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HOSPITAL WASTE MANAGEMENT IN NAIROBI CITY

BY

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DECLARATION

This is my original work and has not been presented for a degree anywhere.

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DEDICATION

This work is dedicated to my late Mom, Wilkister, who planted the seed but did not wait to see it sprout.

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K. – Government of Kenya

H. – Kenyatta National Hospital

W. – Municipal Solid Waste

C. – Nairobi City Council

MA – National Environment Management Authority

EP – South Pacific Regional Environment Programme

S – Statistical Package for Social Scientists

– United Nations

DP – United Nations Development Programme

EP – United Nations Environment Programme

ABSTRACT

The study aims at examining waste management systems in health facilities within Nairobi city. To study these systems, specific attention has been focussed on the types of wastes generated, collection and disposal methods of these wastes, and their environmental impacts.

A sample size of 60 health facilities consisting of hospitals, nursing homes, health centres and clinics have been purposively selected from different areas within Nairobi city, to be used as an inference to the entire population. The study has relied on both primary and secondary data. Questionnaires, Key-Informant Interviews and field observations are among the data collection techniques that have been employed. Data analysis has been aided by SPSS (Statistical Package for Social Scientists) technique, making use of both qualitative and quantitative statistical analyses. The former involved the use of simple descriptives such as averages and percentages, while the latter involved the use of advanced statistical analyses such as Friedman Test and Kruskal Wallis H Test.

The study found out that waste management systems in health facilities are inadequate. They are not only unhygienic and a public health concern, but also a threat to the biological and physical environment. The study therefore recommends that the Government through the relevant authority should strictly carry out thorough inspection of health institutions and firms that are licensed and contracted by Nairobi City Council for waste disposal, to ensure that hospital waste handling, collection and disposal are carried out within the laid guidelines and are generally safe to the public health and to the environment. Future research on management of home based medical waste has also been recommended by the study.

CHAPTER ONE

1.0 BACKGROUND

1.1 Introduction

As far back as 8000 to 9000 BC, people learned to dispose of their waste outside their settlement, to escape or avoid the nuisance of vermin, odour and wild animals. In antiquity, in many cities in Europe and Asia, waste was collected in clay containers and hauled away. In many other areas, pits were used to collect waste and faeces, which were emptied and cleaned periodically. There are records of regulations for the daily sweepings of the streets by residents. Waste haulers were required to move the waste at least 2km beyond the city wall (Tchobanoglous, 1993).

With increasing population, crowding in urban areas and the increasing industrialisation, the quantity of waste has increased greatly. These wastes are generated in form of solids, sludge, liquids, gases and any combination thereof. Depending on the source of generation, some of the waste may degrade into harmless products whereas others may be non degradable and hazardous.

Since the advent of civilization and industrialization, waste management has drawn a lot of concern globally. The environment has been a recipient of a wide range of hazardous wastes and chemicals generated from human activities. For instance, hospitals, committed to patient care and community health have been cited to paradoxically defy their own objectives. On one hand they cure patients and on the other hand, have emerged as a source of several diseases because surprisingly, until recent times, not enough attention has been paid to safe disposal of their waste.

Hospital waste, according to Federal and California laws, refers to waste that is generated or produced as a result of the diagnosis, treatment, or immunization

of humans or animals; in research pertaining to the treatment, diagnosis, or immunization of humans or animals; or in the production or testing of biologicals (medicinal preparations made from living organisms and their products including serums, vaccines, and anti-toxins).

Safe handling of these wastes continues to be a matter of serious concern for health authorities all over the world. Thousands of tones of biomedical wastes originating from hospitals, nursing homes, and clinics in the form of cotton swabs and bandages infected with blood, fluid bags, needles, catheters, human tissues, and body parts, among others continue to be dumped in open garbage bins on the roads in most parts of the country. The generation of these dangerous wastes is expected to increase.

The management of hospital waste is a major problem, especially in urban centres of developing countries. In recent years, these wastes' disposal has posed even more difficulties with the appearance of disposable needles, syringes, and other similar items. Pakistan for example is facing this problem and around 250,000 tonnes of hospital waste is annually produced from all sorts of healthcare facilities in the country. This type of waste has a bad effect on the environment by contaminating the land, air and water resources.

Plate 1: Wastes of all kinds suspended in one of the streams in Nairobi

Global figures based on statistical data of the Environmental Protection Agency of America and Japan's Ministry of Health suggested a volume of 1 to 1.5 kg/day/bed for hospitals, while, waste produced has been quoted up to 5.2 kg in developed countries.

However, the problem of hospital waste is more of quality as compared to quantity e.g. it is estimated that the total amount of hospital waste in most developing countries is only 1.5% of the total municipal waste stream. Yet, a special obligation to deal with this waste in an effective and safe manner is mandatory due to its composition.

