ANALYSIS OF HEALTHCARE ON WASTE MANAGEMENT FOR SUSTAINABLE ENVIRONMENTAL AND HEALTH APPROACHED: A CASE OF SELECTED HEALTHCARE FACILITIES AT KOROGWE DISTRICT COUNCIL

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CERTIFICATION

The undersigned certifies that he has read and here by recommends for acceptance by the Open University of Tanzania a dissertation entitled, **"Analysis of healthcare on waste management for sustainable environmental and health approached: A case of selected healthcare facilities at Korogwe District Council"** in partial fulfilment of the requirements for the award of Degree of Master in Environmental Studies (MES).

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Date

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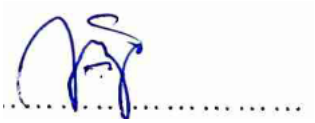
DECLARATION

I, **Mandia Kihiyo**, do hereby declare that, this dissertation is my own original work. It has never been presented to any other University or Institution. Where other people's works have been used, references have been provided. It is in this regard that I declare this work as originally mine. It is hereby presented in partial fulfilment of requirement for the Degree of Master in Environmental Studies (MES).



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19/10/2023

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Date

DEDICATION

I would like to dedicate this work to my family, whose constant presence in my life serves as a motivation for me to strive harder and pursue advanced studies. Additionally, I would like to dedicate this work to the stakeholders involved in the handling, management, and disposal of sewage sludge.

ACKNOWLEDGEMENT

As I reach the completion of this dissertation, I would like to express my heartfelt gratitude to the individuals who have provided various forms of assistance, enabling it to become a presentable document for my Master's Degree and for public consumption.

First and foremost, I would like to express my deepest appreciation to the Almighty God, as it is through His sustenance of good health and wisdom that I have been able to pursue my studies at the university and successfully complete this dissertation. I firmly believe that without God’s help, our fragile human nature would be incapable of accomplishing anything. This dissertation has been made possible through the contributions of numerous individuals, and it is challenging to mention everyone by name. However, out of courtesy, I would like to acknowledge a few individuals, understanding that their mention does not diminish the importance of the anonymous contributors.

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ABSTRACT

The study analyzed healthcare waste management with a focus on sustainable environmental and health practices, using the case study of Korogwe District Council. Several healthcare establishments were chosen for on-site investigations, and an analysis was conducted to assess the current status of healthcare waste management (HCWM) in three selected health centers: Magunga Hospital, Majengo Health Centre (HCW and Saint Raphael Health Centre. The study utilized both primary and secondary data, employing probability sampling techniques to select the health centers within the study area. Weighing scales, interview guides, direct observation schedules, and daily production schedules where used to collect data. The findings indicated that in Korogwe District, the overall rate of healthcare waste generation, as well as the rate of hazardous HCW generation, were as follows for Magunga, Majengo, and St. Raphael health centers: 1.6 kg/ bed/day totaling 569 kg per day, 1.3 kg/bed/day, totaling 119 kg per day, and 0.45 kg/bed/day, totaling 51 kg per day, respectively. The assessment of the management system revealed that 56% of the workers had not received any form of training in healthcare waste handling, while approximately 54% of them did not utilize any safety equipment or protective clothing. It is crucial to provide training to healthcare personnel and the general population on hygiene practices and healthcare waste management to raise awareness and foster a sense of responsibility. This would help prevent exposure to health hazards associated with healthcare waste. The management of healthcare waste in the study area was found to be inadequate, as evidenced by the absence of proper segregation of healthcare waste at its source and insufficient facilities for its management. It is recommended to establish a comprehensive healthcare waste management plan for all healthcare facilities order to safeguard human health and promote environmental sustainability.

Keywords: *Healthcare, Infectious Waste, Pathological Waste, Waste Management, Korogwe*.

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LIST OF ABBREVIATIONS

HCEs	Healthcare establishments
HCFs	Healthcare facilities
HW	Healthcare waste
HWM	Healthcare waste management
IETC	International Environmental Technology Centre
MCDM	Multicriteria decision-making
NGO	Non-governmental organization
SAT	Sustainability Assessment of Technology
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

I.1 Background of the Study

Developing nations face significant challenges in Healthcare Waste Management (HWM), as it encompasses social, environmental, and economic considerations when devising waste management policies (Ali, et al., 2017). Healthcare waste consists of various components, including sharps, heavy metals, pharmaceuticals, infectious waste, genotoxic waste, chemical waste, anatomical and pathological waste, as well as pressurized containers (El-Salam, 2010). As the population continues to grow and healthcare facilities (HCFs) expand, the quantity of healthcare waste generated is rapidly increasing on a daily basis (Lemma, et al., 2021). Researchers have observed that developed nations tend to have higher healthcare waste generation rates compared to developing nations (Chisholm, et al., 2021).

As highlighted by Hsu et al. (2008), healthcare waste is considered the second most hazardous waste, following radioactive waste, necessitating the implementation of stringent policies for its management. Healthcare waste contains pathogens, which pose a risk of air and environmental pollution within healthcare facilities. Hsu et al. (2008) emphasize that it is the shared responsibility of healthcare establishments and waste treatment units to safeguard healthcare facility premises and individuals by implementing effective waste disposal policies.

Insufficient funding allocated by healthcare facility administrations for waste management activities emerges as a significant challenge, as identified by Hsu et al. (2008). The systematic review found that the majority of existing studies conducted

in developing countries regarding the costs of healthcare waste in healthcare centers were of poor quality. This was due to incomplete disaggregation and reporting of environmental expenses, infrequent and inconsistent reporting of unit costs that could be compared across facilities, and limited contextual data on the quality and quantity of services achieved relative to the amount of money spent.

The implementation of Healthcare Waste Management (HWM) faces a second challenge, as highlighted by Ho (2011), which involves unskilled and illiterate workers handling infectious waste. Many of these workers, either knowingly or unknowingly, endanger their own lives or sometimes recycle infectious waste without proper chemical treatment. The third challenge pertains to the utilization of outdated technology for healthcare waste disposal. In Tanzania, the predominant disposal method is incineration, which results in the production of harmful gases and approximately 0.3-0.4 kg of ash residue for every 3.8 kg of healthcare waste disposed (Rajor and Mehta, 2012).

Another challenge is the insufficient handling and segregation practices of Healthcare Waste during its generation, resulting in the entire waste becoming infectious (Athavaleand and Dhumale, 2010). Furthermore, the transportation of healthcare waste to disposal centers often occurs using open trucks or carts, which leads to the dissemination of infectious agents into the air, thereby contaminating the surroundings of healthcare facilities (Patiland 2005).

Hence, the implementation of Healthcare Waste Management system has become a stumbling block for the developing nations (Ferronato et al., 2019). Although, many countries and governing bodies such as US Centers for Disease Control and

Prevention, WHO, US Environmental Protection Agency, and Central Pollution Control Board in Tanzania have laid down several policies for regulating the healthcare facilities on practices like segregation, collection, transportation, storage and disposal of healthcare waste (El-Salam, 2010). However, in most parts of the world, Healthcare Waste management system is poorly managed, and rules remain mainly on the papers.

According to WHO (2012) on study involving 22 developing countries, about 18% to 64% of healthcare establishments are poorly managing healthcare waste (Zhang et al., 2013). Hence, in Tanzania it is necessary for the healthcare administrators to establish a robust healthcare waste system, thus protecting the environment from hazardous waste. Tanzanian healthcare market is growing at 16%–17% compound annual growth rate, which is expected to touch $132 billion by 2023 from $61.8 billion in 2017 (WHO, 2012).

Healthcare center generates about 85% of general waste which is non-hazardous waste comparable to domestic waste, while about 15% is considered hazardous waste that may be infectious, chemical like drugs or radioactive materials (WHO, 2014). These hazardous materials from healthcare units include radioactive substances, biohazardous waste, pharmaceutical wastes, chemicals, pathological wastes, and nontoxic wastes, which can cause a variety of adverse effects on human beings and the environment. The increasing competition in healthcare services has compelled healthcare facilities establishments to provide better and fast healthcare services with minimum possible cost (Athavale and Dhumale, 2010). Some healthcare facilities administration prefers to outsource the healthcare waste

management services to waste disposal establishments in order to save the initial investment and also to avoid strict environmental regulations. Hsu et al., (2008) indicated that approximately 62% out of all public and 76% of all private healthcare facilities are outsourcing the healthcare waste management process to a common healthcare waste treatment facility. Selecting a healthcare waste management partner is the most strategic decision in any healthcare institution; however, selection is made based on experience and cost analysis only.

There is a high relationship between healthcare waste management and healthcare waste generation rate because the higher the generation rate the higher the burden of management. The generation rates will be related to some important factors such as the number of patients, number of beds, and the type of activity conducted in different sections of the healthcare facilities. The relationship between the waste generation rate and the number of patients was more applicable than that expressed in terms of the number of beds. Studies conducted in Kuwait which showed the generation rates in the range of 3.65 to 5.4 kg/patient/day. However the total generation rate differs from one country to another (Hamoda et al., 2005).

In Tanzania, Dar es Salaam city, study done by Mato et al., (1997) showed that healthcare waste generation rates in the surveyed healthcare facilities will be obtained by actual measurements and through assessment of the storage facilities empting frequencies and degree of filling of the waste receptacles. The healthcare facilities with better healthcare facilities will be found to have higher waste generation rates of up to 1.3 kg/patient per day. For the case of Aga Khan Healthcare facilities, this value is nine times that of Temeke healthcare facilities (0.15 kg/patient

per day). However the average waste generation rate is estimated to be 0.66 kg/patient per day with a range of 0.3 to1.8 kg /patient per day (Kaseva et al., 1999). Therefore, it is the intention of this research to facilitate benchmarking among different healthcare facilities at Korogwe district by allowing them to compare their generation rates and its management practices against other healthcare facilities, which will help them to identify possibilities of improving the efficiency of waste management system and predict their waste management expenses.

1.2 Statement of the Research Problem

As the human population in Tanzania grows, there is a corresponding rise in the number of healthcare research institutions (World Care, 2010; Manyele and Anicetus, 2006). Consequently, a significant amount of healthcare waste is being generated, exceeding the capacity of waste management departments to handle. Recognizing the significance of effective healthcare waste management, the Tanzanian government has implemented guidelines to regulate waste management practices (MOHSW, 2006).

As the number of healthcare and research institutions in Tanzania continues to grow, so does the generation of healthcare waste. However, there is still a lack of proper management capacity within these institutions to handle the increasing amount of waste generated. The practices related to the collection, treatment, storage, and disposal of healthcare waste in these institutions have not been adequately documented. Consequently, healthcare waste is often disposed of indiscriminately, and the disposal facilities are not well-maintained or secured.

Therefore, it is crucial to assess the practices and effectiveness of healthcare waste management systems in healthcare and research institutions. This assessment will serve as the foundation for evidence-based recommendations to policymakers.

1.3 Research Objectives

1.3.1 General Objective

The general objective was to analyse healthcare waste management for sustainable environmental and health approached.

1.3.2 Specific Objectives

i. To identify the infrastructure for waste management in from healthcare centers at Korogwe District Council

ii. To evaluate the quality in terms of its strength and weaknesses of waste management by comparing it with a standard

iii. To determine type, the magnitude, capacity and level of healthcare waste generated rate at Korogwe District Council.

1.3.3 Research Questions

i. What is the status of the infrastructure for waste management in from health centers at Korogwe District Council?

ii. What are the strength and weaknesses of waste management by comparing it with a standard at Korogwe District Council?

iii. What are type, the magnitude, capacity and level of healthcare waste generated rate at Korogwe District Council?

1.4 Significance of the Research

The empirical findings of this study offer relevant policy insights to environmental stakeholders such as Government, private healthcare facilities, and Korogwe District council in particular. Also, the research findings would aid in relevant policy insights, strategic waste management planning and resource allocation as regards to promoting such waste management practices.

Finally, the study was important to the researcher, since it will help the respective researcher to fulfil one of the essential requirements for the award of Master's degree. Moreover, it was benefit the upcoming researchers who will be interested in conducting research on related topic.

1.5 Scope of the Study

The study specifically was focused on selected health centres' facilities at Korogwe District Council, two public health centres', and one private health center.The study concentrated on looking the type of waste generated, capacity and magnitude, generation rate, collection facilities, transportation of waste, disposal and general treatment of waste.

