information for local health policy makers, Medicines Regulatory Authority, dealers, health services providers, donors and all other stakeholders involved in medicines sector to effectively plan, manage and supervise safe disposal of medical waste. To the government and policy makers the study may provide information which can be used to formulate more policies so as to enhance medical solid waste management in Kenya.

Researchers and Academicians

The results of this study may provide insight and information thus building the body of knowledge in the field of waste management practices in health facilities. It may therefore be of interest to other researchers who may want to conduct research on this important concept. The study may also provide a base upon which secondary material on waste management practices in public health facilities may be drawn.

1.7 Delimitation of the Study

This study was on the best practices of sustainable medical solid waste management among public hospitals in Meru County, Kenya. Meru County had been chosen as the study area since it is one of the areas where most medical solid waste management has been experiencing challenges. Staff in public hospitals in Meru County formed the population for the study. The study was carried out in a period of three months.

1.8 Limitations of the Study

The study anticipated encountering some limitations that might hinder access to information that the study sought. The respondents targeted in this study might be reluctant in giving information fearing that the information being sought might be used to intimidate them or print a negative image about them. The researcher hopes to handle this by carrying an introduction letter from the

University to assure them that the information they give was treated with confidentiality and was used purely for academic purposes.

The other limitation that the study was based in public hospitals in Meru County the study may not include more slums around the Country owing to the amount of time and resources available. This study may therefore suffer from generalizability of the results if the nature of projects undertaken is significantly different from those in public hospitals in Meru County such as donor funded and implemented projects. In addition, the finding of this study was limited to the extent to which the respondents were willing to provide accurate, objective and reliable information. The researcher checked for consistency and test the reliability of the data collected.

1.9 Basic Assumptions of the Study

The study assumes that there were no serious changes in the composition of the target population that might affect the effectiveness of the study sample. This study also assumed that the respondents were honest, cooperative and objective in the response to the research instruments and was available to respond to the research instruments in time. Finally, the study assumed that the authorities in the firms granted the required permission to collect data from employees.

1.10 Definition of Significant Terms Used In the Study

The following are the definitions of terms that were used throughout this study:

Appropriate technology – this is the application of efficient and effective scientific knowledge for practical purposes, especially in industry.

Availability of Medical Solid Disposal Equipment- is the adequate accessibility of waste management facilities.

Awareness and Training specifically involves the discrepancy between people's concern over the environmental harm posed by household waste and the limited action by those same people to reduce their waste or engage in other pro-environmental behaviours.

Best Practices are professional procedures that are accepted or prescribed as being correct or most effective Best practice encourages appropriate action and behavior regarding waste management and increases the amenity, ease of use of waste services,

environmental performance and ultimate reputation of developments with well-managed waste facilities.

Medical solid Waste: any waste generated in the diagnosis, treatment, or immunization of human beings or animals, related to research, production or testing of biological from all types of healthcare institutions, including hospitals, clinics, dental or veterinary and medical laboratories.

Sustainable waste management is an integral part of sustainable development (Brundtland Commission's approach to development which seeks to meet the needs of the present without compromising the ability of future generations to meet their own needs)

Type of Medical Waste is Waste management hierarchy categorizes used strategies depending on their ability to minimize waste as reduce, reuse and recycling.

1.11 Organization of the Study

This study is organized into five chapters. Chapter one contains the introduction to the study. It presents background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the Study, delimitations of the study, limitations of the Study and the definition of significant terms. On the other hand, chapter two reviews the literature based on the objectives of the study. It further looked at the conceptual framework and finally the summary. Chapter three covers the research methodology of the study. The chapter describes the research design, target population, sampling procedure, tools and techniques of data collection, pre-testing, data analysis, ethical considerations and finally the operational definition of variables.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this second chapter, relevant literature information that is related and consistent with the objectives of the study is reviewed. Important issues and practical problems are brought out and critically examined so as to determine the current facts. This section is vital as it determines the information that link the current study with past studies and what future studies were still needed to explore so as to improve knowledge.

2.2 Sustainable Medical Solid Waste Management

Sustainable waste management is an integral part of sustainable development (Brundtland Commission's approach to development which seeks to meet the needs of the present without compromising the ability of future generations to meet their own needs) WCED (1987) because the amount of waste generated and how it is managed has profound implications for the quality of the environment and for the prospects of future generations. This therefore means that in keeping with the objectives of sustainable development, sustainable waste management can be regarded as an approach to waste management that, in addition to achieving its main goal which is to protect human health and the environment, ensures that the limited resources of the earth are conserved for both present as well as the future generations. It therefore becomes important to minimize the amount of natural resources that human beings extract as well the consumption by recycling waste materials, and conduct waste management efficiently to curtail the environmental impacts of waste disposal and protect ecosystem services for both current and future generations (Baabereyir, 2015).

Klundert and Anschutz (2001) in their definition of SWM points out that it means a system that is appropriate to the local conditions in which it operates, from a technical, social, economic, financial, institutional, and environmental perspective, and; capable to maintain itself over time without reducing the resources it needs as noted by a definition which corroborates with that of World Bank (2009). It can therefore be concluded that a sustainable waste management system is that which takes into respect sustainable development aspect of producing more with less and should be appropriate to local context so that it can be in a position to maintain itself for a long

time and can be achieved through the minimization of waste impacts in terms of quantity or negative impacts, by reducing the volume of waste, reusing the waste products with simple treatment and recycling the waste by using it as resources to produce the same or modified products.

2.3 Best Practices and Sustainable Medical Solid Waste Management

Best practice waste management therefore establishes the design and provision and maintenance of services and infrastructure that enable garbage, recycling, organics and bulky waste services to be made in the best possible way to improve resource recovery. Best practice requires continuously searching for ways to improve infrastructure, systems and services as knowledge and experience accumulates over time. Wastes generated from hospitals originate from various sources within the hospital such as the offices, kitchen, operating rooms, various wards, laboratories and diagnostic centres, pharmacies (Chaerul, Tanaka & Shekdar, 2008).

Best practice management systems are effective and safe. Hospitals can use them with ease and collection crews can easily access and service them. The design, installation and ongoing management of best practice systems encourage Hospitals to use the services appropriately. This includes greater participation in the services provided, minimized waste generation, increased resource recovery and reduced contamination of recyclables and organics. The lack of any recyclables collection service to existing developments further affects overall recycling results. This may happen when a development uses a privately contracted garbage collection service only and/or a council has not required a waste management plan. Councils should encourage these developments to expand the private garbage collection services to include recyclables collection. Also, the engagement of private sector participation has increased from short term contracts to long-term partnership, close to long-term Build Operate-Transfer concessions being awarded to the private sector to manage solid waste (Chartri, 2012).

Hospitals should also avoid using private contractors who do not incorporate recyclables collection, and not offer a refund to site owners for a privately provided service if this is the case. Health institution could consider having an environmental levy for waste and recycling education which is charged regardless of service provider. Best practice waste management can also help maintain a development's aesthetic appeal and efficient management. Facilities for garbage, recycling and organics are essential aspects of a building that are often overlooked or

undervalued. If designed and managed properly, they are virtually invisible to the occupants. If designed or managed poorly, they are a perpetual irritation, which can become worse as the building ages. Planning at the design stage is essential; it can save a great deal of difficulty and inconvenience for residents, building managers and collectors throughout the life of the hospital. The public sectors in many countries are unable to deliver services effectively, regulation of the private sectors is limited and illegal dumping of medical solid waste is a common practice. Local authorities charged with the responsibility of providing services have found it increasingly challenging to play this role (UNEP, 2010).

2.3.1 Awareness and Training and Sustainable Medical Solid Waste Management

Many researchers have argued that the waste problem is caused by human behaviour and therefore the solution lies in changing that behaviour (Milea et. al., 2010). Public awareness and attitudes about waste can affect the whole process. An attitude - behaviour gap often emerges due to a variety of reasons including convenience, social norms, lack of public participation, and lack of education and awareness of effective waste management techniques (O'Connell, 2011). Within this attitude gap exists an inconsistency between one's values and actions. This specifically refers to the discrepancy between people's concern over the environmental harm posed by household waste and the limited action by those same people to reduce their waste or engage in other pro-environmental behaviours (Milea et. al., 2010).

Many researchers observed this gap first hand when conducting observations in communities of the developing world. A negative behaviour often associated with the mismanagement of solid waste in developing countries is the occurrence of littering (Guerrero, Maas & Hogland, 2013). There are a multitude of causes that can contribute to an increase in littering rates, such as a lack of social pressure to prevent littering, absence of realistic penalties or consistent enforcement, and lack of knowledge of the environmental effects of littering.

Other causes include the amount of litter already present at a particular site, presence of signs referring to litter, and the number and/or placement and appearance of waste collection bins at the site. Convenience of garbage bins has been cited many times in research as a priority when disposing of trash, and when these are not present or lacking in areas this has been reason enough to litter (Guerrero, Maas & Hogland, 2013). Other times people become accustomed to throwing their waste in inappropriate places, as there had been no formal system for sorting and disposal,

so when changes are implemented people are not changing their disposal behaviour out of pure habit and custom (Yousif & Scott, 2011).

Similarly, a range of socio-economic factors can affect public attitudes toward littering, frequency of littering, and the effective approaches to impede the littering tendency within an individual (McAllister, 2015). These factors are region and culture dependent, and it is very important to study them if an effective littering prevention program is to be designed. For example, in Cuba, researchers found that a majority of citizens participated in recycling buybacks and non-littering initiatives, not only because the government supports these efforts for economic reasons, but also because of the social pressure created by the community. Citizens also possess internalized social norms and believe that if they do not adapt their behaviours accordingly, they become outsiders and are looked down to (Guerrero, Maas & Hogland, 2013). The participation of the community in the production and use of scientific knowledge is considered the best approach to environmental management of waste. Many studies have been conducted in the developed world to evaluate and apply strategies to reduce littering by means of behavioural interventions (Al-Khatib, et. al, 2015), but in developing countries little has been done.