Policies to reduce waste disposal could lead to improved environmental conditions for three main reasons: first, the problem associated with waste disposal sites would be vastly reduced, including their location and the leaching of dangerous pollutants into the ground and water tables. Secondly, an integrated approach to waste management implies the reduction of waste at source, including packaging material and a concerted effort towards reuse and recycling. Thirdly, most waste products are potentially inputs for other industries known as "zero emission production" or "closing the production loop". Such policies have so far been promoted only in a few countries but they constitute viable alternatives for many cities that struggle with the increasingly politically intractable issue e.g. of finding a landfill site in someone's backyard (Luis and Clarence, 1985).

Hospital wastes are categorized according to their weight, density, and constituents. The World Health Organization (WHO) has classified medical waste into different categories. These are:

1. **General waste:** Include domestic type of waste, packing material, wastewater from laundries, and waste from the offices, kitchens, rooms,

including bed linen, utensils, paper etc.

2. **Pathological waste:** This is defined as any recognizable human or animal body part and tissue. It thus consists of tissues, organs, body parts, human flesh, foetuses, blood and body fluids.
3. **Radioactive waste:** Includes solid, liquid and gaseous wastes contaminated with radioactive substances used in diagnosis and treatment of diseases.
4. **Chemical waste:** This comprises of discarded solid, liquid and gaseous chemicals e.g. from diagnosis, experimental work, cleaning, house keeping and disinfecting procedures.
5. **Infectious waste:** This is material containing pathogens in sufficient concentrations or quantities that, if exposed, can cause disease. It includes tissue cultures and stocks of infectious agents from laboratories, waste from survey and autopsy on patients in isolation wards and dialysis from infected patients.
6. **Sharps:** Includes items like disposable needles, syringes, saws, blades, broken glasses, nails, or any other item that could cause a cut. These are simply devices with sharp edges capable of piercing or cutting the skin.
7. **Pharmaceuticals waste:** This includes pharmaceutical products, drug and chemicals that have been returned from wards, spilled, outdated, contaminated, or are no longer required.

Generally, most local authorities have been unable to cope up with collection treatment and disposal of wastes, more so, the hospital wastes. Nairobi, like other cities in the developing world, experiences the problem of waste management.

According to an Intermediate Technology Development Group (ITDG) 2004 Survey, Nairobi City Council (NCC), which has the responsibility of dealing with waste in Nairobi, has a low capacity of effectively disposing the municipal wastes generated within it. According to the same study, the council

only deals with about 0.6% of total waste within the city, the majority of which is openly dumped at Dandora dumpsite "a haven of disaster in waiting!"
As such, waste is evident in every corner one turns, whether in the city centre or in the estates, not to mention the social institutions such as hospitals, schools, colleges and other institution of higher learning. Hospitals are thus one of the major institutions and industries in Kenya that seriously face the problem of waste management in Nairobi.

1.2Statement of the Research Problem

Nairobi like all other cities in the developing countries is experiencing a phenomenal growth in urban population, (refer to Table 2). This is attributed to rural–urban migration, natural increases, expansion of the city boundary and immigrants from neighbouring war and famine stricken countries (refugees). According to the population census (1999), Nairobi had 2.1 million people. The resulting population pressure has led to greater demand for more infrastructural services, provision of clean water, waste removal and adequate housing. Also attributed to high population pressure in Nairobi is the multiplication of health centres, most of which have not been well planned to face the challenge of hygienically managing the waste generated within them. With the problem of lack of space and corruption, illegal operation of hospitals has cropped up especially within the city centre and slum areas.

When humans are beset with physiological problems, one thing more often than others come up. They have to go to a hospital. They have to consult a doctor there and undergo the tests that they have to do. In short, the hospital for people is an institution of healing, a center for well-being. Hospitals are viewed more or less within this framework.

Have people ever dared to think of the hospital as a source of very dangerous wastes capable of spreading an epidemic? Well, the over-all operations of a health institution inevitably produce wastes. These wastes, like ordinary

wastes, have to be disposed. This is the focal point of this study: How do hospitals manage their wastes?

This study aims to assess the current hospital waste management system in Nairobi City. This is intended to assist both the city and individual medical institutions to improve on waste management. This is expected to awaken people's awareness on the risks involved as well as to remind the authorities concerned to come up with a well-designed waste policy that is both affordable and feasible. Hospitals have a duty to care for our environment and for public health in relation to the waste they produce. Hospital waste includes all the wastes generated by health care establishments, research facilities and laboratories. Between 75% and 90% of the waste produced by hospitals is general waste comparable to domestic waste. The remaining 10-25% of waste produced is hazardous waste (Table 1).

TABLE 1: Categories of hospital Waste

Waste Category	Description
Infectious waste	Waste suspected to contain pathogens Human tissues or fluids
Pathological Waste	Human tissues or fluids
Sharps	Includes needles, syringes and other sharp objects.
Pharmaceutical Waste	Waste containing Pharmaceuticals
Chemical waste	Waste containing Chemical Substances
Radioactive Waste	Waste containing radioactive substances

- What are the common types of wastes generated in hospitals in Nairobi?
- What are the types of containers used in the collection of the different types of hospital wastes within the health facilities?
- What are the various methods used in the disposal of the different types of hospital waste?
- What are the environmental implications associated with the generation, handling and disposal of the hospital wastes?