CHAPTER TWO

LITERATURE REVIEW

2.1 Chapter Overview

This chapter presents review of the related literature that has been drawn from different readings, with the intention of benchmarking among different healthcare facilities at Korogwe district by allowing them to compare their generation rates against other healthcare facilities. It aimed at identifying what other researchers have done in the past concerning healthcare waste management, especially generation rates of different healthcare facilities. The chapter also presents a conceptual framework of the study to show how the key issues are interacted in the study.

2.2 Definition of Key Concept

2.2.1 Healthcare

Healthcare is the improvement of health via the prevention, diagnosis, treatment, amelioration. Medicine, dentistry, pharmacy, midwifery, nursing, optometry, audiology, psychology, occupational therapy, physical therapy, athletic training, and other health professions are all part of healthcare. It includes work done in providing primary care, secondary care, and tertiary care, as well as in public health (WHO, 2018).

Infectious waste: waste contaminated with blood and other bodily fluids (e.g. from discarded diagnostic samples), cultures and stocks of infectious agents from laboratory work (e.g. waste from autopsies and infected animals from laboratories), or waste from patients with infections (e.g. swabs, bandages and disposable healthcare devices (WHO, 2018).

Pathological waste: These waste consists of tissues, organs, body parts, blood, body fluids and other waste from surgery and autopsies. It also includes human foetuses and infected animal carcasses (National health guideline, 2017).

Sharps waste: syringes, needles, disposable scalpels and blades, etc.

Chemical waste: for example, solvents and reagents used for laboratory preparations, disinfectants, sterilises and heavy metals contained in healthcare devices (e.g. mercury in broken thermometers) and batteries (Garba, 2013).

Pharmaceutical waste: expired, unused and contaminated drugs and vaccines

Cytotoxic waste: waste containing substances with genotoxic properties (i.e. highly hazardous substances that are, mutagenic, teratogenic or carcinogenic), such as cytotoxic drugs used in cancer treatment and their metabolites (WHO, 2018).

Radioactive waste: such as products contaminated by radionuclides including radioactive diagnostic material or radio therapeutic materials

Non-hazardous or general waste: waste that does not pose any particular biological, chemical, radioactive or physical hazard.

2.3 Healthcare Waste Management

The infectious healthcare waste is a huge threat to the environment and poses challenges to the healthcare facilities' administration to manage it properly (Muduli and Barve, 2012). Healthcare waste management practices include collection, segregation, storage, and transportation of healthcare waste to treatment facilities,

disposal of healthcare waste, and finally the ash management after the incineration of healthcare waste (Muduli and Barve, 2012). Due to inappropriate healthcare waste handling practices and disposal techniques, the developing nations are struggling to manage their infectious wastes properly (Zhang et al., 2013).

2.3.1 Environmental Pollution

Healthcare waste is a special class of hazardous pollutants. Improper treatment would cause secondary environmental pollution, especially when responding to public health emergencies. Contamination of water supply from untreated healthcare waste can also have devastating effects. If infectious stools or bodily fluids are not treated before being disposed of, they can create and extend epidemics, since sewage treatment in Africa is almost non-existent. For example, the absence of proper sterilization procedures is believed to have increased the severity and size of cholera epidemics in most parts of Africa during the last decade (UNEP, 2002).

Chemical and toxic threats: Chemical and pharmaceutical wastes, especially large quantities, can be health and environmental threats. Since hazardous chemical wastes may be toxic, corrosive, flammable, reactive, and/or explosive, they can poison, burn or damage the skin and flesh of people who touch, inhale or are in close proximity to them. If burned, they may explode.

Therefore, even if the hospitals are discharging their healthcare liquid waste into Sewage system, it is mixed with the sewage and gets in surface water without proper treatment. If the hospital effluents are not treated, concentrated forms of infectious agents and antibiotic resistant microbes are shed into communities resulting in water

borne diseases such as cholera, typhoid fever, dysentery and gastroenteritis. Antibiotics, disinfectants and bacteria resistant to them have been detected in the environmental compartments such as waste water, surface water, ground water, sediments and soils (Kummerer, 2004). Studies have discovered trace level concentrations of antibiotics in waste water treatment plant effluents and surface waters (Kolpin, et al., 2002). Long term exposure of microorganisms to low concentrations of antibiotics in wastewater and surface water has the potential for the development of antibiotic resistance in these organisms.

2.3.2 Collection and Storage of HCW

Waste must be collected regularly at least once a day; it must never be allowed to accumulate where it is produced. A daily collection programme and collection round must be planned. Each type of waste must be collected and stored separately with different known signs on the containers, (Longe and Williams, 2006).

2.3.3 Segregation HCW

Means separating different wastes into different color-coded bins with liners or sharps containers at locations where they are generated and it is always the first and the most important activity in HCWM (Gitonga, 2017). Segregation is one of the most important steps to successfully manage HCW. Given the fact that only about 10-25% of the HCW is hazardous, treatment and disposal costs could be greatly reduced if a proper segregation were performed. Segregating hazardous from non-hazardous waste reduces also greatly the risks of infecting workers handling HCW. Actually, the part of the HCW that is hazardous and requires special treatment could be reduced to some 2-5% if the hazardous part were immediately separated from the

other waste.

The segregation consists in separating the different waste streams based on the hazardous properties of the waste, the type of treatment and disposal practices that are applied. A recommended way of identifying HCW categories is by sorting the waste into colour-coded and well-labelled bags or containers. All the specific procedures of HCW segregation, packaging and labelling should be explained to the healthcare and ancillary staff and displayed in each department on charts located on the walls nearby the HCW containers that should be specifically suited for each category of waste. Segregation should: Always take place at the source, that is at the ward bedside, Operation Theatre, Healthcare Analysis Laboratory, or any other room or ward in the hospital where the waste is generated; Be simple to implement for the healthcare and ancillary staff and applied uniformly throughout the country; Be safe and guaranty the absence of infectious HCW in the domestic waste flow; Be well understood and well known by the healthcare and ancillary staff of the HCFs; Be regularly monitored to ensure that the procedures are respected (UNEP, 2004)

2.3.4 Transportation of Healthcare Waste to Treatment Facilities HCW

Transportation is required when hazardous HCW is treated outside the HCF. The waste producer is then responsible for the proper packaging and labelling of the containers that are transported. One of the reasons for labelling HCW bags or containers is that in case of an accident, the content can be quickly identified and appropriate measures taken. The labelling system should comply with the United Nations Recommendations and contain at least: The United Nations substance class (e.g. class 6, division 6.2, and UN n ° 3291 for infectious waste); the proper shipping

name and the total quantity of waste covered by the description (by mass or volume); the date of collection. The transportation should always be properly documented and all vehicles should carry a consignment note from the point of collection to the treatment facility. Furthermore, the vehicles used for the collection of hazardous / infectious HCW should not be used for any other purpose. They shall be free of sharp edges, easy to load and unload by hand, easy to clean / disinfect, and fully enclosed to prevent any spillage in the hospital premises or on the road during transportation (Mahler, et al., 2017).

2.3.5 Disposal of Healthcare Waste

The choice of a technology for HCW treatment and disposal should always be driven with the objective of minimizing negative impacts on health and the environment. Several technologies exist to treat or dispose of HCW (Ghasemi et al. 2018). They include:

Incineration: It is a controlled combustion process where waste is completely oxidized and harmful microorganisms present in it are destroyed under high temperature.

Autoclaving: is a low-heat thermal process where steam is brought into direct contact with waste in a controlled manner and for sufficient duration to disinfect the wastes.

Microwaving: Microbial inactivation occurs as a result of the thermal effect of electromagnetic radiation spectrum lying between the frequencies 300 and 300,000 MHz Microwave heating is an inter-molecular heating process. The heating occurs inside the waste material in the presence of steam (Ghasemi, et al., 2018).

Hydro claving: This is similar to autoclaving except that the waste is subjected to indirect heating by applying steam in the outer jacket. The waste is continuously tumbled in the chamber during the process.

Shredder: Shredding is a process by which waste are shaped or cut into smaller pieces so as to make the wastes unrecognizable

2.3.5 Environmental Hazards

The general environmental and public health can also be adversely affected by bio-healthcare waste. Improper practices such as dumping of bio-healthcare waste in municipal dustbins, open spaces, water bodies etc., leads to the spread of diseases. Emissions from incinerators and open burning also lead to exposure to harmful gases which can cause cancer and respiratory diseases (Brasil, 2022; Yazie et al. 2019). Plastic waste can choke animals, which scavenge on openly dumped waste. Injuries from sharps are common feature affecting animals. Harmful chemicals such as dioxins and furans can cause serious health hazards to animals and birds. Certain heavy metals can affect the reproductive health of the animals.

2.4 Handling of Healthcare Waste

In pursuing their aims of reducing health problems and eliminating potential risks to people's health, healthcare services inevitably create waste that may itself be hazardous to health (WHO, 2014).`The waste produced in the course of healthcare activities carries a higher potential for infection and injury than any other type of waste. Wherever waste is generated, safe and reliable methods for its handling are therefore essential (Saberi, et al., 2019).

Literatures has highlighted various inadequacies in the current healthcare waste handling practices like ineffective segregation at source (Zhang et al., 2013); less use of coded and colored bags (Saberi, et al., 2019); no proper tracking techniques for healthcare waste bags (binliners) (Athavale and Dhumale, 2010); illegal waste collection practices, unsecure storage of infectious healthcare waste, lack of human skills and financial resources, and poor inspection of healthcare waste disposal centers (El-Salam, 2010).

Moreover, the mixing of general waste with the infectious healthcare waste and open burning of wastes will emit harmful dioxin to the atmosphere (Hsu et al., 2008). Hence, poorly managed infectious wastes may lead to the generation of diseases like respiratory infection; meningitis; anthrax; gastro enteric infection; septicaemia; ocular infection; genital infection; skin infection; AIDS; haemorrhagic fevers; bacteraemia; candidaemia; viral hepatitis A, B, and C; avian influenza; and many more (WHO, 2014).

WHO (2014) advocated that proper healthcare waste management is the responsibility of the healthcare facilities and should be implemented at the national, regional, and local levels to target the sustainable healthcare waste management development (Birkin, Polesie, and Lewis, 2009). According to UNEP (2005), a proper healthcare waste management system should focus on the following objectives: rationalize healthcare waste management practices within the HCFS; establish legal and regulatory framework; develop capacity and conduct training programs; develop operational resources specifically to healthcare waste management system; and set up proper monitoring plan and minimize pollution

while treating the waste.

There is a rising need of implementing a better healthcare waste management system and conducting frequent training programs for waste handling labors. Therefore, the present scenario demands the review of existing healthcare waste management system and policies need to be reframed in order to improve the existing ineffective and inefficient healthcare waste management system.

2.5 Criteria to HWM and Sustainable Environmental Development

Evaluating healthcare waste management practices is a multi-criteria decision making (MCDM) problem, as it involves assessment based on a predefined set of parameters like experiences, relationship dimension, technology and qualification, firm capabilities (Ali et al., 2017). 'Experience' criterion highlights the performance history of an organization in the related field and database of the employees as well as of the customers (Senthil, et al., 2014). By tracking the performance history of the healthcare waste disposal, firms will help the healthcare facilities' administration to select the outsourcing partners.

Relationship dimension depicts the industrial relations of the considered organization within the health centers (Ho et al., 2010). Environmental factors address the hygiene issues of the healthcare wasted firm and find the extent up to which they are conforming to the environment policies (Ali et al., 2017; Hsu et al., 2008). Environmental sustainability would help in reducing the operational costs and also in fetching more business to the organization (Walsh and Dodds, 2017). 'Technology and qualification' criterion demonstrate the technological advancement

of the healthcare wasted firm in handling and treating infectious waste (Senthil et al., 2014). Economic criterion further help to assess the financial position of the waste disposal firms and also cover the pricing policy of the organizations (Ho et al., 2010). ‘Firm's capabilities’ criteria analyses the manpower skills and infrastructure of the healthcare waste handling firms (Senthil et al., 2014).