Another major constraint seen throughout the developing world is the lack of education and awareness of effective waste-management practices. One study in Gaborone, Botswana, found that even though citizens were aware of recycling and other sustainable waste-management techniques, this does not necessarily translate into participation in pro-environmental activities such as recycling initiatives. They appear to have not embraced waste management reforms amid their limited knowledge of such activities (Hazra and Goel, 2009). The lack of interest in the environment creates a culture of non-participation of communities in decision-making processes. That stance enhances lack of responsibility for pollution and waste issues. Ultimately, this produces communities that have little knowledge of, or concern for, their impact on the environment (McAllister, 2015).

Typically, people are more likely to participate in waste management activities, when they observe others in their vicinity doing so. In developing countries, recycling programs are rare, so wealthier members of the country rely on informal recyclers as the behaviour norm (O'Connell, 2011). Aini (2012) indicated that, in order to overcome the medical solid waste crisis, the

conscience of the individual needs to be raised through environmental awareness and concern, inculcation of sustainable consumption practices and education on waste management. Environmental awareness and knowledge about environmental conservation were found to affect waste management attitude positively but positive attitude may not have resulted in recycling if knowledge about it was poor (McAllister, 2015). Niringiye and Omortor, (2010) assessed best practices of willingness to pay for improved health solid waste management in Kampala City. The model used to elicit willingness to pay for improved health solid waste management was a dichotomous choice contingent valuation technique. The study found out that the age of the household head was negatively associated with the willingness to pay for solid waste management and that there was little chance of success if health solid waste collection service charges were introduced.

Successful health solid waste management is often attributed to many reasons arising from policy implementation; however the main reason why most hospitals have succeeded in solid waste management is due to staff waste awareness and support (Babalola, 2010). In addition involving patients in waste management programs often promotes publicity with tips on waste management hence eventually minimizing waste (Young, Ni & Fan, 2010). Similarly Wilson (2010) indicates that two main underpinning group of drivers of waste management include public awareness and responsibility issues. Waste awareness is critical in ensuring that there is waste management sustainability. Its starts from people knowing which waste elements exist in a hospitals and which methods are to be used to effective manage, reduce and properly dispose of the waste. One of the challenges facing proper waste management in Nigeria is lack of proper public waste awareness. This is also observed by the fact the public has a negative attitude towards waste management; hence the government should carry out campaigns to enlighten the public on waste and waste management (Babalola, 2010).

Behavioral instruments play a role in waste management strategies through initiatives that inform and educate, some of these initiatives include waste audits, hospital programs, advertising, training, and competitions. Education has been shown to be a critical component in encouraging staff participation in solid waste management programs (Bolaane, 2008) advocates for waste educational programs that would ensure that everyone involved by increasing awareness and commitment towards waste, increasing capability of different staff in identifying opportunities

that would lead to waste minimization and avoidance and ensuring that operational staff are adequately trained for foster compliance with relevant waste regulations and be able to report any negative implications or observations. Raising awareness about different waste management programs can have positive effects, but there are several methods which can be used to change Behavior to improve participation or correct problems (Timlett & Williams, 2008). Once new initiatives are introduced, people will need time to adjust until the new plan becomes normal Behavior, but once this Behavior is established it is difficult to break (Timlett & Williams, 2009). Awareness of impacts of waste has not been enforced in most areas, we see many companies and communities littering everywhere, this is evidence of lack of proper awareness in most areas when it comes to waste management. One of the goals of National Waste Management is to create awareness on waste management issues and to add practical waste projects to basic education curricula. Enforcing anti littering campaigns and waste separation at source at critical to waste sustainability (Department Environmental Affairs, 2011).

Waste awareness and participation can also be enhanced more by creating recognition programs such as the competitions, coming up with specific performance evaluation criteria and reward and recognition In addition , producer responsibility must be aligned to the overall waste management plans and consumer awareness programs should also be incorporated in the industry waste management plans (Department Environmental Affairs, 2011). Waste awareness can also be created through door to door awareness and motivation programs which involve establishing contact with participants and providing feedback, it also helps in reducing the time lag that would be created between information communication and when the actual waste collection begins. Importance of door to door awareness campaigns is that communication is effectively passed on to the participant and often reduces any elements of rumor mongering, building confidence of the participants and also assisting in clarifications of any issues of concern. Waste awareness can also be created through rallies as people get very excited with rallies and street plays and they tend to attract a large crowd to come and witness what it is all about. Embedding waste management into school programs is also a plus since children are the future of tomorrow, this is a more sustainable tool toward effective waste management (Zhu et al., 2008).

2.3.2 Type of Medical Waste and Sustainable Medical Solid Waste Management

Solid Waste is defined by McDougall et al., (2008) as the by-product of human activity and it contains the same material as are found in the useful products only that it differs from useful products by its lack of value. Wastes can be categorized into different categories based on different attributes including the physical state, original use, material type, physical properties, origin and safety level. Furthermore, depending up on the source waste is classified as a municipal and non-municipal waste. The sources for the municipal solid wastes are mostly from offices, households, streets and public places, shops and hospitals (Zhu et al., 2008).

Waste management hierarchy categorizes waste management strategies depending on their ability to minimize waste as reduce, reuse and recycling. According to Cointreau (1982) solid waste professionals recommend open trucks over compactor trucks, because cost is much lower, maintenance is cheaper and the wastes tend to be very dense with little compatibility. Furthermore the waste collected in Kenya is mostly organic waste so the use of compactor truck implies large debts, more serving per length of time and a modern image. Transfer station is a facility for transferring waste from the collection vehicle to a more appropriate vehicle where longer haul distances are necessary for final disposal. The need for a transfer station and the degree of sophistication required will be determined by the volumes of waste generated, the collection system implemented, and the distance to the disposal site. Transfer stations can be considered the final disposal point by the community, particularly where communal collection services are in operation. Communal disposal facilities, where open bulk containers are utilized, therefore need to be managed and controlled with the same care and responsibility as that required for a landfill site (Zuilen, 2006).

According to study done by Moghadam et al (2009) revealed that Collection, transfer and transport of solid waste was affected by improper bin collection systems, poor route planning and lack of information about collection schedule. Municipalities collected waste from the commercial areas with frequencies that varied from fourteen times a week to once a week. The solid waste generated was collected at fixed stations or door to door and few cities had transfer stations. The door to door collection was done by variety of systems; rick saw, animal tractor, wheelbarrow, tractor, truck, compactor, motorcycle and hand trolley. In general, he concluded that there is a need for municipalities to provide sufficient infrastructure and equipment needed

for waste collection, transfer and transport. Efficient solid waste collection depends on proper selection of vehicles taking in to account of road conditions, availability of spare parts and servicing requirement. The compactor trucks which are very expensive and require high operating cost and additional maintenance are preferable due to the fact that its usage will solve the problem of scattering of waste during transportation to the dumpsites.

Type of medical waste influences tasks regarding planning, implementation and maintenance of collection and transportation systems, waste recovery and final disposal. Thereby one has to take in to consideration the design and collection of facilities and equipment with regard to their operational characteristics, their performance and their maintenance requirements. The need for repair and availability of spare parts should not be forgotten either (Schubeler, 1996). Literature suggests that technical factors influencing solid waste management system are related to lack of technical skills among personnel within municipalities and government authorities, deficient infrastructure, poor roads and vehicles, insufficient technologies and reliable data. We live in a world of increasing scarcity. Raw materials from natural resources are limited, financial resources are often insufficient and securing land for final disposal is more difficult (Hazra & Goel, 2009).

2.3.3 Availability of Medical Solid Disposal Equipment and Sustainable Medical Solid Waste Management

Ineffective equipment has been a major factor that contributes to the inadequate health solid waste management and operational inefficiencies (White et al., 2012). In a study looking at solid waste management (SWM) in the developing world, it was discovered that many sources of waste might only be reached by roads or alleys, which may be inaccessible to certain methods of transport because of their width, congestion, and elevation. This is especially critical in unplanned settlements such as slums or low-income areas and thus largely affects the selection of equipment (Banga, 2011). In India, poor conditions of containers and inadequate maintenance and replacement of worn-out collection vehicles contributed to behaviours such as littering and illegal dumping by citizens who felt they could not properly dispose of trash because trash bins and waste services were not properly maintained (Hazra & Goel, 2009).

Another major constraint is the misuse of technology, which has been documented in numerous cases where sophisticated and expensive technological recycling and composting plants as well

as other waste management systems in developing countries have failed (Yousif & Scott, 2011). Reasons for a breakdown include a failure to adequately and extensively consult the public and relevant stakeholders, adoption of inappropriate technology characterized by imported mechanical and electrical parts which are too expensive to replace or too difficult to maintain and failure to conduct economic and financial assessments. In addition, limited developments of a market for recyclables, financial constraints, and absence of skilled technical personnel to manage these systems have been observed in many developing countries (White, Dranke & Hindle, 2012).

Inadequate landfill disposal is the next factor that contributes to infrastructural challenges. For instance, in Ghana, Asase, Yanful, Mensah, Stanford and Amponsah (2009) noted that there was a lack of proper disposal sites in the country. Unprotected and uncontrolled dumps, which pose a danger to the public health, environmental health, waste renewable resources, and jeopardize residential development in these areas, are a commonality found in many developing countries. Unlike developed nations, third world countries lack sanitary landfills and oftentimes disposal sites are located at a considerable distance from communities. This ultimately creates even more financial constraints because costs to collect, transfer, and dispose of waste are more than many municipalities can afford. Rapid population growth and urbanization have put limits on the location of future landfills, and this reality is something that many of these developing countries confront. Finding ways to minimize waste such as recycling are excellent tools to combat this waste issue (Yousif & Scott, 2011).