The study has also given suitable recommendations for proper management of wastes in health facilities and other related institutions in the city. This will be helpful to policy makers for adoption. Lastly, the research has highlighted areas that need further research as far as waste management systems in urban centres is concerned.

TABLE 2: DISTRIBUTION OF POPULATION BY PROVINCE (1969 – 1999)

Province	**1969**	**1979**	**1989**	**1999**
Nairobi	**509,289**	**827,775**	**1,324,570**	**2,143,254**
Central	1,675,647	2,345,833	3,111,255	3,724,159
Coast	944,082	1,342,794	1,825,761	2,487,264
Eastern	1,907,301	2,719,851	3,768,689	4,631,779
North Eastern	245,757	373,787	371,391	962,143
Nyanza	2,122,045	2,643,956	3,507,160	4,392,196
Rift Valley	2,210,289	3,240,402	4,917,551	6,987,036
Western	1,328,298	1,832,663	2,622,397	3,358,776
KENYA	**10,942,705**	**15,327,061**	**21,448,774**	**28,686,607**

Source: Kenya Population Census' Report, 1999

Nairobi and Rift Valley Provinces' populations have increased considerably since 1969 because they have benefited from considerable urban immigration.

TABLE 3: INTERCENSAL GROWTH RATES (in %)

PROVINCE	1969 – 1979	1979 – 1989	1989 - 1999
Nairobi	**4.9**	**4.7**	**4.8**
Central	3.4	2.8	1.8
Coast	3.5	3.1	3.1
Eastern	3.5	3.3	2.1
North Eastern	4.2	2.8	2.3
Nyanza	2.2	2.8	2.3
Rift Valley	3.8	4.2	3.5
Western	3.2	3.6	2.5
KENYA	**3.4**	**3.4**	**2.9**

Source: Kenya Population Census' Report, 1999

1.3 Objectives of the Study

a. General Aim

To study waste management in selected hospitals in Nairobi city

b. Specific Objectives

i) To identify major types of wastes generated by hospitals in different parts of Nairobi

ii) To find out the methods of waste collection in hospitals

iii) To investigate the various methods of waste disposal in different hospitals within the City.

iv) To establish the environmental implications associated with various disposal methods of hospital waste.

v) To suggest appropriate recommendations for policy makers on sustainable management of hospital waste, and suggest areas for further

research.

1.4 Research Hypotheses

H_o: Generation of hospital wastes in selected health facilities in Nairobi is not significantly different.

H_1: Alternative.

H_o: Containers for collection of different types of wastes from health facilities are not

significantly different.

H_1: Alternative

H_o: Methods of hospital waste collection are similar in different parts of Nairobi.

H_1: Alternative

H_o: Methods of disposal of different types of hospital waste adopted by health facilities in Nairobi are not significantly different.

H_1: Alternative.

H_o: Waste disposal methods in hospitals in various areas of Nairobi are not significantly different.

H_1: Alternative.

1.5 Justification of the Research

Until late 1999, there was no specific framework on environmental legislation. The Environmental Management and Co-ordination Act (EMCA), 1999 is a critical component for sustainable environmental management. This is because it establishes national environmental principles and provides guidance and coherence to good environmental management. It further deals with cross-

sectional issues such as overall environmental policy formulation, environmental planning, protection and conservation of the environment, environmental impact assessment, environmental quality monitoring, environmental quality standards and environmental quality orders, institutional co-ordination, and conflict resolution. EMCA (`1999) does not allow dumping or discharge of pollutants into the aquatic environment. A person who discharges or applies radioactive waste or other pollutants shall be guilty of an offence, which bears any of these penalties.

a A fine of not more than Kshs. 1 million

b Imprisonment for a term of not more than 2 years

c Both such fine and imprisonment.

By induction, it is clear that these regulations also apply to hospitals in terms of waste generation, management and ultimate disposal.

Horror of 20 foetuses found at city dumpsite

Shocked residents stare at the foetuses found dumped at a garbage site in Eastleigh yesterday.

Despite the clarity of the Act as far as management and disposal of waste is concerned, a deficiency in the management of the same is pronounced all over the country. Nairobi is much affected with a population of over 2.1 million people (Population Census, 1999). In May 2004, fifteen foetuses, most likely from a health centre in Nairobi, were found just about to be dumped in Nairobi River (May 26th 2004, Daily Nation page 1). This is a show of negligence in waste

management systems in the hospitals because the foetuses just like other dead human beings deserve dignity in their disposal, and should not be mixed and dumped together with plastics and other types of waste generated in the hospitals. Plastic papers and several other types of wastes can be observed almost everywhere. The dumpsite at Dandora is full of all kinds of solid wastes both hazardous and non-hazardous and, both biodegradable and non-biodegradable.

This shows clearly that management of wastes within the city including the hospitals is in a mess.

Despite the benefits that occur with the existence of hospitals, their negative aspects cannot be ignored, more specifically the role they play in adding pollutants in form of wastes to the environment. Open dumping is neither safe nor hygienic, and it does not make sense to transfer a health risk from the source area to nearby suburbs and refer to it as waste management. Many people are infected and have died of diseases, which are attributed to poor handling of wastes. Agricultural productivity in city hinterlands is also a victim, and so are various species of life in terrestrial and aquatic systems. The current state of Nairobi River and dams, coupled with the current state of the city hospitals raises concern about the safety and efficiency in the handling and management of wastes that are generated within them.