2.6 Global Healthcare Waste Generation

Studies conducted in Kuwait which showed the generation rates in the range of 3.65 to 5.4 kg/patient/day, however the total generation rate differs from one country to another. The collection efficiency can help in achieving greater success through system improvements such as installing new technologies, better collection systems, equipment’s and collection vehicles, proper operational procedures and capacity building to health workers. These developments in the healthcare waste industry improve the service and reduce costs as well as eliminating waste left uncollected in healthcare facilities (World Care, 2010).

The study done in Kuwait (2005) about 818 healthcare centers were assessed, the study show that there is improper management of healthcare waste in most of the public hospitals, there is higher generation rate, improper collection, handling, and poor disposal of healthcare wastes. Hazardous and nonhazardous wastes generated from different divisions of two of the largest public healthcare facilities (capacity of approximately 400 beds each) in Kuwait were quantified and generation rates were determined. The generation rates will be related to some important factors such as the number of patients, number of beds, and the type of activity conducted in different sections of the healthcare facilities.

The relationship between the waste generation rate and the number of patients was more applicable than that expressed in terms of the number of beds. The rates observed will be in the range of 4.89 to 5.4 kg/patient/day, which corresponds to 3.65 to 3.97 kg/bed/day, respectively. These generation rates will be comparable with those reported in the literature for similar healthcare facilities. Minimal waste quantities were collected in the weekends. The study indicated that the healthcare facilities surveyed provide some segregation of hazardous and non-hazardous wastes. Hazardous wastes contributed about 53% of the total quantity of wastes generated at the healthcare facilities (Hamoda et al., 2005).

Handling of healthcare wastes is among the most important environmental problems in Turkey as it is in the whole world. Approximately 25 to 30 tons of healthcare wastes, in addition to the domestic and recyclable wastes, are generated from healthcare facilities, clinics and other small health-care institutions daily in Istanbul (Kocasoy et al., 2004). Unfortunately, these wastes are not handled, collected or temporarily stored at the institutions properly according to Kocasoy et al. (2004). Besides inappropriate handling at the institutions, there is no systematic program for the transportation of the healthcare wastes to the final disposal sites. The transportation of these wastes is realized by the vehicles of the municipalities in an uncontrolled, very primitive way. As a consequence, these improperly managed healthcare wastes cause many risks to the public health and people who handle them.

2.6.1 Healthcare Waste Generation in Africa

Healthcare activities generate waste that should always be discarded at the point of use by the person who used the item to be disposed of. The quantity of HCW

generated should always be minimized and precautions must be taken during their handling waste minimization and recycling. Before producing waste, it should be investigated whether the amount of waste generated could be minimized in order to reduce efforts in subsequent handling, treatment and disposal operations. The reuse of equipment has almost disappeared due to the marketing of single use items and the need to prevent the spread of nosocomial diseases. This is particularly the case for healthcare items such as syringe needles. There are however other opportunities for recycling or reuse, in particular of objects / items which are not directly used for health-care (paper, cardboard, glass, metal containers, plastic wrappings). One of the most efficient measures for waste reduction lies in the careful management of healthcare stocks in the hospital pharmacies (Mahler, et al. 2017).

2.6.2 Healthcare Waste Generation in Tanzania

In Dar es Salaam city, study done by Mato et al. (1997) showed that healthcare waste generation rates in the surveyed healthcare facilities will be obtained by actual measurements and through assessment of the storage facilities empting frequencies and degree of filling of the waste receptacles. The healthcare facilities with better healthcare facilities will be found to have higher waste generation rates of up to 1.3 kg/patient per day. For the case of Aga Khan Healthcare facilities, this value is nine times that of Temeke healthcare facilities (0.15 kg/patient per day). However the average waste generation rate is estimated to be 0.66 kg/patient per day with a range of 0.3 to1.8 kg /patient per day (Kaseva, et al., 1999).

A study conducted outside Dar es Salaam on healthcare waste generation was in Mtwara region putting into consideration the number of healthcare facilities beds in

a given healthcare facilities as indicated in the national health-care waste management plan (national healthcare waste report, 2003). The rate of waste generation at a given healthcare facilities increases with the number of beds available and the occupancy rate. Four healthcare facilities was distributed as follows: 2 in Masasi, 1 each for Newala and Mtwara Urban and none in Mtwara Rural and Tandahimba districts. The quantities of healthcare waste generated follow the same trend similar to that of number of beds (Manyele, 2004).

However, to compare different regions, is advised to use actual measurements of waste generated disregarding the number of beds. Another way of expressing the healthcare waste generation in the healthcare facilities is the sectional overview, that is, waste generation per section of the healthcare facilities. In most healthcare facilities, the dominant trend (in descending order) is large amounts of waste in the surgical, gynaecology, orthopaedic and healthcare sections produce smallest amounts (Manyele, 2004).

Such an overview will assist the healthcare facilities management to direct their waste management resources in the critical areas (Manyele et al., 2003). However, each healthcare facilities needs to generate its own data. This analysis will help the management to know exactly where to place more emphasis like waste collection frequency, number of containers required, and the number of waste handling staff. This will also lead to preparation of effective weekly rosters, and estimation of annual costs for healthcare waste management to improve the budgetary system.

2.7 Policies and Legal Framework

The health policy underscores the strengthening disposal and safe management of

healthcare waste resulting from health services provision including medicines, equipment, healthcare supplies, expired chemicals and laboratory reagents. This will contribute to the quality of health among personnel working in healthcare facilities and/or community through reduction of the risks involved among healthcare workers such as occupational injuries due to the mismanagement of healthcare waste.

2.7.1 The Public Health Act, 2009

The policy guidelines are in line with Public Health Act, 2009 that calls for proper management of all kind of waste including hazardous waste and healthcare waste. The Act addresses handling, treatment and disposal, transportation and importation of HCW including environmental impact assessment.

2.7.2 National Environment Management Act, 2004

The Guidelines is line with the National Environmental Management Act, 2004. It Stipulate clearly the management of healthcare waste by ensuring that healthcare wastes are sorted and stored in prescribed coded containers and transported in refuse trucks designed and registered for that purpose and will ensure proper final disposal of healthcare wastes. The outcome of these measures is minimization of environmental and health risks.

2.7.3 The Health Sector Strategic Plan (HSSP) IV 2016 – 2020

The policy guidelines specifically address Strategic Objective 5: which aim at address the social determinants of health, the health and social welfare sector, collaborate with other sectors, and advocate for the inclusion of health promoting and health protecting measures in other sectors' policies and strategies. Specifically

for the healthcare waste management it targets is By 2020, 80% of health facilities will meet the standards for safe healthcare waste management, developing guidelines to assist LGAs in the implementation in the Healthcare facilities and other implementers on proper management of healthcare waste. Other waste management interventions outside of health facilities will be organized by Local Governments to meet legal requirements for optimal sanitary standards.

2.7.4 The Atomic Energy Act, 2002

This Act provides the, an appropriate system to ensure nuclear safety and physical protection. Furthermore to make rules relating to emergency preparedness and, in particular, the procedure and manner of dealing with radioactive wastes, the accidents involving radiation sources or in connection with the use of sources in any premises including healthcare facilities or an occurrence of any such class or description as may be prescribed.

2.7.5 Local Government Act, 2006

This policy guideline is in line with this act which is aim at taking measures for the prevention and abatement of nuisances, including such as arising outside the area cause annoyance, danger or injury to health within the area; waste control, inspection, movement and produce for waste management; safeguard and promote public health including the prevention of and the dealing with any outbreak or the prevalence of any disease; build, equip and maintain, or grant sums of money towards the establishment, equipment or maintenance of hospitals, health centres, maternity clinics, dispensaries, asylums for the aged, destitute or infirm or for orphans, or institutions for lepers; establish and operate ambulance services;

establish, install, build, maintain and control drains, latrines, public lavatories, baths and wash places; establish, maintain, operate and control drainage and sewerage works;

2.7.6 TFDA Act, 2003

This policy guideline provides measures to ensure food safety at healthcare facilities in line with Tanzania food and drug act, which aim at control of the sale of food for human consumption; promoting hygiene and safe manufacture, transport, storage, packaging, marking, exposure for sale, service or delivery of food intended for human consumption. It also 'provides for the disposal of stacks by disentitle persons.

2.8 Research Gap

Literature across the world has given different aspects to improve and management of healthcare waste management system such as a dedicated management system in the HCF and frequent training programs for waste handling staff and workers (zhang et al., 2013), national regulatory framework (Chisholm et al., 2021), estimating the amount and type of healthcare waste generated (Zhang et al., 2013), outsourcing the healthcare waste disposal process (Ali et al., 2017), and selecting proper disposal techniques (Perey et al, 2018), still the management of healthcare wastes is unsatisfactory in terms of general infrastructures and this is the most cause of environmental problems in Tanzania as it is in the whole world. Also proper management of healthcare waste need to know the waste generation rate, this will help the organization to plan proper equipment to be used in handling waste, man power, financial needed and implementation of available policies.

2.9 Conceptual Framework

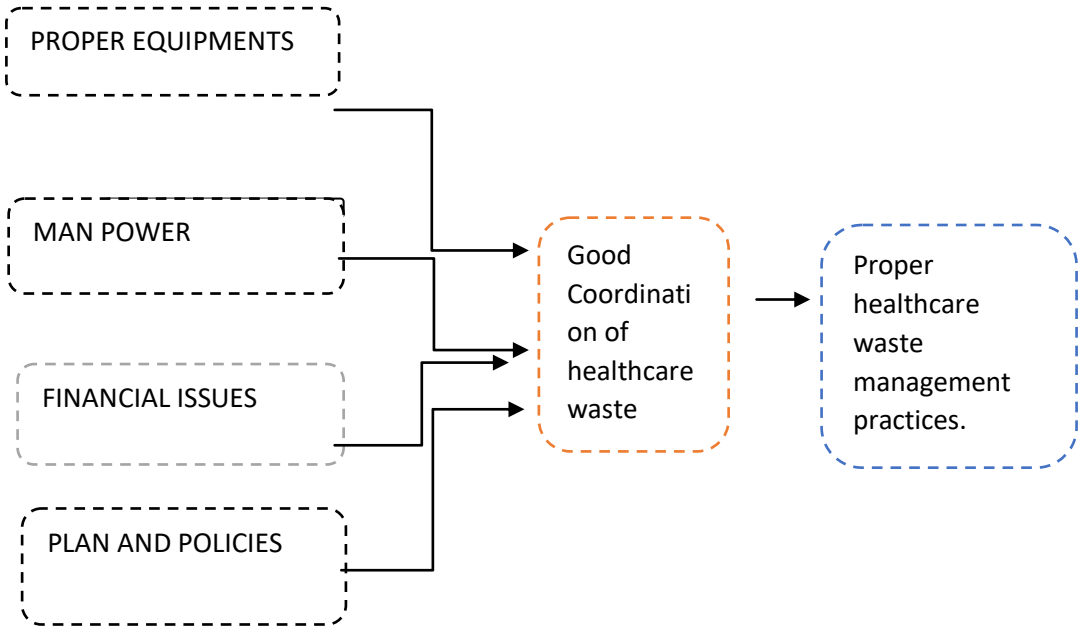

Figure 2.1: Conceptual Framework

The independent variables for this study are availability of equipment's, man power, adequate financial issues in terms of budget, and clear plans and policies that regulate healthcare waste management practices. On other hand the dependent variables was proper healthcare waste management practices while good coordination of healthcare waste management is intermediate variable. The proper management of health-care waste depends largely on good administration, coordination and organization but also requires adequate legislation and financing, as well as active participation by trained and informed staff (Tanzania national healthcare policy, 2017).

Proper Equipment's – Availability of proper equipment's, like dustbins, cars, incinerator's, protective equipment's, plastic bags etc. simplify the process of collection, handling, segregation, storage, transportation and disposal of HCW.

Man Power- availability of man power will facilitate the proper coordination of HCW, the man power always used to the implementation of the process from collection of HCW, storage, segregation, disposal and transportation of HCW. Man power is the one who conduct monitoring and evaluation of the whole process of HCWM. The Central, regional or district Health Authorities should ensure that all the hospitals prepare and implement a proper HCWM plan. They should support man power in the definition and the implementation of the HCWM plan by providing technical advice, supplying adequate material and allocating sufficient financial and human resources.