According to Al-Khatib, Kontogianni, Abu Nabaa, Alsham and Al-Sari (2015), local authorities should increase the number and optimize the distribution of litterbins on the streets and other public places as a measure to discourage people from littering. Convenient access to these units will cut down on littering, alleviate some of the pressure on municipalities and redistribute resources to help properly dispose of waste. Another improvement could be undertaken when it comes to storage containers. Open storage enclosures should be eliminated and converted into closed containers. In addition, the volume of the storage enclosures should be designed by overestimating the generation of waste, not underestimating it, as is currently being done (Hazra and Goel, 2009). This also goes along with upgrading transportation and other equipment, which in the long run will increase operations.

Oteng (2012) advocates for communities to network, collaborate, coordinate, and develop common waste treatment and disposal infrastructure in order to improve waste disposal methods. Formalization of recycling and encouragement to do so would significantly reduce the volume of waste and could save municipalities a substantial amount of money and resources. This approach could also create informal employment opportunities. Lastly, creating new landfill sites with social, economic, and environmental needs in mind is important to sustainable waste management systems (White, Dranke & Hindle, 2012). While sanitary landfills are expensive to maintain, that does not mean that communities in developing countries do not have sustainable waste removal options at their disposal. Composting and recycling initiatives as well as waste reduction are all available options for the developing world to take advantage. Examples of these waste minimization activities have already begun to be looked at as viable options in reducing the amount of waste for disposal in places such as Cameroon (Milea et. al., 2010). What it comes down to are the choices that communities have to make. They need to choose the best infrastructure and technologies that best meets their current needs and capabilities.

2.3.4 Appropriate Technology and Sustainable Medical Solid Waste Management

Organizations today are prolifically integrating new technologies to gain an edge over others in terms of productivity and services. With the help of technology there are remarkable changes in the processes like marketing, production, human development. Technology is useful in accurate decision making, time and money saving etc. and the same is based these days on scientific basis and analysis. Moreover, it has played a major role in conducting financial analysis and control. Although, there are several implications of technology, two implications have the most influence in organizations today. First one is the automation or new technology and the other one is information technology. New technology' or automation is not unanimous words rather they cover a wide range of tools, components and systems (Sheridan, 2002).

Rapid urbanization has resulted in existing dumping sites originally located at a safe distance outside the municipal boundaries are now being increasingly encircled by settlements and housing estates (Schertenleib & Meyer, 1992). This has caused the public to oppose their existence as they cause odour, dust, and other nuisances. People living close to dumpsites are in danger of contracting diseases associated with dumps. Oyaro (2003) notes that tests conducted on 328 children living near the Dandora dumpsite found that half of them had excess

concentrations of lead in their blood. They were also disproportionately affected by anaemia, skin infections, asthma, and other respiratory diseases. These conditions are associated with high levels of toxins at the dumpsite, which receives plastics, rubber, wood, metals, chemicals, and hospital waste (Environmental News Services, 2007; Oyaro, 2003). Figure 2.3 shows livestock grazing in a place littered with waste. Thousands of poverty stricken Africans make a living through salvaging recoverable materials from waste sites. Daily, women, the elderly, and children spend long hours at the open solid waste dumps sifting through the rubbish for valuable items. Wilson, Velis, and Cheeseman (2005) say these people use bare their hands and wear no protective clothing. Waste hierarchy as explained by (Baud et al., 2004) is the basis for waste minimization strategies, and refers to the 3Rs which are reduce, reuse and recycle. The application of the 3R concept in to the waste management minimizes the amount of waste that goes in to dumpsites or land.

Williams (1998), trying to be specific on hospital solid wastes, said that it includes wastes from hospitals, doctors and dentist's surgeries and health centres, nursing homes and veterinary surgeries. He further says that such wastes may also be generated from research centres (such as National Institute of Health), universities and schools of veterinary medicine. He again notes that such wastes may invariably include insulation of wastes. Other wastes from surgery and autopsies, contaminated laboratory wastes, contaminated sharps, hypodermis needles, dialysis unit waste, contaminated animal carcasses, body parts, discarded beddings, contaminated food and other products and contaminated equipment. The present study in agreement with Williams's definition has singled out hospital wastes as those from hospitals, doctors and dentists' surgeries, health centres and nursing homes to enable a detailed investigation into the study topic.

Mostly, illegal waste dumping incidents are handled on individual basis such as among local authorities, or community groups or even environmental agencies within a community setup. But this normally happens with no cohesive and cooperative prevention framework. There have been initiatives to use ICT to help reduce illegal waste dumping. For instance in Estonia, a virtual waste management system was developed where people used cell phones and GPS to map and take images of illegal dumps around the country using Google Earth Software (Hanfman, 2012). The aim was to make people more environmentally conscious. The system is now being used to survey 61 countries since it was initiated in 2005. It has so far identified 6,244 dump sites that

are illegal containing an estimate of 18,022 tons of trash. These surveys help in assessing and documenting as many illegal open sites as possible; therefore enabling planning of the solid waste as well as identifying and executing of the recycling services needed. Another research done by (Mutai, 2013) concluded that mobile phone technology can be used by the environmental management bodies to report incidences of illegal dumping. However, the system was only limited to reporting by use of photos. According to one pilot program, implementing a database for reporting and tracking system immediately increased community reporting and improved communication between the key stakeholders and hence resulting to faster response and action (Vonk & Schnepf, 2006). New technologies such as surveillance that enable all recyclables to be collected together have made these programs easier and more affordable to implement, as well they have proven to be an extremely effective step in diminishing the incidents of illegal dumping in an area not to mention the added convenience to local residents (Nestor, 2014).

Infrared cameras with high withstanding capabilities are able to capture images at night and can be placed at known dumping sites discreetly. These cameras are positioned in a way they capture individuals in the act as well as vehicle license plates. Images are then transferred live to computers or mobile devices, cell phones inclusive. Evidently, using these photographs as a prosecution tool, results in convictions. The fear on seeing one's self in these preserved photographs is sufficient to reform the first time offenders. These convictions and publicizing acts, increase the degree of risk perception even for seasoned violators. If the surveillance cameras could be deployed in/at every municipality having active dumpsites, then publicized arrests and finally prosecutions would greatly decrease these incidences. Another effective used method in relation with the cameras is the act of marking the illegal dumping locations with a crime scene tape. These give local observers a strong signal that illegal dumping can and could end up being a criminal offense. In facilitation of 14 this process, many countries exploit Joint Code Enforcement Officer Service whereby other external persons can assist with the administration. In a study done in Japan by (Katsuya & Kuniko, 2006), they found out that the root cause of illegal dumping is that the waste-generating enterprises involved do not always pay appropriate levies, so waste disposal firms are unable to make enough income for their sustenance. They then recommended that policies and procedures need to be enacted so as to enable waste-generating enterprises to select reliable and reputable waste disposal firms, which are also affordable. Government policies and experimental initiatives have also to be formulated

to directly monitor illegal dumping. That is, satellite monitoring systems had to be developed, to detect illegal dumping in order to prevent its spread and minimize its impact. These are some of initiatives formulated by governments and relevant authorities as a result of information gathered in terms of illegal dumping (Katsuya & Kuniko, 2006). These initiatives also oversee the concern for the next generation and children growing up as they will need a better environment than we are experiencing today. Therefore the need to preserve the environment as at now before it will be too late to do so. An illegal dumping tracking or monitoring system shared by all stakeholders such as mobile phones; is one of the best ways for communities to adequately assess and address this challenge through reporting.

Modern production systems use computer based technology for integrating various aspects of manufacturing process in a better and improvised manner and also allow quick and cost efficient modifications of any product to minimize medical solid waste. Technology can be liberating in enabling people to work at times and in places of their own choosing. Technology also has enormous potential to transcend geographical, cultural and temporal boundaries and so increase collaborations amongst organizations and their members (Cartwright, 2003). The knowledge may be shared and distributed with this turbulent technological change. The electronic media is responsible to reduce the social aspects of communication between the individuals working together. As the electronics has been invasive, useful and established therefore the earlier relationship between technology and employment may be transformed. It is expected in future to have new establishment of organizational behavior, a new feature of work, new model of production of goods and services and a new style of employment (Rahmati et. al., 2012). Also it more depends upon the distant leadership.

2.4 Theoretical Orientation

This section discusses the theoretical foundation on which the study is anchored. The study will be grounded on the Systems Theory and Systems Thinking, Stakeholder Theory

2.4.1 Systems Theory and Systems Thinking

The theoretical systems literature has put forward a number of different explanations for systems and applicability of systems thinking. General systems theory, discusses inputs and the interactions with the various components or subsystems within the wider system to effectuate outcomes. A key characteristic of systems in general, is the integration of information and

information flows from one level to the next. It is necessary to ensure that this information is understandable and translated into a language understandable to the receiver. This is particularly relevant with social systems (Schwaninger, 2006).

Systems become complex according to Schwaninger (2006) by displaying different patterns of behaviour or variety within the system. The level of uncertainty, in relation to the effects of changes in the external environment (technologies, legislations, new information), increases or constrains the decision-making process within the system. Highly complex systems tend to generate high level of uncertainty. In order to understand complex systems, various schools of systems theory were developed and models were applied to study the relations of the theory with an aspect of the real world.

Cybernetics, a branch of systems theory, has been applied significantly in operational research and looks at the essential conditions required for functional systems. It is a study relating to self-regulating or autonomous systems (organizations) of control and communication in natural and man-made organizations within complex and uncertain environment. It looks at biotorganismic and mechanistic organizations. Cybernetic approaches to environmental management have been proposed by Meadows (as cited by Espinosa, Harnden & Walker 2007) and emphasized the importance of feedback loops in order to find different ways to address the problems. Espinosa et al. claims that this approach will provide deeper understanding of the system and its functions.