Most of the previous researches have concentrated on the holistic study of solid wastes management within the city of Nairobi especially in the residential estates, the Central Business District (CBD) and in the industrial area (sector), however, very few have been institutionalized. The proposed research is thus, justified to investigate waste management systems in hospitals within the city. Therefore, the study aims to fill the gap in institutionalized research on waste management in the city of Nairobi.

1.6 Scope and Limitation of the Study

The study has been based on investigation of the different methods of hospital waste collection, management and disposal that are being used within the city of Nairobi. There are various forms of waste generated in hospitals namely; liquid, sludge, solids and gaseous, however, this study has not comprehensively considered liquid and gaseous wastes. Despite the fact that wastes emanate from virtually all institutions that people operate; this study has only dealt with those originating from health care institutions.

Similarly, the study has restricted itself to its main objectives, studying the major types of wastes generated in hospitals, the various methods of collection in the hospitals, and the methods of disposal of these wastes generated from the hospitals. In addition, the study has established the environmental implication associated with the various waste disposal methods. This study has involved only selected hospitals in the city. This is to allow in-depth investigation of the problems of waste management in hospitals. However, these are expected to give an accurate representation of the ideal situations existing in other hospitals within the city and elsewhere in the country.

Due to the fact that illegal dumping of hospital wastes has received immense publicity of late, especially after the last year incidence of the 15 foetuses, which were recovered as they were about to be dumped in Nairobi River, the research has been faced with hostility and lack of maximum cooperation from medical officers and staff (employees) of various health facilities. Again, isolation of effects of hospital wastes from the effects of wastes from other sources on the environment once both are combined in one dumping site is problematic. However, in spite of these, the study has involved a thorough inquest and as such it has succeeded in providing a representative discussion on the issues of concern.

1.7 Definition of Terms /Operational Concepts

Hospital: According to the "Heritage Illustrated Dictionary of the English Language, International Edition (1975)", a hospital is an institution providing medical or surgical care and treatment for the sick and the injured. The present study considers clinics, nursing homes, and dispensaries as hospitals.

Waste: This refers to any useless, unwanted or discarded material. It may be a liquid, solid or gas. Examples include used unreturnable bottles, worn out appliances, sewage sludge, and mining and industrial waste among many other forms of waste.

Hospital Waste: these are discarded materials that are generated within the hospitals. They include potentially pathological materials such as used bandages, needles, syringes and items contaminated with fluids including blood.

Hazardous Waste: these include any discarded materials that may pose a substantial threat or potential hazard to human health or the environment when improperly handled. They include a variety of toxic, ignitable, corrosive, or dangerously reactive substances such as acids, cyanides, pesticides, solvents from drycleaners, compounds of lead, mercury, arsenic, and cadmium, soil contaminated with PCBs and dioxin; infectious wastes from hospitals and research laboratories; improperly treated sewage sludge, obsolete explosives, herbicides, and low and high level radioactive materials.

Environment: According to the "Heritage Illustrated Dictionary of the English Language (1975)", the word "environment" refers to the following:

1. Something that surrounds an organism.
2. The total of circumstances surrounding an organism or group of organisms, especially;

a The combination of external or extrinsic physical conditions that affect and influence the growth and development of organisms.

b The complex of social and cultural conditions affecting the nature of an individual or community.

For this study, the word "environment" refers to the biophysical and socio-economic and cultural factors that surrounds and influence the life of an organism as shown in figure 1.