Financial Issues- financial is very important in the management and coordination of HCW. Without specific financial resources, it is impossible to get sustainable improvements in the management of health-care waste. HCWM is an integral part of health-care and thus needs to be budgeted for. Finances used to pay man power used, to buy proper equipment's and hence the proper coordination will be archived.

Plan and Policies - Provide guidance to technical personnel, decision makers and communities on safe healthcare waste management procedure. Availability of clear policies and plans guiding the HCWM process enhance the proper coordination of HCW and proper HCWM will be achieved in case the close follow-up of those policies and plans are implemented well.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Chapter Overview

This Chapter outlines various steps that are necessary in carrying out the study in order to achieve the research objectives outlined in Chapter One of this study. The chapter focused on the research design, study area, target population, sample and sampling procedures, research instruments, data collection procedures, as well as data analysis.

3.2 Research Approach

Both qualitative and quantitative methods were utilized through which the data was collected was analyzed and presented using statistical and descriptive methods. While quantitative data can reveal generalizable information for a large group of people, the data however, fails to provide specific answers, reasons, explanations or examples for in-depth understanding of a particular problem. On the other hand, Qualitative approach was used to gather subjective assessment of healthcare waste generation rate and collection efficiency. The use of a mixed approach (qualitative and quantitative) helps to triangulate and back up one set of findings from one method of data collection to another, and these capturers an in-depth and detailed primary and secondary data for comprehensive understanding of the study (Amaratunga, et al., 2002).

3.3 Research Design

This study, applied descriptive research design, since, when the design allowed the researcher to collect information about people’s attitude, opinion or any of the

variety of social issues as this was done through interviews, observation and administering a weighing scale for measuring healthcare waste.

3.4 Study Area

The study area was selected hospitals at Korogwe district council. Magunga, Majengo and St. Rafael hospitals were selected to be study areas so as to have comparison between them. Also these hospitals are Government and private hospital facilities full registered with all departments and services needed by the study; they are also convenient to the researcher in terms of time, cost and management willingness.

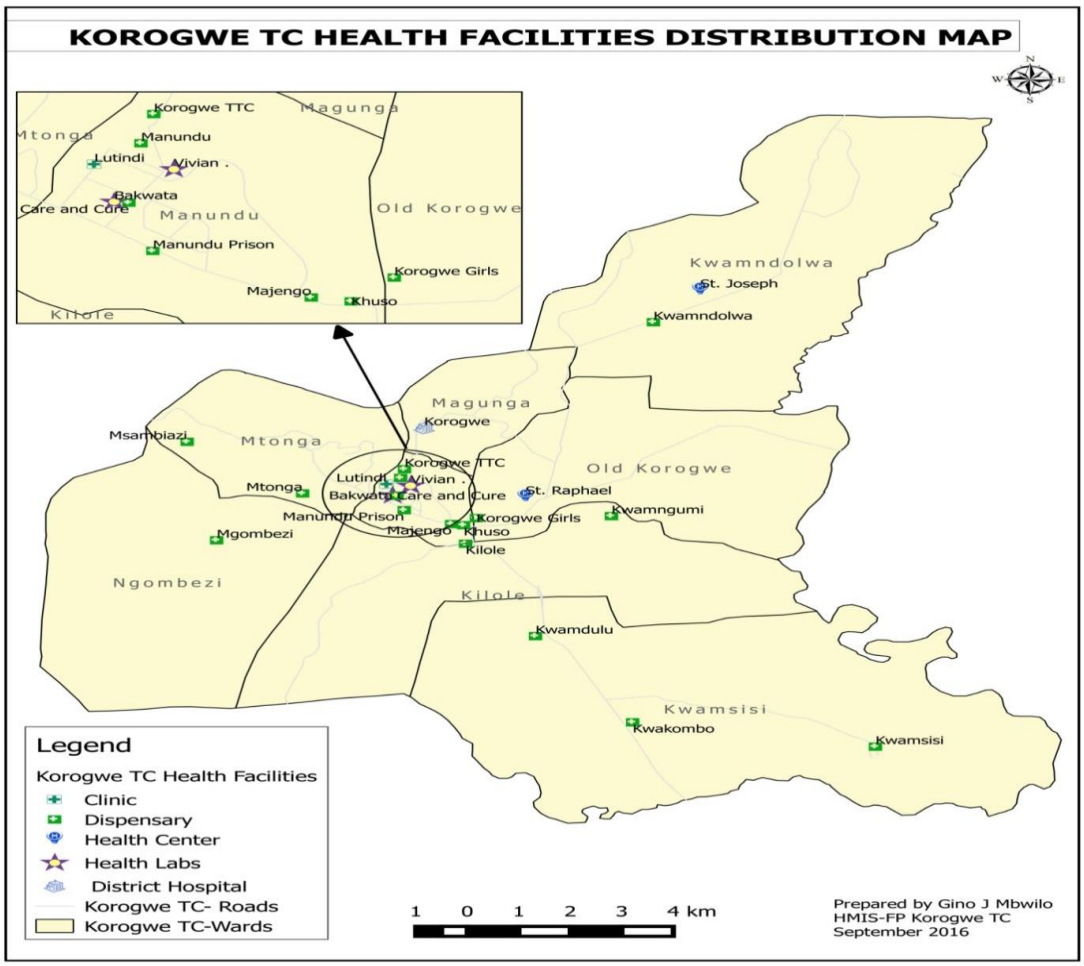

Figure 3.1: A Map of Korogwe District Council
Source: Korogwe Town Council Annual Health Profile (2018).

3.5 Target Population

The target population for the study was a total 120 employees from Magunga, Majengo and St. Rafael hospitals, environmental health practitioners, environmental officers, community health worker, district environmental stakeholders, from Korogwe District Council.

3.6 Sampling Procedure

Simple random sampling and purposive sampling was used to select respondents from selected hospitals in Korogwe districts. The random sampling techniques permitted the researcher to provide equal opportunity of selection for each element of the population. All individuals in the defined population have an equal and independent chance of being selected as a member of the sample. Furthermore the purposive sampling, which is non-probability sampling technique, was employed by the researcher; in sampling Hospitals employees, while the simple random technique was used to target all environmental stakeholders.

3.7 Sample Size and Unity of Analysis

The sample of this study was three hospitals selected at Korogwe district council; the selected hospital was Magunga, Majengo and St. Raphael. The unity analysis was the tangible or real measured waste generated that was recorded for three months per days at each hospital in kg/day, collected and measured at every hospital section

The sample size in this study was determined by the formula shown below:

$$n = \frac{N}{1+N*(e)^2}$$

Where: n = the sample size

N = total population

e = the acceptable sampling error, assuming a 96% confidence level, the acceptable sampling error is thus 0.04.

$$n = \frac{120}{1+120(0.04)^2}$$

n=100

3.8 Data Collection Techniques

In order to collect the required information the study, three techniques of data collection instruments was used; observation checklist, interview schedule and measurement scale. Three tools were employed to collect data for the study, namely, observation checklists, interviews checklist, and weighing scale. Observation checklist was used to gain intimate familiarity and some insights concerning the healthcare wastes management practices, health workers' perceptions and their involvement, and perceptions and knowledge as well as adherence to healthcare will waste management policies and regulations.

They were used to collect and record information from the health workers on the amount of healthcare waste generated by hospitals, to check adherence to waste segregation, collection mode and frequency and technical matters such as storage facilities available at the hospitals, and transportation and final disposal of the wastes. Checklists also were used to record information regarding problems encountered by the hospitals in the management of healthcare waste as provided by the informants and other health worker.

3.9 Validity of the Instrument

Validity of the instrument is measured by justifying each question in relation to the objective of the study. Also pilot study was done; the tools were pretested in one of selected wards to the respondents before actual data collection to test for the accuracy of tool to yield valid information. Pilot study helped to identify problem with research instrument and increased validity of instrument used. The aim of the piloting was to see how long for the participants answer interview questions to identify flows such as ambiguity in question and establish whether or not the instruction was understandable. Moreover, the use of different instruments for data collection (triangulation) aim at ensuring the reliability and validity of data to be collected (Cresswell, 2009). In this case four methods were used; the questionnaire, focused group discussion, interviews and documentary analysis, for one method to crosscheck the validity of the other.

3.10 Reliability of the Instrument

Golafshan (2003) state that the extent to which results are consistent over time and an accurate representation of the total population under study is referred to reliability and if the results of a study can be reproduced under a similar methodology, then the researcher instrument is considered reliable". Therefore, to ensure the reliability of the study, the researcher used triangulation methods which involve using multiple data sources in a study, through triangulation methods, the findings can be verified and any weaknesses in the data can be compensated by the strengths of the other data by increasing the validity and reliability of the results. In maintaining reliability in this study, the researcher deployed multiple sources of evidence, namely interviews,

questionnaire, documentary review, and focus group discussion to respondents. The quality of the data gathering instrument was dependent on whether the instrument can measure what it is supposed to measure and if items carry the same meaning for all respondents (Thatcher, 2010).

3.11 Data Analysis Plan

Data regarding the demographic information of respondents, the profile of the sampled hospitals, and the current situation of healthcare wastes management practices was extracted from observation checklist, record from weighing scale and interviews. The Microsoft Office Excel and Statistical Package for Social Sciences (SPSS version 20.0) programme were used to analyze the data. Presentation of the outputs was done by using tables.

Waste **generation rates:** waste generation per day, Wd, is defined as the total weight of waste (in kg) generated per day, that is,

$$W_{dp} = \frac{W_d}{N_p}$$

Healthcare waste collection efficiency, Ec: Defining Wdc as total waste collected per day, then, collection efficiency was determined as:-

$$E_c = \frac{W_{dc}}{W_d} \times 100\%$$

3.12 Ethical Consideration

The permission was obtained from the Ethical Clearance Committee, Institutional Board Review of the Open University of Tanzania (OUT). The letter of consent was obtained from all institutions under the study. Protection of the respondent's rights on the study was considered by giving them freedom to participate or not. Privacy

and confidentiality are maintained, the written informed consent was attached to the questionnaire, which was signed by the respondents who agreed to participate.

Furthermore, a consent form was prepared and presented to all respondents to secure their will to participate in the study. This was done for the sake of ensuring that informants understand what it means by participating in a research study hence consciously and deliberately participate in the study. Also, participants were informed that they are allowed to withdraw from the study at any time for any reason. Thus, the research was done honestly and legally.

CHAPTER FOUR

RESULT AND DISCUSSION

4.1 Introduction

This chapter gives presentation of the data analysis and discussion of the obtained results. This chapter presents the research findings, based on the research methodology and research questions. The study focused on assessing analysis of healthcare waste management for sustainable environmental and health approached in Tanzania Hospitals using Korogwe District Council hospital as a case study.

4.2 Healthcare waste Generated at Magunga, Majengo and St. Raphael Hospitals

Findings indicates that the healthcare waste generated at Korogwe District council hospitals are similar and common with other healthcare waste generated to other hospitals in Tanzania, but the different is on the capacity and generation rate. The wastes generated at three hospital at Korogwe district council it was including sharps (like scalpel blades, glass slides, surgical and hypodermic needles, syringes, lancets and scissors), which were the most common types of wastes in all the three health facilities visited. Culture and stocks (laboratory waste, biological products and culture dishes) and waste blood were also produced in all three hospitals. The generations of infection fluid waste also were in both three hospitals at KDC as well as the production of anatomical and pathological wastes.

The study (Table 4.1) revealed that waste generation rate is slightly higher at Magunga hospital by 1.6 kg bed^{-1} day^{-1} with total waste per day 569kg/day that is public owned hospital, this is higher than the private health centres, followed by

another public hospital Majengo by 1.3 kg bed^{-1} day^{-1} with the total 119kg per day, Saint Raphael is a private hospital generate 0.45 kg bed^{-1} day^{-1} with 51kg per day. Therefore public HCFs produced more wastes than that of the Private HCEs due to more numbers of beds, departments, and wards in comparison with private hospitals. The amount of HCW generated in the HCEs was positively correlated with the number of beds.