Management cybernetics according to Al-Khatib (2007) is a way in which the principles relating to self-regulation, control and communication within complex systems can be applied to organizations. He argues that previous management theories claim organizations should function independent of its environment (closed-system¹⁶). But the development of the open-system model in later years provided a better way of understanding the functions and interactions of the organizations- the organization and the environment within which it operates was now viewed as a system. Information flow is a vital element in this context along with the interaction of the organization and its environment giving the basis for cybernetic theory. WHO (2009) proposed 4 principles to support cybernetic theory in communication and learning. He claims that the system should have the capacity to sense, monitor and scan significant aspects of their environment; the system should be able to relate this information to the operating norms that guide system

behaviour; the system should be able to detect significant deviations from these norms; and finally corrective actions should be initiated when discrepancies detected”.

2.4.2 Stakeholder Theory

In their proposition of a convergent stakeholder management theory Jones and Wicks (1999), began by outlining the basic domain of stakeholder management theory. The essential premises of stakeholder management theory are that the corporation has relationships with many constituent groups "stakeholders" that affect and are affected by its decisions, the nature of these relationships influences the firm and its stakeholders and the interests of all (legitimate) stakeholders have intrinsic value. In addition, the theory states that no set of interests is assumed to dominate the others and the theory focuses on managerial decision making (Nathanson, 2015).

Consequently, stakeholder theory indicates that organizations do explicitly manage their relationships with different stakeholder groups. Getz and Timur (2012) point out that although this is descriptively true; organizations appear to manage stakeholders for both instrumental reasons and, at the core, normative reasons. Building on the work of others, Ojedokun (2011) defines primary stakeholders as those without continuing participation, the corporation cannot survive suggesting that these relationships are characterized by mutual interdependence. He includes here shareholders or owners, employees, customers, and suppliers, as well as government and communities. Jensen, (2010) envisions corporations as fundamentally relational, that is, as a system of primary stakeholder groups, a complex set of relationships between and among interest groups with different rights, objectives, expectations and responsibilities.

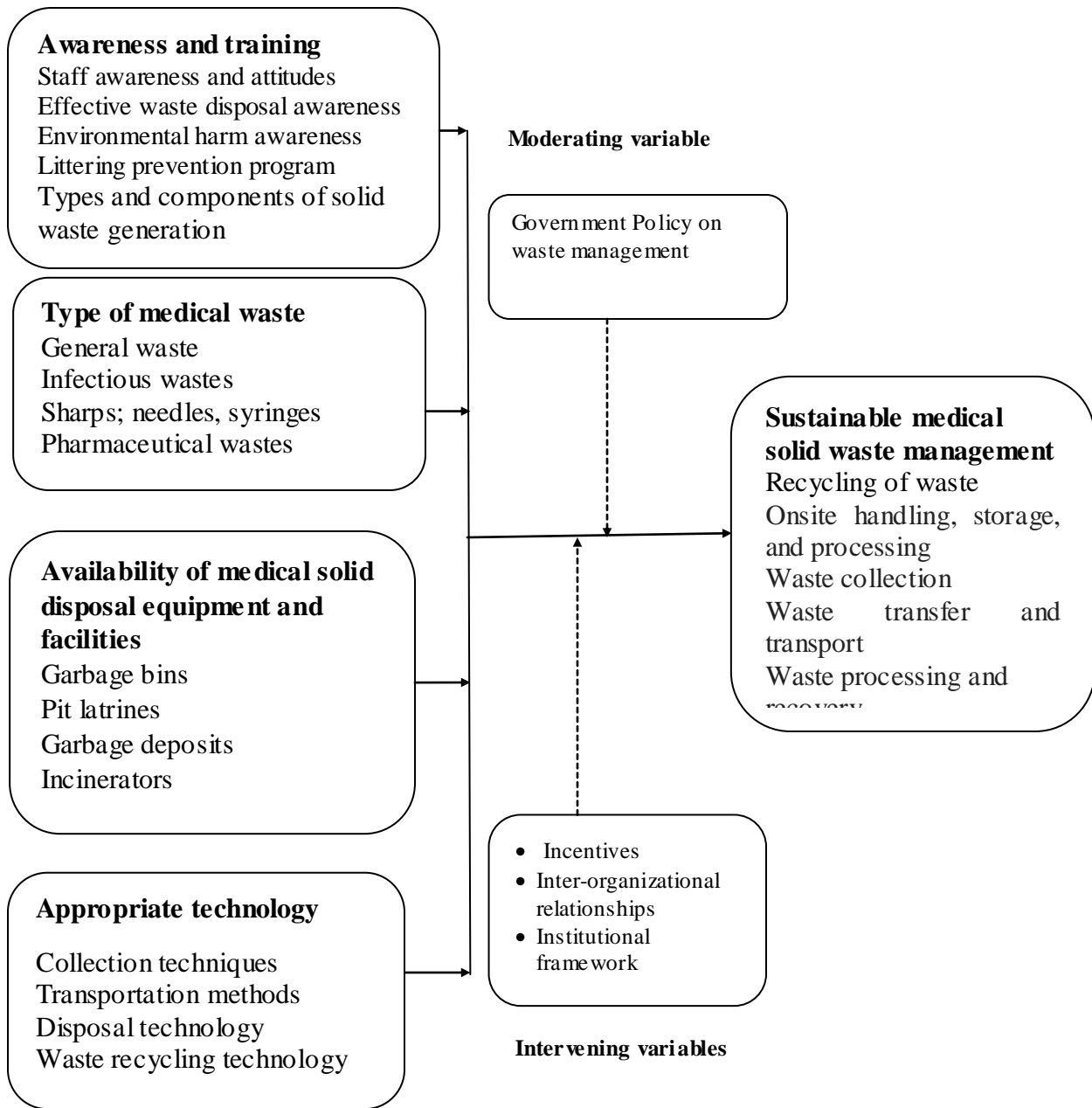
The stakeholder approach to policy making, planning and management is expected to yield two positive outcomes on health solid waste management: realistic and more effective policies and plans and improved implementation. These outcomes are achieved because the stakeholder approach improves decision-making processes by making it easier to develop more realistic and effective policies, laws, regulations and projects by bringing greater information and broader experiences into the decision-making process. This is achieved by embedding new initiatives into existing legitimate local institutions and cultural values and by building political support from, and reducing opposition to policy proposals through incorporation of stakeholder concerns (Clarkson, Coleman, Keates & Lebbon, 2013).

The stakeholder concept can be a useful tool in solid waste management in Meru town. In particular, the process known as, stakeholder analysis, can provide organizations with a lens through which to pay attention to the full range of interested parties. Stakeholder theory suggests that we should pay attention to the interests of any group or individual who is affected by, or may affect, a decision or policy (Périou, 2012). In addition, Stakeholder management theory is distinct because it addresses morals and values explicitly as a central feature of managing organizations. The ends of cooperative activity and the means of achieving these ends are critically examined in stakeholder theory in a way that they are not in many theories of strategic management (Getz & Timur, 2012).

Nonetheless, the stakeholder theory is not without criticism. The critics charge that the stakeholder approach is incapable of guiding necessary improvements in corporate governance that multiple lines of accountability implied by acknowledging a multiplicity of stakeholders reduces efficiency and that indeed the very idea of stakeholders as morally significant undermines the morally significant relationships between corporations and stockholders. Jensen, (2010) argue that managers should make decisions so as to take account of the interest of stakeholders in an organization including not only financial claimants, but also employees, customers, communities, and government officials.

2.5 Conceptual Framework

The conceptual framework hinged on the Teece (2007) constructs shows the relationship between the independent variables (awareness and training, type of medical waste, availability of medical solid disposal equipment and appropriate technology) and dependent variable (sustainable medical solid waste management).



Independent Variables

Dependent Variable

Figure 1: Conceptual Framework

Source: Author (2017)

Conceptual framework shows the relationship between the independent variables and dependent variable. The independent variables include; awareness and training, type of medical waste, availability of medical solid disposal equipment and appropriate technology. Awareness and

training whose measurement were Staff awareness and attitudes, Effective waste disposal awareness, Environmental harm awareness, Littering prevention program and Types and components of solid waste generation. Type of medical waste whose measurements are; general waste, infectious wastes, sharps; needles, syringes and pharmaceutical wastes. Availability of medical solid disposal equipment and facilities will be measured through; Garbage bins, Pit latrines, Garbage deposits and Incinerators. Appropriate technology measurements include collection techniques, transportation methods, disposal technology and waste recycling technology while the dependent variable will be sustainable medical solid waste management whose measurement will include recycling of waste, onsite handling, storage, and processing, waste collection, waste transfer and transport and waste processing. The government policy on waste management will be the moderating variable and incentives, inter-organizational relationships and institutional framework the intervening variables of the study.

2.9 Summary and Research Gaps

Local authorities in developing countries increasingly face challenges in adequate provision of this service to her citizens for various reasons such as unanticipated increase in hospital population, and lack of financial resources, and capacity among other reasons. As a result, communities establish initiatives whether formal or informal to manage medical solid waste, as waste production is unavoidable and its expeditious safe removal is important. Sustainable waste management provides a framework that is holistic in its approach, and would go a long way in ensuring SWM actors collectively establish feasible, sustainable and integrated tailor made waste management systems as a way of mitigating the inadequacies or gaps in the current system. In addition, the guiding principles developed by van de Klundert and Anschütz (2000) for each of the sustainability aspects, can be used to develop indicators to measure the sustainability of domestic waste management systems.