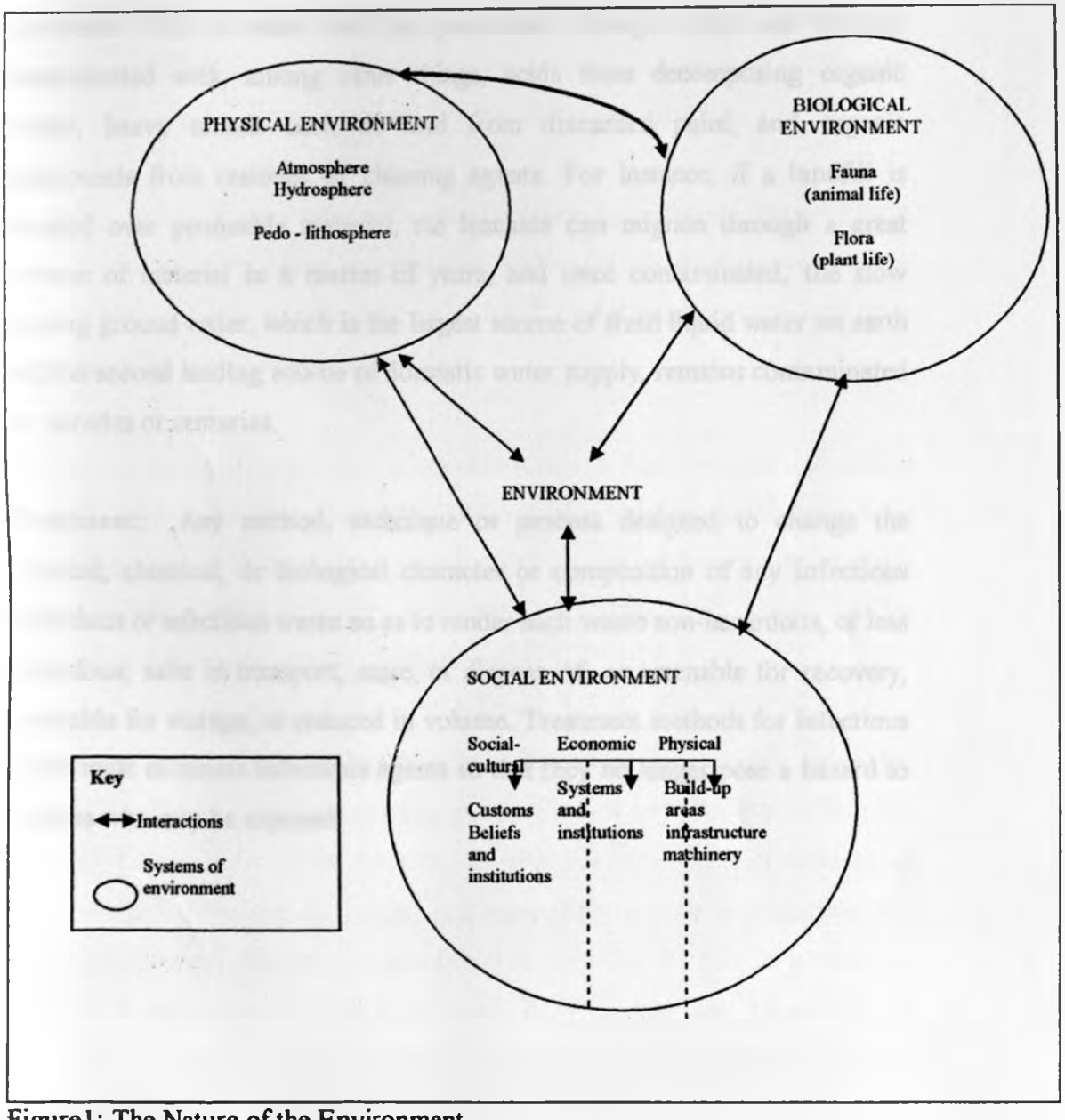


Figure1: The Nature of the Environment,

Source: Muthoka, M.B, Rego, A.E, Rimbui, Z.K (2005)

Disposal: According to "Webster's' Intermediate Dictionary", the word 'disposal' means getting rid of something or putting something out of the way. For this study, disposal means getting rid in a safe manner of waste generated from hospitals. Examples of disposal methods for these wastes include incineration, land filling, composting, and open dumping among others.

Leachate: This is water that has percolated through waste and become contaminated with, among other things, acids from decomposing organic matter, heavy metals such as lead from discarded paint, and organic compounds from residues of cleaning agents. For instance, if a landfill is situated over permeable material, the leachate can migrate through a great volume of material in a matter of years, and once contaminated, the slow moving ground water, which is the largest source of fresh liquid water on earth and the second leading source of domestic water supply, remains contaminated for decades or centuries.

Treatment: Any method, technique or process designed to change the physical, chemical, or biological character or composition of any infectious hazardous or infectious waste so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume. Treatment methods for infectious waste must eliminate infectious agents so that they no longer pose a hazard to persons who may be exposed.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

The aim of this literature review is to show the contribution of past research in this area of study, with a view of pointing out strength, weaknesses and gaps in their contributions and how relevant they are to the present study.

Globally, several studies have been done on waste management practices most of which are incorporated in published textbooks on environment. These studies have focused on effluents, solid, liquid and gaseous wastes, and their impacts on the environment as a whole.

Literature on waste management is broad in scope for both developed countries as well as for developing countries. However, few specific studies have been done that attempts to solve the inherent problems related to urban solid waste management, particularly for developing countries and more so on institutionalized wastes such as hospital waste.

Marsh and Grossa Jr. (2000), describe solid waste as assorted, discarded materials variously described as trash, garbage, refuse and litter from urban and rural land uses. They further note that in most countries the vast majority of solid waste is produced by mining and agriculture mainly at extraction and production sites. However, the duo failed to consider the role of institutions such as hospitals in the waste problem. They ignored the potentiality of hospitals as producers of most of the harmful wastes including hazardous wastes.

It has been argued that solid waste is an unofficial measure of prosperity in a nation, but that individual differences within societies must still be considered. For instance, Americans are said to be the highest producers of solid waste on earth, yet America has not produced the dirtiest cities on earth (Rosenbaum, 1974; Sada 1977). Consequently, the volume of solid waste visible in the cities of developing countries, like Nigeria, cannot be taken as an indicator of prosperity (Akinbami, et al). On the contrary, it reveals the inability of local urban authorities to manage these inevitable products of development.