Table 4.1: Overall HCW (Hazardous And Non-Hazardous) Generation Rate From Different HCEs

Name of the HCE	Number of beds	Ownership Category	Total generated waste, kg/day	bed^{-1} day^{-1}
Magunga hospital	333	Public	569	1.6
Majengo hospital	102	Public	119	1.3
St. Raphael hospital	14	Private	51	0.45

Source: Data analysis, 2022

The average waste generation per bed per day in which is much lower than that of the developed countries like the United States (4.5 kg bed^{-1} day^{-1}), the United Kingdom (3.3 kg bed^{-1} day^{-1}), and Spain (4.4 kg bed^{-1} day^{-1}) (USEPA, 2002). In high-income countries, HCW generation is usually higher than that in the middle and low-income countries (Hassan and Rahman, 2018). The rate of waste generation mainly depends upon geographical location, living standard, healthcare facilities, waste collection services, and so on.

In other side of the above about 80% of waste generated is non-hazardous and the other 20% is hazardous which is much lower than reported in developing countries like Denmark (25%) and the United States (28%) (Rahman et all, 2018). Among hazardous waste, 8% is infectious, 5% pathological, 4% plastic, 2% sharps, and 1% is chemical waste (Figure 4.1).

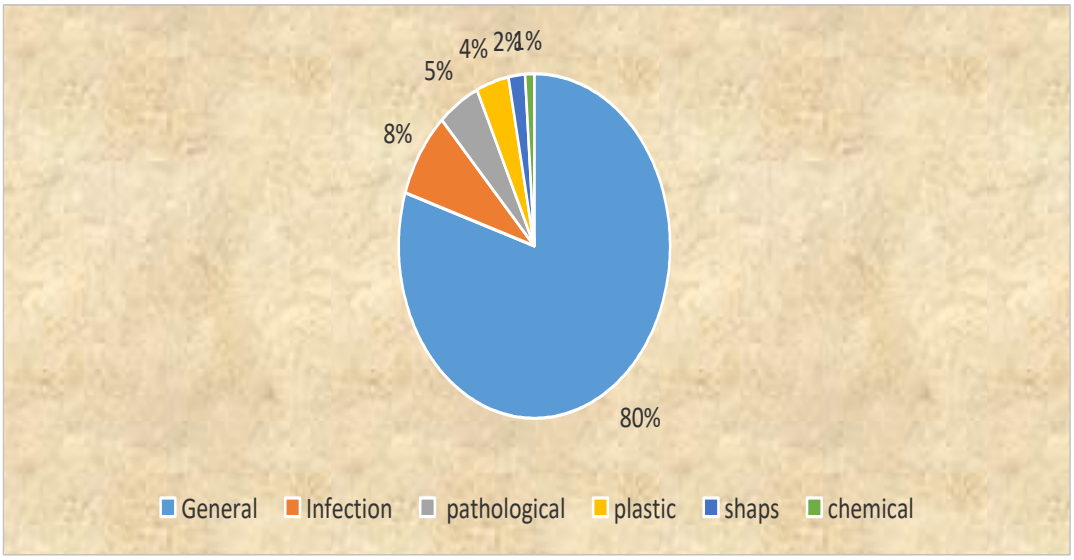

Figure 4.1: Overall Composition of HCW in studied HCEs
Source: Data analysis, (2022).

4.2.1 Sharps Generated in the Studied HCEs

According to WHO/UNICEF (2015) sharps are used items like syringes and needles, intra-venous (IV) tubing with needles attached, giving sets, scalpel blades, knives, lancets, blades and broken glass, form a class of healthcare waste known as sharps waste. Sharps waste contains items that can cause cuts or puncture wounds to healthcare workers. Result (Figure 4.2), shows the generation rate of sharp waste from St. Raphael hospital lie between 0.00 to 0.03 kg bed^{-1} day^{-1}, 0.01 to 0.05 kg bed^{-1} $day^{-1}$for Majengo hospital and 0.07 to 0.15 kg bed^{-1} day^{-1} at Magunga hospital.

The generation rate for Magunga 8kg/day, 3kg/day for Majengo and 2kg/day for Saint Raphael. Whether sharps are infected or not, are considered highly dangerous and potentially infectious waste, due to their puncture or cutting property (WHO, 2015).the result shows about 65.7% of sharps at the study area are placed in a plastic bag and 11.4% placed in heavy-duty plastic container**.**

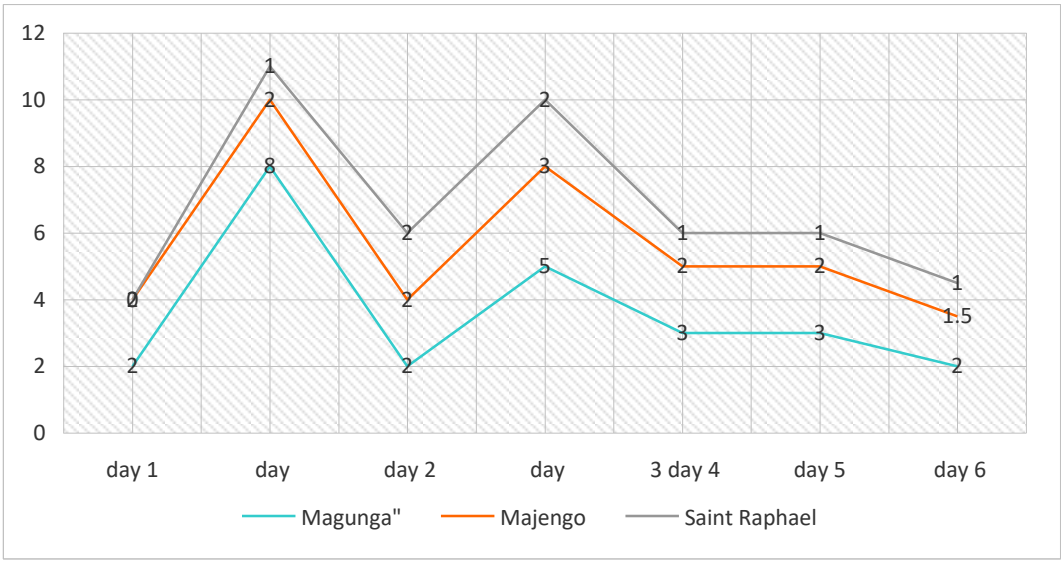

Figure 4.2: Sharp Generation Rate

4.2.2 Infectious Waste Generated in the Studied HCEs

Waste from infected patients in isolation wards. Waste contaminated with blood or other body fluids include free-flowing blood, waste pharmaceutical materials (expired chemicals) blood components and other body fluids; dressings, bandages, swabs, gloves, masks, gowns, drapes and other material contaminated with blood or other body fluids; and waste that has been in contact with the blood of patients undergoing haemodialysis (e.g. disposable towels, gowns, aprons, gloves and laboratory coats).

Figure 4.3 shows the quantity of infectious waste collected from different hospitals ranges from 0.18 kg bed^{-1} day^{-1} to 0.45 kg bed^{-1} day^{-1}, 0.22 to 0.46, and 0.01 to o.08 kg bed^{-1} day^{-1}. This study has provided information on the infectious waste generation excluding the plastic bottles and pathological items, allowing bench-marking between hospitals.

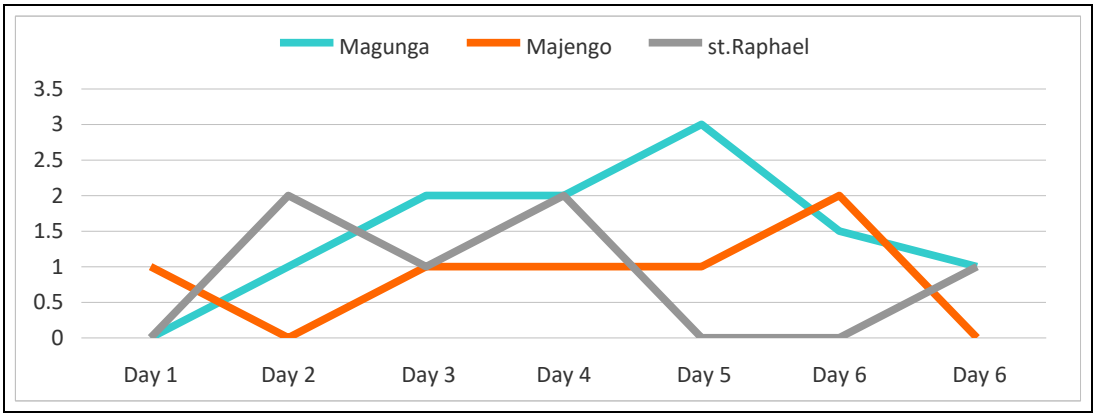

Figure 4.3: The Quantity of Infectious Waste Collected From Different Hospitals

4.2.3 Pathological Waste Generated in the Studied HCEs

This waste consists of tissues, organs, body parts, blood, body fluids and other waste from surgery and autopsies. It also includes human foetuses and infected animal carcasses (National health guideline, 2017). The amount measured for pathological waste call upon the use biogas technology. This will lead to production of methane by anaerobic digestion helps to reduce the amount of waste that must be disposed of using other methods like incineration or land filling that generally does not have environmental benefits. The range from 2-8.5 kg/day recorded at Magunga hospital, 0-4 kg/day Majengo hospital and the lowest is 0-2kg/day from St. Raphael (Figure 4.4).

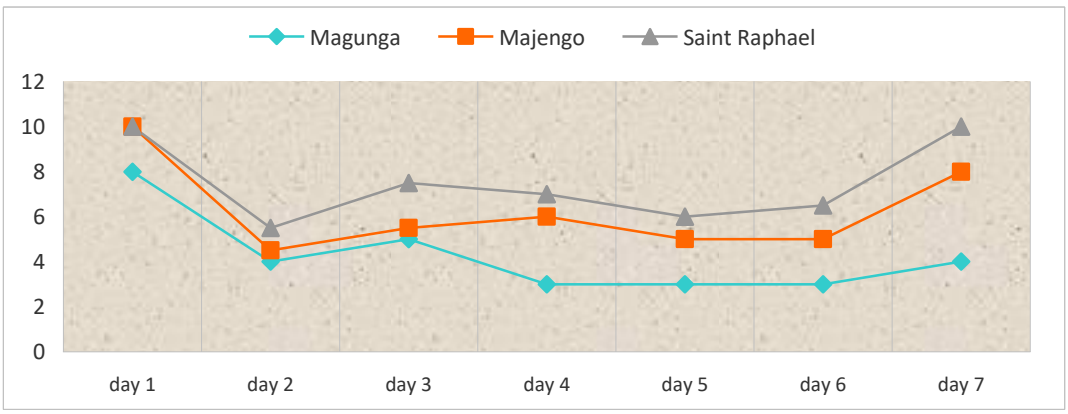

Figure 4.4: Pathological Waste

4.2.4 Non-Infectious Waste Generated in the Studied HCEs

When we consider the rate of generation of non-infectious waste the order can be arranged as 11kg/day (Magunga Hospital) greater than 2 kg/day (St. Raphael Hospital) and 3 kg/day (Majengo Hospital) (Figure 4.5). The non-infectious waste are mostly generated from the administrative and housekeeping activities of healthcare facility establishments which include waste generated during maintenance of health-care premises or from food preparation and facility surrounding such as Packaging, food remains, scraps, paper, unwanted flowers, empty saline bottles, non-bloody.