The study has reviewed how technology influences the solid waste management. Of particular interest is that technological advancement has enabled waste management to be improved over time in a number of countries, including Kenya as equipment are purchased for purposes of waste management. Ochoro (2016) established strategic factors affecting sustainable industrial waste management in Kenya a case study of Nairobi Bottlers Limited. Muniafu and Otiato (2010) studied solid waste management in Nairobi, Kenya, a case for emerging economies. It is

estimated that about 45% of health care waste generated in the county alone, for instance cannot be accounted for, indicating that it is being illegally dumped, buried or burnt somewhere, thus affecting the health of the people and the environment (MOH, 2009). However; studies need to be carried out to assess their effectiveness in the developing world such as selected towns of Kenya, since there is little evidence of research studies in Kenya.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research design and research methodology that was employed in this study. This chapter is set out with the following subheadings; research design, target population, sample size and sampling procedures, data collection instruments, data collection procedure, instrument validity and viability, data analysis techniques, ethical considerations and finally, operational definition of variables.

3.2 Research Design

The study used descriptive research design. Singleton (2009) describes descriptive research design as a systematic, empirical inquiring into which the researcher does not have a direct control of independent variable as their manifestation had already occurred or because the inherently could not be manipulated. The current research design was chosen because the study is not confined to the collection and description of the data, but sought to determine the existence of certain relationships among the research variables.

3.3 Target Population

A population of study is the entire group of persons or objects that the researcher wishes to investigate and for whose benefit the research is being carried out (Mbweza, 2006). It is also the total collection of elements about which a researcher makes inferences. According to Ngechu (2004), a population is a well-defined or set of people, services, elements, and events, group of things or households that are being investigated. The target population comprised of staff involved in management of public hospitals in Meru County. This population was chosen since the people in the management are the ones involved in the day to day running of the hospitals and thus are well conversant with the subject matter of the study.

Table 3. 1: Target Population

Category	Number of People	Percentage
Senior managers	54	17

Middle level	127	38
Lower level	146	45
Total	327	100

3.4 Sample size and Sampling Procedures

3.4.1 Sample Size

A sample is a subset of the population, Bartlett, Kotrlik and Higgins (2011) and the reason why they are used is because it is impossible to study all the members of a population for a research project. It just costs too much funding and time and therefore a selected few participants who make up the sample are chosen to ensure that the sample is representative of the population (Babbie, 2012). In order to obtain statistical significance an optimal sample size need to be obtained in research (Owino, 2013). The following Slovin's formula was therefore used to determine the sample size for the current study as shown below:

$$n = \{N / (1 + Ne^2)\}$$

Where n = number of samples

N = total population

e = 0.05 (margin of error)

$$n = \{323 / (1 + 323 * 0.05^2)\}$$

$$n = 177 \text{ management staff}$$

The formula had been used successfully by Noor (2014) where a precision of 10% was used to come up with a representative sample size. It also agrees with Krejcie and Morgan formula which also gives almost the same sample size. With a precision of 10% the sample is almost what is proposed by Jankowicz (2012) indicating that 30% of the population gives a representative sample for the study.

Table 3. 2: Sample Size

Category	Number of People		Sample Size
Senior managers	54	$(54/323)*177$	30
Middle level	127	$(127/323)*177$	68
Lower level	146	$(146/323)*177$	79
Total	327		177

Source: Author (2017)

3.4.2 Sampling Procedures

Sampling techniques are the strategies applied by researchers during the statistical sampling process. This process is done when the researcher aims to draw conclusions for the entire population after conducting a study on a sample taken from the same population (Kothari, 2014). In this study stratified sampling technique was adopted as it provides greater precision and guarantees that the resultant samples were representatives of the population (Garson, 2012). This technique has also been successfully applied by Gathenya (2012) in their studies. Simple random sampling was then applied to pick individual firms from the different strata and respondents respectively. The purpose of this technique is to increase precision by ensuring that key population elements are represented in the sample (Garson, 2012; Saunders et al. 2009).

A sample of public hospitals in Meru County was randomly selected. This is supported by Saunders et al. (2009) assertion that the final sample size is almost always a matter of judgment as well as of calculation, given the competing influences which include confidence level, margin of error, type of analysis to be undertake and lastly the size of the population from which the samples are to be drawn. Sample size was allocated proportionally to the population size of each hospital. As explained by Garson (2012), probability proportionate to size sampling is a sampling procedure under which the probability of a unit being selected is proportional to the size of the ultimate unit, giving larger strata a greater probability of selection and smaller strata a lower probability. This method ensured that every organization in the sampled areas has a known chance of being selected.

3.5 Research Instruments

In any study instruments are needed to collect needed information (Kinoti, 2013). Triangulation strategy will be used in this study which combined various instruments of data collection and sources in order to validate data. This method aims at using different methods of collecting data so as to be sure that information collected is valid (Saunders et al. 2009). The process made use of questionnaires, secondary data and interviews. Questionnaires however will be the main instrument for primary data collection, and they consisted of both structured and unstructured interview questions. They were based on a predetermined and standardized set of questions.

The study involved the use of both quantitative and qualitative methods of data collection where qualitative methods answered questions related to how much, how often, how many, when, and who and are used in survey research designs for theory testing (Cooper & Schindler, 2014). Qualitative research is based on researcher's deep involvement with the phenomenon under study, thereby gathering data which provide a detailed description of events, situations and interaction between people and things, hence providing depth and detail. On the other hand quantitative data consisted of participant responses that are coded, categorized, and reduced to numbers so that these data may be manipulated for statistical analysis (Saunders et al. 2009).

3.6 Pilot Testing

Pilot study is the measurement of a dependent variable among subjects. Its purpose is to ensure that items in the instrument are stated clearly and have the same meaning to all respondents. The purpose of pre-testing the data instrument was to ensure that the items in the instrument are stated clearly and have the same meaning to all respondents. In this study this involved checking whether the questions are clear and revoking any positive or negative response. It was also help to find out whether the questions are measuring what is expected. The pilot study was carried among public hospitals in Meru County. The respondents were also informed that the research is meant for academic purposes only and that the study had no intention of using the information for personal gains. The respondents were not required to indicate their names and participation in the study was on voluntary basis.

3.7 Validity of the Instruments

Validity is the degree by which the sample of test items represents the content the test is designed to measure. Content validity which was employed by this study is a measure of the degree to which data collected using a particular instrument represents a specific domain or content of a particular concept. Mugenda and Mugenda (2003) contend that the usual procedure in assessing the content validity of a measure is to use a professional or expert in a particular field. To establish the validity of the research instrument the researcher sought opinions of scholars and experts including the supervisor. This allowed modification of the instrument thereby enhancing validity. Furthermore, the study assessed the responses and non-responses per question to determine if there was any technical dexterity with the questions asked.

3.8 Reliability of the Instruments

Reliability of a measure indicates the extent to which it is without bias (error free) and hence ensures consistent measurement across time and across the various items in the instrument. It is an indication of the stability and consistency with which the instrument measures the concept and helps to assess the “goodness” of measure. Reliability of the research instruments were confirmed by pre-testing the questionnaire with a selected sample from the sustainable medical solid waste management. The reliability test was conducted by both the principle researcher and the research assistants to enhance clarity of the questionnaire. The accuracy of the data collected largely depends on the data collection instrument in terms of reliability. This instrument was reviewed based on the pre-test experience. Internal consistency method was tested using Cronbach’s Alpha. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. A reliability of above 0.7 was achieved and this was considered reliable as recommended by Zikmund and Barin (2012) who recommended that a reliability test which yields a coefficient greater than or equal to 0.7 is sufficient enough. Reliability coefficient of the research instrument was assessed using Cronbach’s alpha (α) which is computed as follows:

$$A = \frac{k}{k-1} \times [1 - \frac{\sum (S^2)}{\sum S^2 \text{sum}}]$$

Where:

α = Cronbach’s alpha

k = Number of responses

$$\sum (S^2) = \text{Variance of individual items summed up}$$
$$\sum S^2_{\text{sum}} = \text{Variance of summed up scores}$$

3.9 Data Collection Procedures

The study used primary data which was collected by use of questionnaires; use of questionnaires is based on the fact that they are suitable for a descriptive study given that they are easy to administer, ensure fast delivery and the respondent can answer at their convenience. The questionnaires were self-administered through drop and pick later method. The researcher delivered the questionnaire and gives the selected respondent a maximum of 3 days after which the researcher collected the completed questionnaire for analysis. The researcher also assured the participants that the information they give was treated with strict confidentiality. The researcher then proceeded to administer the questionnaires through the designated officers and co-ordinate with them to ensure respondents have adequate time to complete them. The management of different departments was issued with letters of authorization explaining the purpose of the study. This enabled to create a conducive environment for the distribution and administration of the questionnaire. Administration of the questionnaire followed the agreed schedule with the departmental heads.

3.10 Data Analysis Techniques

Data from the field was voluminous and was not absorbed. It had to be put in the form that an average mind can understand and make sense of. Data analysis involved assessing and evaluating the questionnaires and other sources. At the completion of the data collection process, the questionnaires were sorted, coded and analyzed. The Statistical package for social sciences (SPSS) was used to generate the required frequencies and percentages to answer the research questions. Mean and standard deviation was used to analyze the operationalized data. In order to enhance simplicity and ease of understanding, tables were used to present the data. Cooper and Schindler (2011) notes that the use of percentages is important for two reasons; first they simplify data by reducing all the numbers to range between 0 and 100. Second, they translate the data into standard form with a base of 100 for relative comparisons. The qualitative data from the open ended questions was analyzed using conceptual content analysis and presented in prose

Inferential data analysis was done using multiple regression analysis. Multiple regression analysis was used to establish the relations between the independent and dependent variables. In

addition, to quantify the strength of the relationship between the variables, the researcher conducted a multiple regression analysis. The data was broken down into the best practices of sustainable medical solid waste management. This offered a quantitative and qualitative description of the objectives of the study. The regression equation was:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \varepsilon$$

Whereby; Y = sustainable medical solid waste management

β_0 = the regression intercept,

$\beta_1, \beta_2, \beta_3$ & β_4 = Regression Coefficients

X_1 = Awareness and training

X_2 = Type of medical waste

X_3 = Availability of medical solid disposal equipment and facilities

X_4 = Appropriate technology

ε = Error term normally distributed about a mean of 0 and for purposes of computation ε is assumed to be 0.