2.2 Waste Stream Analysis

Luis and Clarence, (1985) argue that a thorough understanding of the characteristics of the waste is a prior requisite to the making of a rational decision on waste management. Hence a sound composition survey is important. The duo contends that a survey of composition is essential to the determination of the dimensions of key elements in waste management. According to Luis and Clarence, a full knowledge of the composition of the waste is an essential element in:

- The selection of the type of storage and transport most appropriate to a given situation.
- The determination of the potential for resource recovery.
- The determination of the environmental impact exerted by the waste if they are improperly managed.

According to Sada (1977) waste is divided into three major classes; gaseous, liquid and solid waste. The sensitivity of different societies to each of these kinds of waste varies depending on the level of public awareness, technology and social – economic development, development ideologies and philosophy. The present study while dealing with hospital waste considers specifically solid wastes generated from these institutions.

According to World Health Organization – WHO (in www.healthcarewaste.org – 2005) hospital wastes are categorized according to their weight, density and constituents into seven categories namely, general waste, pathological waste, radioactive waste, chemical waste, infectious waste, sharps and pharmaceutical waste. The present study has depended on the classification to carry out an in depth quest into the management of each category of the hospital waste.

Akinbami, et al (1986) agree that solid waste can be put into two major categories, depending on its source; industrial waste and commercial – domestic solid waste industrial waste consists of refuse generated in the course of manufacturing and includes metal scraps, clips, grits from machine shops, saw dust, waste paper, pieces of glass among others. Commercial domestic solid wastes are the by-products of housekeeping activities and consumption. It includes food residues, wrapping paper, empty cans and containers. They went further to note that some of these wastes may be toxic, flammable and some non-biodegradable. According to them, other items such as leaves, bones, cotton rags and various food leftovers are quite biodegradable and constitute more of a nuisance than a danger to the environment, since they can be decomposed by nature. However, this study is not clear on other harmful wastes outside the industrial and commercial domestic groups of waste.

Therefore, waste categorization is very important in any waste management system. It involves the determination of the various types of waste and their quantity for proper planning and management of the system.

2.3 Waste Minimization Strategies

South Pacific Regional Environmental Programme (SPREP) (1999) noted that waste minimization strategies include all actions to reduce the quantity of waste requiring disposal. These actions include: reducing waste at source, reusing materials, recycling waste materials and reducing use of toxic or harmful materials.

Waste minimization has a number of advantages. These are in terms of socio-economic direction, public health concerns and environmental health concerns. These advantages include reduced volume of waste for disposal, reduced cost of collection and disposal, reduced disposal sites maintenance and construction costs, reduced environmental and public health impacts, and reduced costs through more efficient use of resources.

African solid waste experts, researchers and consultants have stressed the need to adopt composting as part of a strategy to improve Municipal Solid Waste Management (MSW) in urban areas (Raymond et al 1996). This emphasis arises from the fact that the compostable fraction of the waste stream in African cities is very high. The organic waste consists of food, vegetables, leaves, and animal droppings generated by households, food vendors, restaurants and markets. The compostable waste can be diverted from the dump and recycled into compost.

However, the issue as far as this study is concerned is whether the waste minimization strategies echoed by these scholars, researchers and consultants are also practicable when it comes to hospital waste considering the situation surrounding their generation and the level of toxicity in most of them.

2.4 Waste Separation and Collection

Feinbaum and Gehi (1995), in their study to validate the logistics of source separation of waste found out that in 1990, Alameda County, California waste management plans estimated that about 4-7% of the county's waste stream were food residues from commercial and industrial sources most of which could be kept out of landfills. This would substantially reduce the cost of landfill construction and maintenance in the county.

Chanyasak and Kubota (1983) in the study "Source Separation of Garbage for Composting" discovered that the application of composting to municipal refuse has been very limited mainly because of the large quantity of biologically non-

biodegradable materials (e.g. plastics, and toxic heavy metals) in municipal refuse, which seriously restricts the use of compost product. They concluded that the source separation maybe the only satisfactory answer to the start of proper waste management system.

For hospital waste, which in constituents is more varied, source separation is really very crucial in sound management of the waste.

Baun and Parker (1974), noted that the collection of transportation to the point of disposal and that the method of collection of the waste is related to the method of disposal. This study was done in the United States of America and Europe, which are in the developed world. The present study has tried to investigate collection of waste in hospitals of a developing country.

2.5 Hospital Waste Management

According to Habitat (1990), managing solid wastes is one of the costly urban services to provide as it generally absorbs up to 1% of the Gross Domestic Product (GDP) and 20 to 40% of municipal revenues in developing countries. The research further notes that the objectives of authorities should be to remove and dispose of solid wastes safely, reliably and cost effectively. It is upon this objective that the present research has investigated to what level the hospital authorities are complying to waste management ethics.