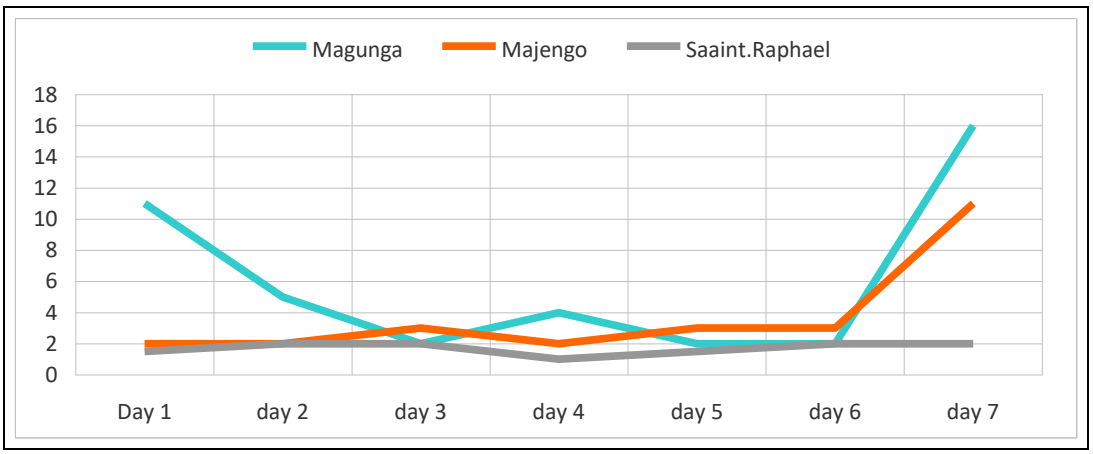

Figure 4.5: Amount of Non-Infection Waste

The analysis also showed generation rate for general waste to be higher compare to other categories of waste such as pathological. This is good news to hospital administrators, as if well segregated, can easily and economically be collected, treated and disposed of using the normal municipal technologies to reduce cost and help hospitals to concentrate with much hazardous waste which are dangerous and costly to handle. The rate of healthcare waste collection in both hospitals is not very good as some of wastes are left uncollected which call for more effort to be kept in this area as healthcare waste left uncollected can harm human health and

environment.

4.3.4 The Magnitude, Capacity and level of Healthcare waste Generated Rate

The survey (Figure 4.6) shows the range of healthcare waste that generated rate per day at Korogwe District Council for the surveyed three hospitals it range's 0.5kg/day/bed, 0.57kg/day/bed, 0.1kg/day/bed for Magunga, Majengo and St. Raphael hospitals respectively. Also finding shows total waste generated rate per day for each hospital was range 150kg/day, 120kg/day, 100kg/day for Magunga, Majengo and St. Raphael respectively. Also finding revealed public hospital like Magunga and Majengo generated more kg/day of waste as compared to private hospitals like St. Raphael at Korogwe District Council.

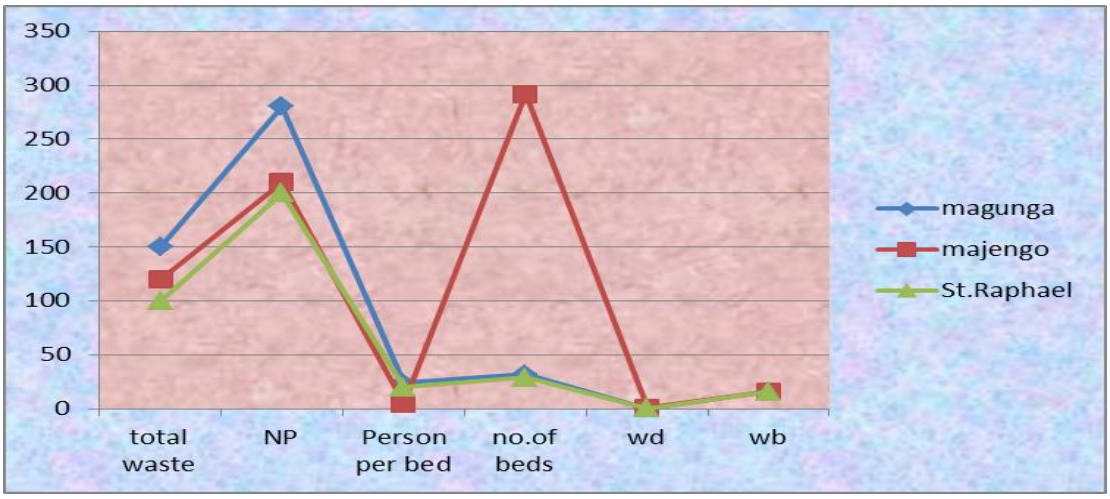

Figure 4.6: The Magnitude, Capacity and Level of Healthcare Waste Generated Rate

The various categories of waste; general, pathological, chemical, infectious, sharp and pharmaceutical were found in all the hospital units, apart from the Pharmacy which does not generate pathological waste, the laundry, kitchen, administration and engineering units also generate general wastes alone. A study in Maldives revealed that 76.3% of the total solid wastes generated in a regional hospital was general

wastes, 18.3% was infectious wastes, and 5.4% was sharps (Sharma, 2007). Omojasola et al. (2009) reported that main types of wastes generated by hospitals in Ilorin Metropolis in Nigeria were blood, faeces, urine, used syringes and needles, gauze, cotton swabs, specimen bottles, gloves and catheters.

In a more recent study, Oruonye (2012) has reported that the healthcare wastes generated in the hospitals and clinics in the Jaringo Metropolis, Nigeria include needles and syringes, soiled dressings, body parts, diagnostic samples, blood, chemicals, pharmaceuticals, healthcare devices and radioactive materials with 26.7% of the waste generated being needles and other sharps. These reports reflect the similarities in types of activities undertaken in the healthcare facilities in different parts of the world and also the global nature of the challenges concerning healthcare waste management.

4.4 Knowledge of Employees on Classification Healthcare Wastes

The healthcare workers at three sampled hospitals some of them seem to be aware of the type and the hazardous nature of healthcare waste, but not all healthcare attendants are aware on the classification of the healthcare waste and make separation of waste to be difficult. For those who are aware it's because of their familiarity and long experiences in using syringes and needles and the accidents that might happen as a result of sharps injury. The analysis (Table 4.2) show that the healthcare attendant in the study area classify healthcare waste as follows:- paper, cartons, and boxes 24%, 12%, and 8% classified as healthcare waste at Magunga, Majengo and Saint Raphael hospital respectively.

Table 4.2: Knowledge of Employees on Classification Healthcare Wastes

Type	Respondents who considered wastes as healthcare waste (%)		
	Magunga	Majengo	Saint Raphael
Paper, cartons, and boxes	24	12	8
Dressing cotton and plasters	89	43	63
Chemicals	77	50	37
Pathological materials	90	70	50
Pharmaceuticals	97	75	57
Unused medicines	85	60	55
Kitchen wastes	33	20	37
Pressurized containers	47	42	52

Source: Data analysis (2022).

dressing cotton and plasters classified by 89%,43, and 63%, Chemicals presented by 77%, 50, and 37%, pathological materials presented by 90%, 70%, 37 and 50%, pharmaceuticals presented by 97%,75% and 57%, unused medicines classified by 85% 60%, and 55%, kitchen wastes presented by 33% ,20% and 37%, pressurized containers presented by 47% 42% and 52%. It is therefore clear that even when separation of wastes is practiced, wastes are likely to be mixed because employees cannot distinguish healthcare wastes from general wastes.

Tiong, et al., (2012) in their survey of 19 private healthcare clinics in Malaysia observed that 57.9% of the private clinics were practicing improper management of healthcare wastes because of lack of awareness. It was further revealed that from selected three hospitals 44 of the 58 nurses (76%) classified the wastes correctly. However, only 2 of the 8 doctors (25%), 40 of 121 healthcare attendants (33%), and 9 of 20 environmental health officers (45%) completed correct classification. It therefore appears that nurses have more knowledge of type of wastes than other healthcare workers probably because they are regularly involved with waste management practices.

A study in Zambia revealed that only a few healthcare centres, district hospitals and general hospitals conducted training in waste management to newly hired waste management staff (Lubasi-Kapijimpanga, 2008). The remaining facilities did provide any form of training to such workers, implying that such workers were at risk of exposure to occupational hazards associated with healthcare waste management. Similarly, Oruonye (2012) has reported that most of the healthcare waste handlers, particularly in the private hospitals/clinics in the Jaringo Metropolis, Nigeria do not have formal training in waste management techniques and hospital/clinic administrators pay very little or no attention to appropriate management and disposal of healthcare waste.

Longe and Williams (2006) recommended that handlers of healthcare wastes should be trained on methods and new techniques for waste management and hazardous effects of the wastes while Manyele and Anicetus (2006) recommended that all new employees in the health sector need to acquire training on healthcare waste management in order to equip them with the knowledge to tackle problems associated with healthcare waste management in their work places. Sharma (2007) also emphasized that all persons involved in healthcare waste management such as doctors, nurses, par healthcare staff, housekeeping supervisors, healthcare workers, waste handlers etc. shall be trained on health impacts of healthcare wastes and safe practices of healthcare waste management.

4.4.1 Knowledge of Policies, Laws, and Regulations Regulating HCWM

Generally, there was very low level of awareness of existence of documents regulating healthcare wastes and by extension the environment, among the

respondents. It was observed that only 16.9% of the respondents knew about the existence of the WHO manual on safe management of wastes from healthcare activities (2014). Only 17.9% and 13.5% of the respondents had the knowledge of the existence of the Environmental Management Act (2004) and the Public Health Act (2009), respectively. It was surprising to learn that 51.7% of health workers including those in the top administrative positions were not aware of the existence of any one of the three documents.

Among the interviewed administrative staff, the national healthcare policy, Environmental Management Act (2004), and Public Health Act (2009) were particularly well known by only 2 of the 9 respondents (22.2%), but no one was sure where these documents are kept. In general, higher age groups (experienced) people were relatively keener on improving the waste management practices whereas most of the employees in the younger age group were relatively unconcerned with waste management. A similar behavior was reported by Denniss (2005) who observed that young generations were less aware of the environmental issues and are less concerned with waste management.

Elsewhere, Kaiser, et al. (2001) in a study in the United States reported a gap on awareness of environmental issues in general by hospital workers, which negatively affects and influences the choice of materials used in hospitals. A case study conducted by Patil and Pokhrel (2005) in a hospital in India found that the pockets of non-compliance with statutory requirements were due to a lack of enforcement. Policies, acts, regulations, and codes of practice contain information that justifies their formulation and they emphasize the importance of the issue they regulate. It is

therefore absolutely important that those who implement them are familiar with their contents and requirements.

4.5 Collection, Transportation of Healthcare Waste to Disposal Sites at KDC

Collection and transport of healthcare waste to treatment centres is a critical operational problem that local authority's face in all region and cities in the country. Of the total waste generated at hospitals, about 85% is general waste and 15% is hazardous material that can be toxic, infectious, or radioactive (World Health Organization, 2015). The majority of healthcare waste generators are laboratories, mortuaries, blood banks, research centres, hospitals, and nursing homes. Healthcare waste contains potentially dangerous micro organisms that may infect healthcare centre patients, staff, public, and the environment.

4.5.1 Collection of Healthcare Waste at KDC

Result indicated that the general wastes generated in the surveyed hospitals at KDC were collected and stored in 240 L bins that stood outside the wards and offices but within the hospitals' premises. These were emptied once or twice a day by waste collectors and sent to bigger containers which were emptied by third-party companies.

St. Raphael Hospital container had secondary 240 L bins and a bigger container with a capacity of 12 m3 which gets filled with general waste every 2 days and is emptied by the responsible trained employee (Figure 4.7a). There is an open pit for burning infectious waste, the hospital has no incinerator was non-functional at the time of this study, so the hospital used incinerator of Magunga hospital (Figure 4.7b and c).

Magunga hospital is the big hospital due to capacity of receiving large number of patient as compared to St. Raphael and Majengo hospitals. So the generation rate of healthcare waste from the findings above is very high, this hospital used bigger container and bucket placed around the hospital for collection, the incinerator is working properly at this hospital.

Figure 4.7a: St. Raphael Hospital Container for Infectious Waste

Figure 4.7b: Burning Method at St. Raphael Hospital

Figure 4.7c: Waste Incinerator at Magunga Hospital

At Majengo Hospital, waste incineration was phased out, and a steam-based treatment method, known as autoclaving, was now used to treat only the infectious blood-borne components of the waste including cotton pads, soiled bandages, and blood-stained needles and syringes.

4.5.2 Disposal and Transportation of Healthcare waste Practiced at KDC

The main disposal methods (Figure 4.9) comprised of open pit burning (50%), burying (30%) recycle (8%), water ways disposal (10%) and incineration (2%) of the waste. A large proportion (71%) of the hospitals used dust bins for transporting waste from generation points to incinerator without plastic bags. Magunga hospital had low incineration capacity, Majengo having fire brick incinerators, while st. Raphael has no incinerator at all. Most of the respondents preferred on-site versus off-site waste incineration. All three hospitals were using unskilled healthcare waste collectors and general cleanliness.