Multiple regressions allowed the researcher to predict a score of one variable on the basis of their scores on several other variables. The main reason why multiple regressions was used instead of other inferential statistics is because it enables one to learn more about the relationship between the independent or predictor variables and a dependent or criterion variable.

3.11 Ethical Considerations

The researcher observed the following standards of behaviour in relation to the rights of those who become subject of the study or are affected by it: First, in dealing with the participants, they were informed of the objective of the study and the confidentiality of obtained information, through a letter to enable them give informed consent. Once consent is granted, the participants will maintain their right, which entails but is not limited to withdraw or decline to take part in some aspect of the research including rights not to answer any question or set of questions and/or not to provide any data requested; and possibly to withdraw data they have provided. Caution was observed to ensure that no participant is coerced into taking part in the study and, the

researcher sought to use minimum time and resources in acquiring the information required. Secondly, the study adopted quantitative research methods for reliability, objectivity and independence of the researcher. While conducting the study, the researcher ensured that research ethics were observed. Participation in the study was voluntary. Privacy and confidentiality was observed. The objectives of the study were explained to the respondents with an assurance that the data provided was used for academic purpose only.

3.12 Operationalization of Variables

The operationalization of variables is shown in Table 3.3.

Table 3.3: Operationalization of variables

Objectives	Type of Variable	Indicator	Measuring of Indicators	Tools of analysis	Type of analysis
To assess how awareness and training sustainable management of medical waste solid management in public hospitals in Meru County;	Independent	Awareness and training	Staff awareness and attitudes Effective waste disposal awareness Environmental harm awareness Littering prevention program Types and components of solid waste generation	Percentages Mean score	Descriptive statistics Regression analysis
To examine how type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County;	Independent	Type of medical waste	General waste Infectious wastes Sharps; needles, syringes Pharmaceutical wastes	Percentages Mean score	Descriptive statistics Regression analysis
To determine how availability of medical solid disposal	Independent	Availability of medical solid disposal equipment and facilities	Garbage bins Pit latrines Garbage deposits Incinerators	Percentages Mean score	Descriptive statistics Regression analysis

equipment and facilities influence sustainable medical solid waste management in public hospitals in Meru County;					
To establish how appropriate technology influence sustainable management of medical solid waste in public hospitals in Meru County.	Independent	Appropriate technology	Collection techniques Transportation methods Disposal technology Waste recycling technology	Percentages Mean score	Descriptive statistics Regression analysis
	Dependent	Sustainable medical solid waste management	Recycling of waste Onsite handling, storage, and processing Waste collection Waste transfer and transport Waste processing and	Mean score	Descriptive statistics Regression analysis

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION AND PRESENTATION

4.1 Introduction

This chapter discusses the findings that were obtained from the primary data collected using questionnaires. It presents the response rate, reliability analysis; background information of the respondents, opinions of the respondents on several variables covered in this study and multiple

regression analysis. The researcher provided tables that summarized the collective reactions of the respondents.

4.2 Response Rate

Questionnaires that the researcher administered were 177 out of which only 126 fully filled questionnaires were returned giving a response rate of 71.19% which was within what Gathenya (2012) prescribed as a significant response rate for statistical analysis and established at a minimal value of 50%.

Table 4. 1: Response Rate

		Response Rate
Response	126	71.19%
Non-response	51	28.81%
Total	177	100

4.3 Reliability Analysis

The researcher sought to establish how reliable the variables for this study are. This was done using Cronbach's Alpha which measures the internal consistency by establishing if certain items within a scale measure the same construct. Zikmund and Barin (2012) established the Alpha value threshold at 0.7, thus forming the study's benchmark.

Table 4. 2: Reliability Analysis

	Alpha value	Comments
Awareness and training	0.768	Reliable
Type of medical waste	0.886	Reliable
Availability of medical solid disposal equipment and facilities	0.702	Reliable
Appropriate technology	0.773	Reliable

Cronbach Alpha was established for every objective which formed a scale. The findings in table 4.2 illustrates that all the four variables were reliable as their reliability values exceeded the prescribed threshold of 0.7, Kothari (2004). This, therefore, depicts that the research instrument was reliable and therefore required no amendments.

4.4 Background Information

The researcher in this section sought to establish the respondents' background information including gender, how long they have been working with public hospitals, highest level of

education and the age bracket to ensure their suitability to respond to the questions concerning the subject under study. This general information is presented in form tables.

4.4.1 Gender of the Respondent

The respondents were requested to indicate their gender. Their responses were as shown in table 4.3.

Table 4. 3: Gender of the Respondent

	Frequency	Percent
Male	54	42.9
Female	72	57.1
Total	126	100

The results showed that majority of the respondents were female as shown by 57.1% while the rest were male as shown by 42.9%. This shows that the researcher considered all respondents irrespective of the gender to obtain reliable information concerning the subject under study.

4.4.2 Period at the Company

The respondents were also requested to indicate the number of years they have been in the company. Their responses were as shown in table 4.4.

Table 4. 4: Period at the Company

	Frequency	Percent
Less than 3 years	3	2.4
3-9 years	48	38.1
9-12 years	36	28.6
Above 12 years	39	31.0
Total	126	100.0

As per the findings, 38.1% of the respondents had been in the company for 3-9 years, 31% were in the company for above 12 years, 28.6% were in the company for 9-12 years while 2.4% were in the company for less than 3 years. This shows that majority were in company for long enough to comprehend and give reliable and accurate information on the subject under study.

4.4.3 Respondents Level of Education

The respondents were asked to indicate their highest level of. Their responses were presented in table 4.5.

Table 4. 5: Respondents Level of Education

	Frequency	Percent
Diploma	48	38.1
Degree	54	42.9
Masters	24	19
Total	126	100

From the findings the study found that 42.9% of the respondents had degree and 38.1% of the respondents had diploma while 19% of the respondents had masters. This implies that majority of the respondents had high academic qualifications to be able comprehend and give reliable information about the subject under study.

4.4.4 Age Bracket of the Respondent

The respondents were further asked to indicate the age bracket to which they belong to. Their responses were as shown in table 4.6.

Table 4. 6: Age of the Respondent

	Frequency	Percent
20-30 years	7	16.7
31-40 years	6	14.3
41-50 years	23	54.8
51-60 years	6	14.3
Total	42	100

The findings illustrates that most of the respondents were aged between 41-50 years as shown by 54.8%, between 20-30 years as shown by 16.7%, between 31- 40 years and 51-60 years as shown by 14.3%. This shows that majority of the respondents were mature enough making them to be cooperative in giving reliable information concerning the subject under study.

4.5 Best Practices Influencing Sustainable Medical Solid Waste Management

The researcher was interested in investigating best practices influencing sustainable medical solid waste management among public hospitals in Meru County, Kenya. Those covered in this study were awareness and training, type of medical waste, availability of medical solid disposal equipment and facilities and appropriate technology.

4.5.1 Awareness and Training

The researcher asked the respondents to tell the extent to which awareness and training influence sustainable management of medical solid waste management in public hospitals in Meru County. Their responses were as shown in table 4.7.

Table 4. 7: Extent of Influence of Awareness and Training

	Frequency	Percent
Low extent	9	7.1
Moderate extent	33	26.2
Great extent	54	42.9
Very great extent	30	23.8
Total	126	100

From the findings, the respondents indicated that awareness and training influences management of medical solid waste management in public hospitals in Meru County greatly as shown by 42.9%, moderately as shown by 26.2%, very greatly as shown by 23.8% and lowly as shown by 7.1%. This shows that awareness and training influences management of medical solid waste management in public hospitals in Meru County greatly.

Further the researcher asked the respondents indicate the extent to which various aspects of awareness and training influence sustainable management of medical solid waste management in public hospitals in Meru County. Their collective responses were as presented in table 4.8.

Table 4. 8: Extent of Influence of various Aspects of Awareness and Training

	Mean	Std. Dev.
Staff awareness and attitudes	3.9286	.6715
Effective waste disposal awareness	2.5714	1.2613
Environmental harm awareness	3.9762	.8046
Littering prevention program	4.3333	.6812
Types and components of solid waste generation	3.3095	1.0390

From the findings the respondents indicated that Littering prevention program as shown by a mean of 4.3333, environmental harm awareness as shown by a mean of 3.9762 and staff awareness and attitudes as shown by a mean of 3.9286 greatly influence sustainable management of medical solid waste management in public hospitals in Meru County.

However the respondents indicated that types and components of solid waste generation as shown by a mean of 3.3095 and effective waste disposal awareness as shown by a mean of 2.5714 moderately sustainable management of medical solid waste management in public hospitals in Meru County.

4.5.2 Type of Medical Waste

The respondents were requested to indicate the extent to which type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County. Their responses were as shown in table 4.9.

Table 4. 9: Extent of Type of Medical Waste Influence

	Frequency	Percent
Low extent	21	16.7
Moderate extent	24	19
Great extent	66	52.4
Very great extent	15	11.9
Total	126	100

From the results, the respondents indicated that type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County in a great extent as shown by 52.4%, in a moderate extent as shown by 19%, in a low extent as shown by 16.7% and in a very great extent as shown by 11.9%. This shows that type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County in a great extent.

The respondents were further asked to indicate the extent to which various aspects of type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County. Their responses were as shown in table 4.10.