UN (1992), defines solid waste as consisting of that waste generated from household, industries, hotels, hospitals, as well as those from the streets and gardens, solid waste treatment plants and from the digging of pit latrines. It also includes waste from all domestic refuse and non-hazardous solid wastes. It defines solid waste management as the discipline associated with the control of generation, storage and disposal of solid waste in accordance with the best principle of public health, economies, engineering, conservation, aesthetics and other environmental considerations which is also responsive to public attitudes

in its scope. This definition by UN considers hospitals as one of the major sources of solid wastes and therefore goes together with the present study's aim of studying waste management in hospitals of which solid waste is an important component.

Holmes (1981) noted that the local authorities in many developing countries are responsible for waste disposal. But the question is "are the local authorities also responsible for the disposal of hospital wastes?" The present study intends to answer this question more because hospital wastes are diverse in composition and far much different from the common refuse of municipal and domestic activities. Most of them are hazardous and therefore require special attention.

Holmes (1983), in a different publication, "The option facing the public authorities in disposal and recovery of municipal waste" notes that to many committed people, the public authorities may seem to adapt philistine and insensitive attitudes to waste management or persist in pursuing cheap and seemingly irresponsible courses of action. His view is that though the authorities are faced with pressures from the general public, they are constrained to operate a vital public service in an efficient and economic way. This study considers the views of Holmes and relates them to operations of both public and private hospitals

Oweis and Khera (1990) in "Geotechnology of Waste Management", mention pharmaceuticals as one source of industrial waste. The duo however, do not give a specific and in depth study on various pharmaceutical wastes, their sources, how they are handled, and their ultimate disposal. The present research has tried to specifically study hospital wastes from generation to disposal. Oweis and Khera concluded that the amount of waste generated and the type of hazardous materials present in the waste stream increases with increasing industrialization of the country. This calls for a detailed study

focused on a country and its waste management systems from generation to disposal.

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

SPREP (1999) outlines the steps to go about the planning process from an integrated waste management plan in the small island developing states in the Pacific region. The steps he outlined are general and could be applicable to hospital waste management system. The steps are as follows:

1. Knowing what one is dealing with i.e. understanding the source of waste, how it enters the country, the quantity and nature of the material generated. This information is essential for sound waste planning.
2. Consulting widely i.e. seeking the views of people and organizations currently involved in waste management.
3. Setting of objectives of the waste management plan. These objectives should be clear and widely agreed. They make clear what the plan is trying to achieve, provide target against which its success can be measured and will assist in setting priorities for action.
4. Identification of actions needed to overcome the obstacles and achieve each

objective.

5. Prioritisation of the actions. Ideally all the actions would be implemented at once, but this is unlikely to be the case. Inevitably constraints of money and labour will require implementation of the plan over a number of years. It will be necessary to set priorities. Consider the benefits arising from an objective, the obstacles to achieving it and the resources available. Then sort the actions into the immediately achievable, the medium tern and the long term.
6. Getting agreement on the plan. As the plan is taking shape, the solutions proposed will not only be technical, for example requiring new equipment. There will be social and cultural issues also to be addressed. This requires the involvement of many stakeholders. The roles of the stakeholders and budget provision should be made and agreed.
7. Implementation of the waste management plan.
8. Reviewing the progress to ensure it is working. This requires periodic reviewing and updating.

2.6 Waste Management Systems Specific to Kenya

In Kenya, a number of studies have focused on the effect of waste on the environment. Most of these studies have been carried out in the major urban centres of the country and the studies have been inclined towards municipal, domestic and industrial wastes leaving behind hospital wastes.

Rimbui (1988) asserted that over the years, the issue of solid waste management has featured prominently, both locally and internationally because it poses a danger to the environment. She further observes that the rate of generating waste is so high that even the available technologies of waste management cannot cope with the large volume generated. However, it is important to note that human's activities are so complex that natural process are no longer able to cope with them especially where non-biodegradable materials are involved, it is also prudent to recognize the role of technology in

"reduce waste, reuse and recycle", all of which Rimbui overlooked.

According to Ikonya (1991), urban waste can be categorized into four groupings as listed below:

i) Household garbage and rubbish: This refers to domestic or residential solid wastes consisting of kitchens solid wastes such as vegetables, potato peelings, carrot peelings, food remains, waste papers, tins, and bottles among others.
ii) Commercial refuse: These consists of solid wastes from stores, offices, fuel service stations, restaurants, warehouses and hotels, packaging materials and containers, used office supplies and food solid wastes.
iii) Sanitary residuals: These include residues from latrines, municipality, households, and open drains cleaning night soils. Night soils are the wastes that accumulate in the sanitation system (and most commonly collected at night) and workers have a tendency to dump the night soil in the closed possible inconspicuous location relative to their collection area.
iv) Industrial wastes: These consist of wastes from processing and non-processing industries as well as utilities. They comprise of packaging materials, food wastes generated from both domestic, processing, and non-processing industries as well as utilities. This method of categorization as done by Ikonya leaves out the institutional wastes, which have really increased in Kenya, especially those from hospitals. The categorization thus ignores the role of wastes from hospitals in environmental degradation in Kenya.