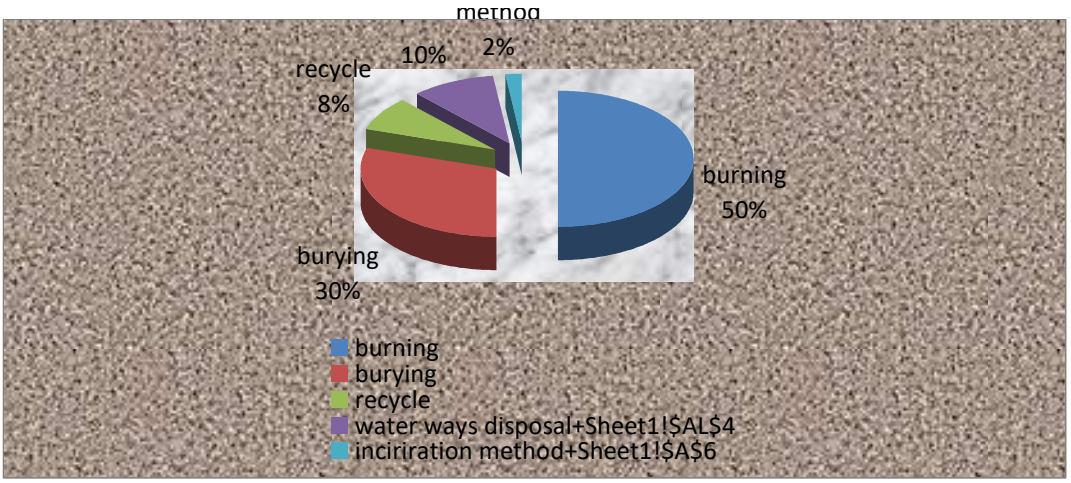

Figure 4.8: Disposal of Healthcare Waste Practiced at KDC

The knowledge level in healthcare waste management issues was low among the health workers, they used experiences. It is concluded that hospital waste management in Tanzania is poor. There is need for proper training and management regarding awareness and practices of healthcare waste management to cover all carders of health workers in the country.

The findings are similar with the finding of Manyele and Anicetus (2006) established that the main disposal methods for healthcare wastes in the hospitals comprised of open pit burning (48%), burying and incineration. Although it was used by a large number of the hospitals, open pit burning is not advisable as it releases toxic gases to the environment. It has been reported that indiscriminate solid waste and liquid waste disposal contributes significantly to water, air and soil pollution in Tanzania (VPO, 2005).

4.6 Environmental Risks Associated with Improper Management of HCW

This section explain about the evaluation on the environmental risks caused by poor management of healthcare wastes generated in the different places that providing

health services from lower level up to the higher level authorities.

4.6.1 Environmental Risks due to Improper Management of Healthcare Waste

Findings revealed about 75% from Magunga hospital said the environment is at high extent degraded or destructed by poor management of healthcare waste generated in the hospital while about 25% said moderate.

On the remaining two hospitals about 70% 95% from Majengo and St.Raphel hospital respectively, commented that to very high extent miss management of healthcare waste pose a lot of effect to the environment (Figure 4.10).

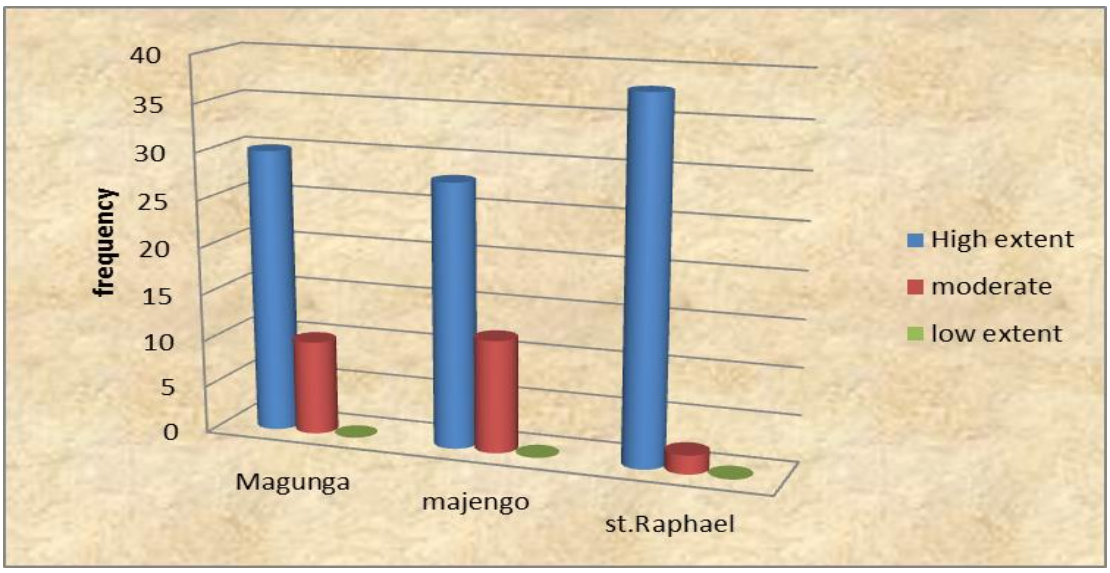

Figure 4.9: Environmental Risks Due to Improper Management of Healthcare Waste

These findings supported by environmental officer of Korogwe District Council who stated that:

> *"If there is a poor management of healthcare waste this may be problematic to the health of workers, patients and public. Also, owing to the toxic nature of healthcare waste, if there is improper handling, it may lead to the destruction of the natural environment. This may eventually cause a disruption in the balance of the prevailing ecosystem. Even though both the*

private hospital and public hospital have established healthcare waste practices aiming at minimizing health risks, there are still associated environmental consequences. The Government of Tanzania is totally dedicated to increase the safety of workers, the public well-being, as well as to protect the environment. Hence, it is forceful that there is significant investment for the proper management of healthcare waste in order to reduce the associated health and environmental risk'' (interviewee no.1 held on 17/7/2022).

"The environment is being affected and degraded not only because of emission of dangerous gases from waste incinerator, but due to the fact that the incinerator is designed in such a way that when it rains, water can get through the incinerator resulting in incomplete combustion of hazardous wastes. And since ashes are disposed in landfill, this may contaminate the land. The incinerator is surrounded by trees and owing to excessive heat and pollution, all the leaves are almost dried endangering species like birds (interviewee no.2 held on 19/7/2022).

"*However healthcare wastes are being managed to minimize health risks, the health of people managing these wastes are being constantly put at risk. Moreover, the environment is being affected and degraded not only because of emission of dangerous gases from waste incinerator, but due to the fact that the incinerator is designed in such a way that when it rains, water can get through the incinerator resulting in incomplete combustion of hazardous wastes. And since ashes are disposed in landfill, this may contaminate the land. The incinerator is surrounded by trees and owing to excessive heat and pollution, all the leaves are almost dried endangering species like birds".* (interviewee no.3 held on 19/7/2022).

In relation to the above findings Omojasola, et al., (2009); reported that majority of healthcare facilities in Ilorin, Nigeria left untreated waste in open dump sites, burning them twice a week. This practice allowed microorganisms in the waste to discharge from waste heaps into the environment during the interval between dumping and burning, thereby contaminating it.

As was the case in Ilorin, no sanitary land filling was practiced for healthcare wastes in Morogoro Municipality, implying that environmental contamination was a real risk. Sharma (2007) also reported that in Maldives, liquid

wastes, either infectious or others, generated from healthcare facilities are disposed into ground without any treatment through soak pits which ultimately find their ways into the ground water aquifers. Ayers (1993) reported that leaking underground storage or disposal tanks constitute the biggest threat to underground water and efforts should be made to ensure ground pits are leakage-proof.

Johnson (2011) reported that chemical waste in majority of healthcare institutions in Enugu, Nigeria was either disposed through a sink which goes to an underground pit or disposed into an open pit, thereby becoming a potential environmental hazard through the contamination of surface and groundwater resources. Open burning of wastes results into soil and air pollution because of the release of toxic materials and gases into the air and underground. In an assessment conducted by the World Health Organization in 22 developing countries, it was revealed that the proportion of health-care facilities that did not use proper waste disposal methods ranged from 18% to 64% (WHO, 2004).

It has been observed that hospitals that burn wastes or dumping bins which are transported to unsecured dumps release into the environment the wastes containing mercury and other heavy metals, chemical solvents and preservatives such as formaldehyde, which are known to be carcinogenic. Also, when plastics are combusted, they produce dioxins and other pollutants that pose serious human health risks not only to workers but to the general public (BAN and HCWH, 1999). Johnson (2011) reported that majority of the workers involved in the final disposal of wastes complained that coughing and catarrh respiratory discharges were their most common health problems.

4.7 Institutional Arrangements for HCWM in KDC and their Limitations

At the local level, only KDC a public organization, and NGO stakeholders, are involved in HCWM in KDC. KDC does not have any special arrangement for the collection and disposal of HCW separately as they are not obliged to do according to their ordinance. The conservancy department of KDC identifies the lack of trained manpower and resources as the principal reasons for not having any arrangement to handle the HCW.

KDC does not have any research facility to identify the extent of different problems and to provide guidelines to mitigate that. Around 47% of the money spent on waste management goes for the maintenance purpose of the vehicle and the remaining 53% is spent on providing remuneration of the staff engaged in solid waste management in KDC. KDC collected the HCW in the same vehicle together with other wastes from the public dustbin twice a day and dumped it together in the dumping ground. KDC also dumped wastes for landfilling purpose at different locations of the city. It increased the risk of health hazards to the adjacent community.

On the other hand, KDC started their journey in May 2000, with the financial aid from the Swiss Development Cooperation, UNDP, and the World Bank. Initially, they started their project with 20 HCEs, which increased to 100 in 2013. KDC segregated wastes at the source of segregation. They provided a set of four covered drums to dispose of four types of waste separately. An auto covered van of 1.0-ton capacity was used for transportation of HCW from different HCEs. Generally, collection took place in the morning every day. KDC took service charge from the HCEs they served and the charge was determined depending on the size (number of

bed) and earnings of the HCEs.

The study revealed that 44% of monthly expenditure is spent on providing wages for the staff. Vehicle maintenance cost is 46% and the remaining 10% is for purchasing the required materials. KDC burnt infectious waste in a locally made burning pit at a comparatively low temperature (about 400°C or below). It may, in some cases, cause unfinished burning and in the case of the presence of any type of plastic material in the waste, experts opine that "this is more harmful as it helps in producing dioxin gas." They disposed of the needles and all other sharp materials in a concrete pit. This could be viable at a small scale; however, in the case of the entire city, where the yearly generation of sharps waste is about 25 metric tons, the volume reduction is crucial. The present HCWM system of KDC is not a very structured and cost-effective one. The project is not internally balanced and continuity of the project is totally dependent on the availability of foreign aid.

4.8 Existing HCWM Practices in KDC and Its Impacts

With the upward trend of population and mushrooming growth of HCEs together with lack of operational waste disposal mechanism, the environmental condition of KDC is gradually becoming more alarming. The existing HCWM status in the KDC area is unsatisfactory and unsafe for health. Most of the HCEs in KDC had no apposite waste management system and they did not use any sort of protective clothing like gloves, a mask, and so on. Hospital authorities were found to be less concerned regarding proper disposal of clinical waste. Although proper segregation and treatment of infectious waste before dumping are very crucial to minimizing health risks to the community, they had not been exercised in any of the HCEs

studied.

It was revealed from the study that more than 80% of HCW is non-hazardous which may be considered as general waste. This huge amount of non-hazardous waste is excessively contaminated with hazardous waste due to a lack of proper waste separation practices. Moreover, there are few distinct color-coded collection bins for HCWM and all categories of waste from HCEs comprising reusable and sharp waste are dumped in common places, dumping grounds, or municipal waste collection containers. This malpractice elucidated the inefficiency of HCWM in KDC as well as increasing the chances of contamination of an entire mass of solid waste tainting it with infectious HCW.

HCW comprises biodegradable and no biodegradable polymers. Biodegradable polymers are easily decomposed by the action of microorganisms, while no biodegradables are very difficult to decay. The change in biological character of HCW disinfects it, which reduces the infectious bio hazardous properties of the waste. The microorganisms may create a cyst to stay alive in adverse condition and contaminate the environment. Chemical effluents produced from several HCEs were released straight into the municipal cesspool and may have toxic effects on the natural ecosystems of receiving waters.