Table 4. 10: Extent of Influence of Various Aspects of Type of Medical Waste

	Mean	Std. Deviation
General waste	2.8571	.6414
Infectious wastes	4.2857	.5914
Sharps; needles, syringes	4.3333	.6812
Pharmaceutical wastes	3.3095	.9672

As per the findings, the respondents indicated that sharps; needles, syringes as expressed by a mean score of 4.3333, infectious wastes as expressed by a mean score of 4.2857 greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The respondents also indicated that pharmaceutical wastes as expressed by a mean score of 3.3095 and general waste as expressed by a mean score of 2.8571 moderately influence sustainable management of medical solid waste management in public hospitals in Meru County

4.5.3 Availability of Medical Solid Disposal Equipment and Facilities

The researcher asked the respondents to tell as per the likert scale 1-5 the extent to which availability of medical solid disposal equipment and facilities influence sustainable management of medical solid waste management in public hospitals in Meru County. Their responses were as shown in table 4.11.

Table 4. 11: Availability of Medical Solid Disposal Equipment and Facilities Influence

	Frequency	Percent
Low extent	21	16.7
Moderate extent	27	21.4
Great extent	57	45.2
Very great extent	21	16.7
Total	126	100

The respondents indicated that availability of medical solid disposal equipment and facilities greatly influence sustainable management of medical solid waste management in public hospitals in Meru County as illustrated by 45.2%, moderately as illustrated by 21.4%, very greatly as illustrated by 16.7% and lowly as shown by 16.7%. This implies that availability of medical solid disposal equipment and facilities greatly influence sustainable management of medical solid waste management in public hospitals in Meru County.

Further the respondents were asked to tell as per the likert scale 1-5, the extent to which various aspects of availability of medical solid disposal equipment and facilities influence sustainable management of medical solid waste management in public hospitals in Meru County. Their responses were as shown in table 4.12.

Table 4. 12: Aspects of Availability of Medical Solid Disposal Equipment and Facilities

	Mean	Std. Deviation
Garbage bins	4.3810	.75744
Pit latrines	3.9762	.80463
Garbage deposits	4.3333	.68118
Incinerators	2.8095	1.05614

From the findings, the respondents indicated that garbage bins as illustrated by a mean score of 4.3810, garbage deposits as illustrated by a mean score of 4.3333 and pit latrines as illustrated by a mean score of 3.9762 greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. However the respondents indicated that

incinerators as illustrated by a mean score of 2.8095 moderately influence sustainable management of medical solid waste management in public hospitals in Meru County.

4.5.4 Appropriate Technology

The researcher requested the respondents indicated the extent to which appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County. Their responses were as shown in table 4.13.

Table 4. 13: Extent of Appropriate Technology Influence

	Frequency	Percent
Little extent	18	14.3
Moderate extent	60	47.6
Great extent	48	38.1
Total	42	100

As per the results, the respondents revealed that appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County in a moderate extent as shown by 47.6%, in a great extent as shown by 38.1% and in a little extent as shown by 14.3%. This clearly reveals that appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County in a moderate extent.

The respondents were asked to indicate the extent to which various aspects appropriate technology of influence sustainable management of medical solid waste management in public hospitals in Meru County. Their responses were as shown in table 4.14.

Table 4. 14: Extent of Influence of aspects Appropriate Technology

	Mean	Std. Deviation
Collection techniques	2.7857	.7441
Transportation methods	3.6429	1.0234
Disposal technology	4.3810	.7574
Waste recycling technology	3.9762	.8046

From the findings, the respondents indicated disposal technology as shown by a mean of 4.3810, waste recycling technology as shown by a mean of 3.9762 and transportation methods as shown by a mean of 3.6429 greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The respondents however indicated that

collection techniques as shown by a mean of 2.7857 moderately influence sustainable management of medical solid waste management in public hospitals in Meru County.

4.5.5 Sustainable Medical Solid Waste Management

The respondents were asked to indicate the trend of various aspects of sustainable medical solid waste management among public hospitals in Meru County for the last 5 years. Their responses were as shown in table 4.15.

Table 4. 15: Trend of various Aspects of Sustainable Medical Solid Waste Management

	Mean	Std. Deviation
Recycling of waste	3.6190	.9538
Onsite handling, storage, and processing	3.8333	1.0257
Waste collection	3.0714	.7063
Waste transfer and transport	4.1667	.7874

As per the findings, the respondents indicated that waste transfer and transport (Mean=4.1667), onsite handling, storage, and processing (Mean=3.8333) and recycling of waste (Mean=3.6190) have improved over the last five years while waste collection (Mean=3.0714) has been constant.

4.6 Regression Analysis

Multiple regression analysis was used to test the relationship between the variables where it shows how the dependent variable is influenced by the independent variables.

Table 4. 16: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.934	0.872	0.860	0.633

The ANOVA tests whether the model is fit for data. From the ANOVA table, the independent variables were statistically significant predicting the dependent variable since adjusted R square was 0.86 implying that awareness and training, type of medical waste, availability of medical solid disposal equipment and facilities and appropriate technology explains 86% variation in sustainable medical solid waste management.

Table 4. 17: ANOVA Test

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	123.121	4	30.78	71.745	.000
	Residual	18.019	42	0.429		

Total	141.14	46
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The probability value of 0.000 indicates that the regression relationship was significant in determining how awareness and training, type of medical waste, and availability of medical solid disposal equipment and facilities and appropriate technology influence sustainable medical solid waste management. The F calculated at 5 percent level of significance was 71.745. Since F calculated is greater than the F critical (value = 2.6060), this shows that the overall model was significant.

Table 4. 18: Coefficients of Determination

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.984	.182		12.885	.000
Awareness and training	.664	.196	.584	3.388	.002
Type of medical waste	.512	.208	.539	2.462	.018
Availability of medical solid disposal equipment and facilities	.774	.208	.562	3.721	.000
Appropriate technology	.733	.312	.572	2.349	.023

The established model for the study was:

$$Y = 0.984 + 0.664X_1 + 0.512X_2 + 0.774X_3 + 0.733X_4 + \epsilon$$

Where:-

Y= Sustainable medical solid waste management

β_0 =constant

X_1 = Awareness and training

X_2 = Type of medical waste

X_3 = Availability of medical solid disposal equipment and facilities

X_4 = Appropriate technology

The regression equation above has established that taking (awareness and training, type of medical waste, availability of medical solid disposal equipment and facilities and appropriate technology), sustainable medical solid waste management will be 0.984. The findings presented also show that taking all other independent variables at zero, a unit increase in the awareness and training would lead to a 0.664 increase in the score of sustainable medical solid waste management. Thus variable was significant since .0016 < 0.05.

Further it was found that a unit increase in the scores of type of medical waste would lead to a 0.586 increase in the scores of sustainable medical solid waste management. Thus variable was significant since $.018 < 0.05$. Further, the findings show that a unit increases in the scores of Availability of medical solid disposal equipment and facilities would lead to a 0.774 increase in the scores of sustainable medical solid waste management. Thus variable was significant since $.000 < 0.05$.

The study also found that a unit increases in the scores of appropriate technology would lead to a 0.733 increase in the scores of sustainable medical solid waste management. Thus variable was significant since $.024 < 0.05$.

Overall, availability of medical solid disposal equipment and facilities had the greatest effect on sustainable medical solid waste management in Meru County followed by appropriate technology, then awareness and training while type of medical waste had the least effect on the sustainable medical solid waste management in Meru County.

CHAPTER FIVE

SUMMARY, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presented summary of the findings, conclusions as well as the recommendations of the study. This study focused on the best practices influencing sustainable medical solid waste management among public hospitals in Meru County, Kenya.

5.2 Summary

The study found that awareness and training influences management of medical solid waste management in public hospitals in Meru County greatly. The study also found that littering prevention program, environmental harm awareness and staff awareness and attitudes greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The study also found that types and components of solid waste generation and effective waste disposal awareness moderately sustainable management of medical solid waste management in public hospitals in Meru County.

The study revealed that type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County in a great extent. The study found that sharps; needles, syringes, infectious wastes greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The study also found that pharmaceutical wastes and general waste moderately influence sustainable management of medical solid waste management in public hospitals in Meru County

The study found that availability of medical solid disposal equipment and facilities greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The study further revealed that garbage bins, garbage deposits and pit latrines greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The study further found that incinerators moderately influence sustainable management of medical solid waste management in public hospitals in Meru County.

The study found that appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County in a moderate extent. The study further revealed that disposal technology, waste recycling technology and transportation greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The study further found that collection techniques moderately influence sustainable management of medical solid waste management in public hospitals in Meru County.

5.3 Discussion of the Findings

5.3.1 Awareness and Training

The study found that awareness and training influences management of medical solid waste management in public hospitals in Meru County greatly. The study also found that littering prevention program, environmental harm awareness and staff awareness and attitudes greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. These findings are in line with McAllister (2015) who argue that range of socio-economic factors can affect public attitudes toward littering, frequency of littering, and the effective approaches to impede the littering tendency within an individual.

The study also found that types and components of solid waste generation and effective waste disposal awareness moderately sustainable management of medical solid waste management in public hospitals in Meru County. This is similar to Bolaane (2008) who argue that behavioral instruments play a role in waste management strategies through initiatives that inform and educate, some of these initiatives include waste audits, hospital programs, advertising, training, and competitions.

5.3.2 Type of Medical Waste

The study revealed that type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County in a great extent. The study found that sharps; needles, syringes, infectious wastes greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. These findings agree with Cointreau (1982) who noted that solid waste professionals recommend open trucks over compactor trucks, because cost is much lower, maintenance is cheaper and the wastes tend to be very dense with little compatibility. Furthermore the waste collected in Kenya is mostly organic

waste so the use of compactor truck implies large debts, more serving per length of time and a modern image.

The study also found that pharmaceutical wastes and general waste moderately influence sustainable management of medical solid waste management in public hospitals in Meru County. These findings conform to Moghadam et al (2009) revealed that Collection, transfer and transport of solid waste was affected by improper bin collection systems, poor route planning and lack of information about collection schedule.

5.3.3 Availability of Medical Solid Disposal Equipment and Facilities

The study found that availability of medical solid disposal equipment and facilities greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. This is in line with Al-Khatib, Kontogianni, Abu Nabaa, Alsham and Al-Sari (2015) who suggested that local authorities should increase the number and optimize the distribution of litterbins on the streets and other public places as a measure to discourage people from littering.

The study further revealed that garbage bins, garbage deposits and pit latrines greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. The study further found that incinerators moderately influence sustainable management of medical solid waste management in public hospitals in Meru County. Oteng (2012) advocates for communities to network, collaborate, coordinate, and develop common waste treatment and disposal infrastructure in order to improve waste disposal methods.

5.3.4 Appropriate Technology

The study found that appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County in a moderate extent. The study further revealed that disposal technology, waste recycling technology and transportation greatly influence sustainable management of medical solid waste management in public hospitals in Meru County. These conform to study by Oyaro (2003) who notes that tests conducted on 328 children living near the Dandora dumpsite found that half of them had excess concentrations of lead in their blood where they were also disproportionately affected by anaemia, skin infections, asthma, and other respiratory diseases.

The study further found that collection techniques moderately influence sustainable management of medical solid waste management in public hospitals in Meru County. This correlate with Williams (1998) who when trying to be specific on hospital solid wastes, said that it includes wastes from hospitals, doctors and dentist's surgeries and health centres, nursing homes and veterinary surgeries.

5.4 Conclusion

It was concluded that awareness and training influences management of medical solid waste management in public hospitals in Meru County greatly. Littering prevention program, environmental harm awareness, staff awareness and attitudes types and components of solid waste generation were found to have a great influence on sustainable management of medical solid waste management in public hospitals in Meru County.

The study concluded that type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County in a great extent. The sharps; needles, syringes, infectious wastes had great influence on sustainable management of medical solid waste management in public hospitals in Meru County.

The study concluded that availability of medical solid disposal equipment and facilities greatly and positively influence sustainable management of medical solid waste management in public hospitals in Meru County. It was revealed that garbage bins, garbage deposits and pit latrines greatly influenced sustainable management of medical solid waste management in public hospitals in Meru County with incinerators having a moderate influence on sustainable management of medical solid waste management in public hospitals in Meru County.

It was concluded that appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County in a moderate extent. The study revealed that disposal technology, waste recycling technology and transportation greatly influence sustainable management of medical solid waste management in public hospitals in Meru County.

5.5 Recommendations

The study recommends that technology needs to be at the centre stage of all solid waste management programs of Meru County government as well as other counties in Kenya. Thus,

technology needs to be adopted in solid waste management in the public hospitals across the waste value chain.

From the study the awareness of the benefits of solid waste management should be created and the general population mobilized. The county government should be the initiator of community participation. The several methods studied would be effective in changing mindset of the population. The TV media, public Barraza's, posters and person to person should be utilized depending on the budgets available.

The county should invest in more types of treatment for solid waste management. This will enable them to be able to carry-out the different kinds of treatments that are required for different types of wastes produced and ensure that they reduce volume of waste and its hazardous effect.

The public hospitals in the Meru County should diversify the form of waste disposal used. This will enable them to address the different nature of waste produced in the county. Different types of waste that are generated in a county require different methods to address the problem of waste disposal the more options the county has in methods of disposal the more they are able to address different types of wastes generated.

The county government can formulate programs and education/training packages to empower the households in solid waste reduction and segregation. This will aid towards achieving the zero waste principle. This informed by the positive attitude by public hospital management to be involved and trained in solid waste management.

The county government could help establish the residential solid waste committees. This will create a forum of communication, engagement and working together between the households and the department in solid waste service provision. This is supported by the citizen participation theory.

The government should encourage better waste management practices and help create markets for waste materials through policy making, economic incentives, regulations, enforcement of regulations, and campaigns/promotions. By recognizing and giving awards to best practices in waste management, the government would help increase the public's awareness of initiatives and encourage others to adopt similar approaches.

The study also recommends that public hospitals management should organize educational activities such as the organisation of conferences, seminars and workshops, publication of training manuals, case studies and best practices, and provision of technical and financial assistance should also be conducted.

5.6 Suggestions for Further Research

This study focused on the best practices influencing sustainable management of medical solid waste management in public hospitals in Meru County. Therefore a similar study should be done based on public hospitals in other counties.

The study recommends another study on other best practices influencing sustainable management of medical solid waste management in public hospitals in Meru County which may not have been identified in this study.

APPENDICES

Appendix I: Letter of Transmittal

P.O Box.

Meru.

Dear Sir/ Madam,

RE: ACADEMIC RESEARCH PROJECT

I am a Master of Arts in Project Planning and Management student at University Of Nairobi. I wish to conduct a research entitled Best practices of Sustainable Medical Solid Waste Management among Public Hospitals in Meru County, Kenya. A questionnaire has been designed and will be used to gather relevant information to address the research objective of the study. The purpose of writing to you is to kindly request you to grant me permission to collect information on this important subject from your organization.

Please note that the study will be conducted as an academic research and the information provided will be treated in strict confidence. Strict ethical principles will be observed to ensure confidentiality and the study outcomes and reports will not include reference to any individuals.

Your acceptance will be highly appreciated.

Yours faithfully,

Rosaline Gakii

Appendix II: Research Questionnaire

This questionnaire is to collect data for purely academic purposes. The study seeks to investigate the *best practices of sustainable medical solid waste management among public hospitals in Meru County, Kenya*. All information will be treated with strict confidence. Do not put any name or identification on this questionnaire.

Answer all questions as indicated by either filling in the blank or ticking the option that applies.

Background Information (Please tick (√) appropriate answer)

- 1) Please indicate your gender: Female [] Male []
- 2) For how long have you been working with public hospitals?
 - Less than 3 years [] 3 to 9 years []
 - 9 to 12 years [] Above 12 years []
- 3) State your highest level of education
 - Certificate [] Diploma [] Degree [] Masters [] PhD []
 - Others (Specify) -----
- 4) Please Indicate your age bracket 20-30 yrs [] 31-40 yrs []
 - 41-50 yrs [] 51 – 60 []

Awareness and training

- 5) To what extent does awareness and training influence sustainable management of medical solid waste management in public hospitals in Meru County?
 - Not at all [] Low extent []
 - Moderate extent [] Great extent []
 - Very great extent []

- 6) To what extent do the following influence sustainable management of medical solid waste management in public hospitals in Meru County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Staff awareness and attitudes					
Effective waste disposal awareness					
Environmental harm awareness					
Littering prevention program					

Types and components of solid waste generation					
--	--	--	--	--	--

7) In your view how do the above aspects of awareness and training influence sustainable management of medical solid waste management in public hospitals in Meru County?

.....

Type of medical waste

8) To what extent does type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County?

- Not at all []
- Low extent []
- Moderate extent []
- Great extent []
- Very great extent []

9) To what extent do the following influence sustainable management of medical solid waste management in public hospitals in Meru County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
General waste					
Infectious wastes					
Sharps; needles, syringes					
Pharmaceutical wastes					

10) In what way does type of medical waste influence sustainable management of medical solid waste management in public hospitals in Meru County?

.....

Availability of medical solid disposal equipment and facilities

11) To what extent does availability of medical solid disposal equipment and facilities influence sustainable management of medical solid waste management in public hospitals in Meru County?

Not at all [] Low extent []
 Moderate extent [] Great extent [] Very great extent []

12) To what extent do the following influence sustainable management of medical solid waste management in public hospitals in Meru County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Garbage bins					
Pit latrines					
Garbage deposits					
Incinerators					

Appropriate technology

13) To what extent does appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County?

Not at all []
 Low extent []
 Moderate extent []
 Great extent []
 Very great extent []

14) To what extent do the following influence sustainable management of medical solid waste management in public hospitals in Meru County?

	Very great extent	Great extent	Moderate extent	Low extent	Not at all
Collection techniques					
Transportation methods					
Disposal technology					
Waste recycling technology					

15) In your view how does appropriate technology influence sustainable management of medical solid waste management in public hospitals in Meru County?

.....

Sustainable Medical Solid Waste Management

16) What is the trend of the following aspects of sustainable medical solid waste management among public hospitals in Meru County for the last 5 years? Where, 5 = greatly improved, 4= improved, 3= constant, 2= decreased, 1 = greatly decreased

	1	2	3	4	5
Recycling of waste					
Onsite handling, storage, and processing					
Waste collection					
Waste transfer and transport					

Thank you for participating

Appendix III: Budget

Item description	Quantity/cost per item (Kshs)	Total Cost Ksh
Stationery	5 rims of fullscaps @ 600 each	2,000
	2 biro packets @ 200 each	900
	2 printer cartridges @ 2500 each	7,500
	6 notebooks @ 1000 each	3,600
Proposal writing and research	Internet research	9,500
	Fare	8,100
	Binding and photocopies 300 pages @ 3 per page	6,800
The project	Data analysis consultancy	7,900
	Binding and photocopies	4,700
Miscellaneous	Phones, meals, etc	5,500
	Total	55,500

Appendix IV: Time Plan

No	Task/Activity Details	WORK SCHEDULE IN MONTHS				
		1	2	3	4	5
1	Problem Identification	■				
2	Literature review		■			
4	Data Collection			■		
5	Data Processing				■	
6	Data Analysis				■	
7	Report Writing					■
8	Submitting the Report					■