Most landfills are not constructed properly, which may contaminate drinking water. Surface overflow directly from deposited waste can pollute surface water easily. Direct ejection of blood, body parts, feces, and urine of contagious patients in a public sewer system may cause a spate of communicable diseases. Lack of

awareness regarding the damaging effects of HCW was also found among the workers involved in the total management process as well as general people in the studied area.

Most of the disposal site is open and thereby emits unpleasant odours and an anaesthetic view, causing a huge public nuisance. While grazing, ready access of domestic animals in open dumps may create the possibilities of introducing microbes and pathogens into the food chain. Indiscriminate junking of HCW may create the chances of adulteration of food supplies, soil, surface water, groundwater, and air. The majority of the municipal waste receptacles are not designed appropriately and are open without a cover or lid. Therefore, vectors, like insects, rodents, worms, birds, and so on, can easily enter the collection containers and can take a place on the exposed piles of rotting trash causing the spread of contagious bugs. These also stimulate the mechanical transmission of deadly waterborne diseases like diarrhea, typhoid, dysentery, hepatitis, and cholera.

Moreover, mosquitoes promote biological transmission of many types of diseases like malaria, dengue, and yellow fever under humid environment. Rubber and plastic trash being burnt in the open air releases fumes containing carbon monoxide, dioxins, furans, and so on. When these toxic components are inhaled through smoke, they may cause cancer, respiratory diseases, and many other deadly results to humans.

Informal waste collectors (known as scavengers) engaged in collecting refuse from HCEs are suffering from various intestinal, parasitic, and skin diseases. Waste

pickers collect used healthcare equipment, particularly syringes, from the garbage and sell them at a low price. Many drug addicts may suffer from cholera, typhoid, hepatitis, AIDS, and other hazardous and contagious diseases as they are reusing these syringes. Scavengers are scooping out waste from the dustbins, roads, and garbage lots for the recyclables with bare hands, without taking any safety measures, therefore, facing a high risk of salient epidemics of infectious diseases. The waste pickers involved in the recycling process are extremely poor, having no proper education, and incautious of detrimental consequences of exposure to contaminated and harmful waste.

The inadequate disposal of HCW may be catastrophic to health and the environment as well as the wellbeing of society. If the HCW in KDC is not handled in a proper way, it will undoubtedly pose a danger to the workforce employed in the HCEs as well as to the neighbouring people.

CHAPTER FIVE

CONCLUSION AND POLICY IMPLICATION

5.1 Introduction

This chapter explains on the findings that have been presented in chapter four relating to the study objectives. And also, the chapter reflects on the study methodologies that have been used in obtaining and analysing the data. The study draws conclusion from the obtained findings and the recommendations that have been made.

5.2 Summary of the Study

This study renders a comprehensive analysis of healthcare waste management (HCWM) practices and the technological options for its better management through a case study in Korogwe District Council. A number of healthcare establishments (HCEs) in the study area were selected for field investigations, was performed to find out the present status of HCWM and its limitations. The study revealed that the overall HCW generation rate and hazardous HCW generation rate in Korogwe district for Magunga, Majengo, St. Raphael were 1.6 kg bed^{-1} day^{-1} total of 569kg/per day and 1.3 kg bed^{-1} day^{-1} total of 119kg/day, 0.45kg bed^{-1} day^{-1} total of 51kg per day respectively.

Assessment of management system revealed that 56% of workers did not receive any form of training in the handling of hazardous waste; therefore they are doing that job because of long time of experiences without any formal training. Around 54% of them did not use any safety equipment or clothing. It has been found from the study

that, among different technological alternatives based on the final score, incineration was the most suitable option for the treatment of hazardous waste in KDC. Finally, some guidelines have been put forward to improve its existing management practices.

5.3 Conclusions and Policy Implication

The analysis also showed generation rate for general waste to be higher compare to other categories of waste such as pathological and chemical, this is a good news to hospital administrators, as if well segregated, can easily and economically be collected, treated and disposed of using the normal municipal technologies to reduce cost and help hospitals to concentrate with much hazardous waste which are dangerous and costly to handle.

Also study has mainly focused on the existing HCWM paradigms of KDC and on the question of how it can be made a more efficient and acceptable one. The existing HCWM pattern in KDC has many drawbacks and is in dire need of immediate attention and improvement. The analysis shows generation rate for non-infectious waste to be higher compared to other categories of waste such as pathological, sharps and infectious waste. It was observed from the investigation that the hazardous waste was not treated separately in almost all of the HCEs in KDC. The Government of Tanzania is totally dedicated to increase the safety of workers, the public well-being, as well as to protect the environment. Hence, it is imperative that there is significant investment for the proper management of healthcare waste in order to reduce the associated health and environmental risk.

5.4 Policy Implication

Intervention is required at all stages of waste management from the formulation of appropriate laws, segregation, and transportation of waste to the final disposal method. The process and method adopted for waste management should be technically and financially sustainable in the long run. It has to also be ensured that there are no adverse health and environmental consequences of waste handling, treatment, and disposal activities.

National legislation is the basis for improving HCW practices in any country. Therefore, a national management plan will be required which will permit HCWM options to be optimized on a national scale. The law should be complemented by a policy document and technical guidelines developed for implementation. This legal document should specify regulations on treatment for different waste categories, segregation, collection, storage, handling, disposal, transportation, responsibilities, and training requirements. Training of healthcare personnel as well as general people regarding hygiene and HCWM is needed to create awareness and foster responsibility among them which will prevent exposure to related health hazards.

Among different waste treatment options, it has been found from the study that the incineration system is the most suitable one for KDC based on the final score considering technical suitability and environmental, economic, and social aspect. However, the system should be maintained properly with an appropriate air pollution control device. The ranking order of the second technological choice was microwaving followed by autoclaving, considering all aspects. The assessment of treatment alternatives in this investigation is subjected to the selection as well as

weighting of the criteria and strongly dependent on the reliability to the response of the experts' personal judgment. Besides, the waste generation rate that was calculated in this investigation was excluding seasonal variation.

A further detailed study is required incorporating more HCEs with an extended period of collected data as well as seasonal variation to explore the sustainability of such management option. Furthermore, it is recommended to develop a great variety of healthcare waste management methods to evaluate such HCW treatment alternatives. Overall, the study will give an insight promulgating guidelines for the future planning and design of HCWM strategies in KDC as well as other municipalities in developing countries.

A Sharps Management System must be set in hospitals. Also, there is a need of placing proper equipment and containers at all sharp generating points. Training on the proper handling and management of sharps must be given to the staff of hospitals. Healthcare waste treatment facilities such as incinerators and autoclaves must be operated under an expert proper supervision. Workers must be provided with protective equipment and clothes to wear on their work premises.

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APPENDICES

I am Mandia Kihiyo a student at the Open University of Tanzania; i am conducting a study to assess analysis of healthcare waste generation rate for sustainable environmental and health approached. I humbly request your cooperation in answering these questions to enable me get information for the study. All information given will be treated with high levels of confidentiality and be used for academic purpose only. Thank you for taking the time to share with me in this study

APPENDIX 1- Observation checklist

i. Type of healthcare waste generated
ii. The magnitude, capacity and level of healthcare waste generated rate
iii. Number of patient per bed
iv. The level of knowledge and extent of adherence of the staff to policies, plans, that govern health waste management
v. Collection process of healthcare waste
vi. Availability of tools
vii. Transportation of healthcare waste
viii. Treatment and Disposal process
ix. Collection efficiency
x. The environmental risks due to improper management of healthcare waste

APPENDIX II -Interview guide

i. What are the status of the infrastructure for waste management in from health centers at Korogwe District Council
ii. What are the strength and weaknesses of waste management by comparing it with a standard at Korogwe District Council?
iii. What are type, the magnitude, capacity and level of healthcare waste generated rate at Korogwe District Council?
iv. What is the common practice of waste management at selected health centers at Korogwe district council?
v. Challenges hindering proper management of healthcare waste
vi. What should be done

Appendix III: Schedule for Daily production of hazardous and non-hazardous healthcare waste mixed together

containers		Monday			Tuesday			Wednesday			Thursday			Friday			Saturday			Sunday				
n	volume (kg)	nb emptied	fill rate	total	nb emptied	filling rate	total	nb emptied	filling rate	total	nb emptied	filling rate	total	nb emptied	filling rate	total	nb emptied	filling rate	total	nb emptied	filling rate	total		
																							GRAND	
	Total(kg)			0			0			0			0			0			0			0	TOTAL	0

Estimation of the total volume of waste (hazardous and non-hazardous mixed together) generated during one we

Appendix IV: Research Clearance Letters

THE OPEN UNIVERSITY OF TANZANIA

DIRECTORATE OF POSTGRADUATE STUDIES

P.O. Box 23409
Dar es Salaam, Tanzania
http://www.out.ac.tz

Tel: 255-22-2668992/2668445
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Our Ref: PG201900350

3rd August 2022

Region Administrative Secretary (RAS),

Tanga Region,

P .O. Box 255,

TANGA.

RE: RESEARCH CLEARANCE

The Open University of Tanzania was established by an Act of Parliament No. 17 of 1992, which became operational on the 1st March 1993 by public notice No.55 in the official Gazette. The Act was however replaced by the Open University of Tanzania Charter of 2005, which became operational on 1st January 2007.In line with the Charter, the Open University of Tanzania mission is to generate and apply knowledge through research.

To facilitate and to simplify research process therefore, the act empowers the Vice Chancellor of the Open University of Tanzania to issue research clearance, on behalf of the Government of Tanzania and Tanzania Commission for Science and Technology, to both its staff and students who are doing research in Tanzania. With this brief background, the purpose of this letter is to introduce to you **Mr. KIHIYO, Mandia, Reg No: PG201900350** pursuing **Master of Science and Environmental Studies (MES).** We here by grant this clearance to conduct a research titled **"Analysis of Healthcare on Waste Management for Sustainable Environmental and Health Approached: A Case of Selected Three Healthcare Facilities at Korogwe District Council"** He will collect his data at Magunga Hospital,Majengo Hospital and St.Rafael Hospital from 4th August 2022 to 4th September 2022.

In case you need any further information, kindly do not hesitate to contact the Deputy Vice Chancellor (Academic) of the Open University of Tanzania, P.O.Box 23409, Dar es Salaam.Tel: 022-2-2668820.We lastly thank you in advance for your assumed cooperation and facilitation of this research academic activity.

Yours,
THE OPEN UNIVERSITY OF TANZANIA

Prof. Magreth S.Bushesha
DIRECTOR OF POSTGRADUATE STUDIES.

JAMHURI YA MUUNGANO WA TANZANIA
OFISI YA RAIS
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

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Ofisi ya Mkuu wa Mkoa
S.L.P. 5095,
TANGA

Unapojibu taja:

Kumb. Na.RM/R.20/I VOL III/93

11/08/2022

Mkurugenzi wa Mji,
KOROGWE

Yah: RUHUSA KWA MTUMISHI BW. KIHIYO MANDIA KUFANYA UTAFITI JUU YA TAKA ZINAZOZALISHWA KATIKA VITUO VYA HUDUMA ZA AFYA

Tafadhali husika na somo tajwa hapo juu.

2. Ofisi ya Katibu Tawala wa Mkoa wa Tanga imepokea barua ya tarehe **3/8/2022** yenye Kumb. Na. **PG201900350** inayomuombea ruhusa mtajwa hapo juu ili aweze kufanya utafiti juu ya taka zinazozalishwa katika vituo vya Huduma za Afya ambavyo ni Hospitali ya Magunga, Kituo cha Afya Majengo na Kituo cha Afya cha St. Rafael kuanzia tarehe **04/8/2022** hadi **04/9/2022**.

3. Kwa barua hii, naomba kumtambulisha kwako ili uweze kumruhusu na kumpatia ushirikiano aweze kukamilisha utafiti huu.

Nakutakia utekelezaji mwema,

Dkt. Jonathan E. Budenu
Kny: KATIBU TAWALA MKOA
TANGA

Nakala: Mhe. Mkuu wa Mkoa wa Tanga
S.L.P 5095
TANGA

Katibu Tawala Mkoa (Aione kwenye jalada)
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TANGA