Otiende et al editors (1991) noted that uncontrolled dumping of toxic wastes such as outdated or expired medicine is common. The argued that these are sometimes picked up by scavengers and occasionally re-sold on the black market, where they often carry infectious diseases, which are easily transmitted by humans and animals scavenging on the dump site. Even though Otiende and

his colleagues recognized the danger associated with improper disposal of expired drugs, they fail to mention other wastes from hospitals, which can also pose the same threat to people and the environment. The present study in filling this gap has holistically dealt with waste from hospitals and the channel they follow up to their final destination (disposal).

Lastly, Makokha (2002) stated that most hospitals are affected by financial constraints, which limit their efforts to improve on the waste management methods in the premises. The present study has tried to investigate whether the argument is true for both public and private hospitals, and also to find out if there are other underlying factors, that negatively affect sound solid waste management in hospitals. Makokha's recommendation for a more detailed assessment on the environmental impacts of waste from hospitals, and consequent advice to the hospital management authorities on the effective waste management systems which have the least effects on the environment formed part of the trigger for the present research.

Recently, it has come to the realization of scholars and researchers that there exist poor waste management systems in hospitals and health centres in the country. This was brought to light by the media in early 2004, when 25 foetuses and other wastes from an unknown hospital were found wrapped in black polythene bags ready to be dumped in Nairobi River. Then, it did not last long before another 20 were found in a dumping site in Eastleigh estate (East African Standard, Saturday September 11, 2004, back page). These and many other incidences have increased concern not only on the waste management systems in hospitals, but also on the composition of hospital wastes. These incidences have triggered research on hospital waste management including the present study.

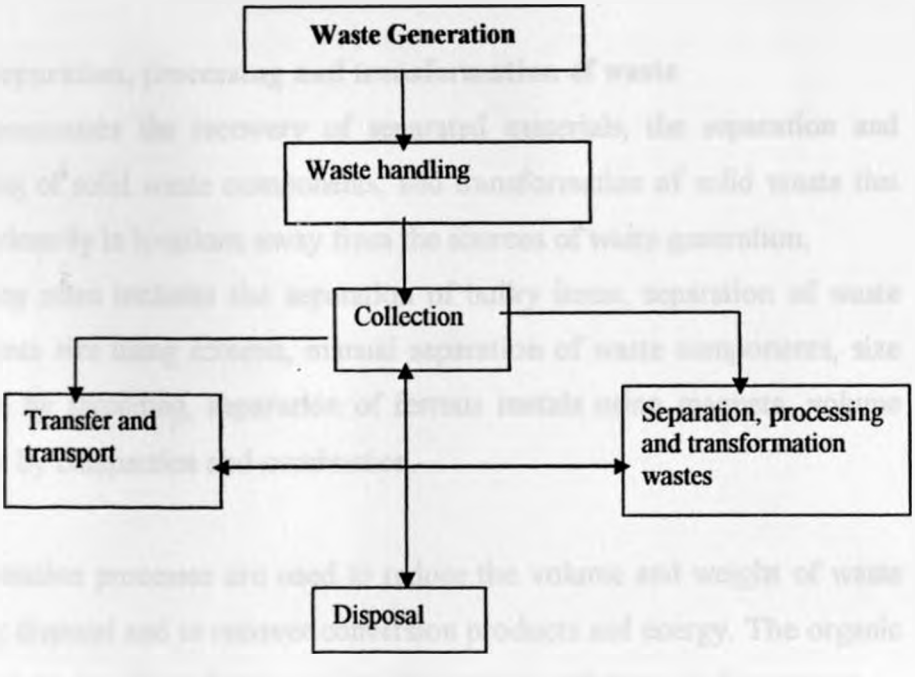
2.7 Theoretical Framework

A good understanding of the waste steam is extremely important in designing a sustainable waste management system.

In a waste management system, there are six functional elements that need to be considered (Tchobanoglous, 1993). These are:

i) Waste generation
ii) Waste handling and separation, storage and processing at the source
iii) Collection
iv) Separation and processing, and transformation of wastes
v) Transfer and transport
vi) Disposal

The interrelationship between the functional elements in a waste management system as outlined in figure 2.



Source: Researcher, 2005

a) Waste Generation:

This encompasses activities in which materials are identified as no longer being of value and are either thrown away or gathered together for disposal.

b) Waste handling and separation (Storage and processing at the source)

Waste handling and separation involves the activities associated with the management of wastes until they are placed in storage containers to point of collection.

Separation of waste component is a very important step in waste management especially if there are materials for reuse and recycling.

b) Waste collection:

This involves the gathering of wastes as well as transportation of these materials, after collection to the location where the collection vehicle is emptied.

c) Separation, processing and transformation of waste

This encompasses the recovery of separated materials, the separation and processing of solid waste components, and transformation of solid waste that occurs primarily in locations away from the sources of waste generation.

Processing often includes the separation of bulky items, separation of waste components size using screens, manual separation of waste components, size reduction by shredding, separation of ferrous metals using magnets, volume reduction by compaction and combustion.

Transformation processes are used to reduce the volume and weight of waste requiring disposal and to recover conversion products and energy. The organic wastes can be transformed by a variety of chemical and biological processes.

Chemical transformation – involves combustion, which is used in conjunction with the recovery of energy in the form of heat. Biological transformation – involves aerobic composting.

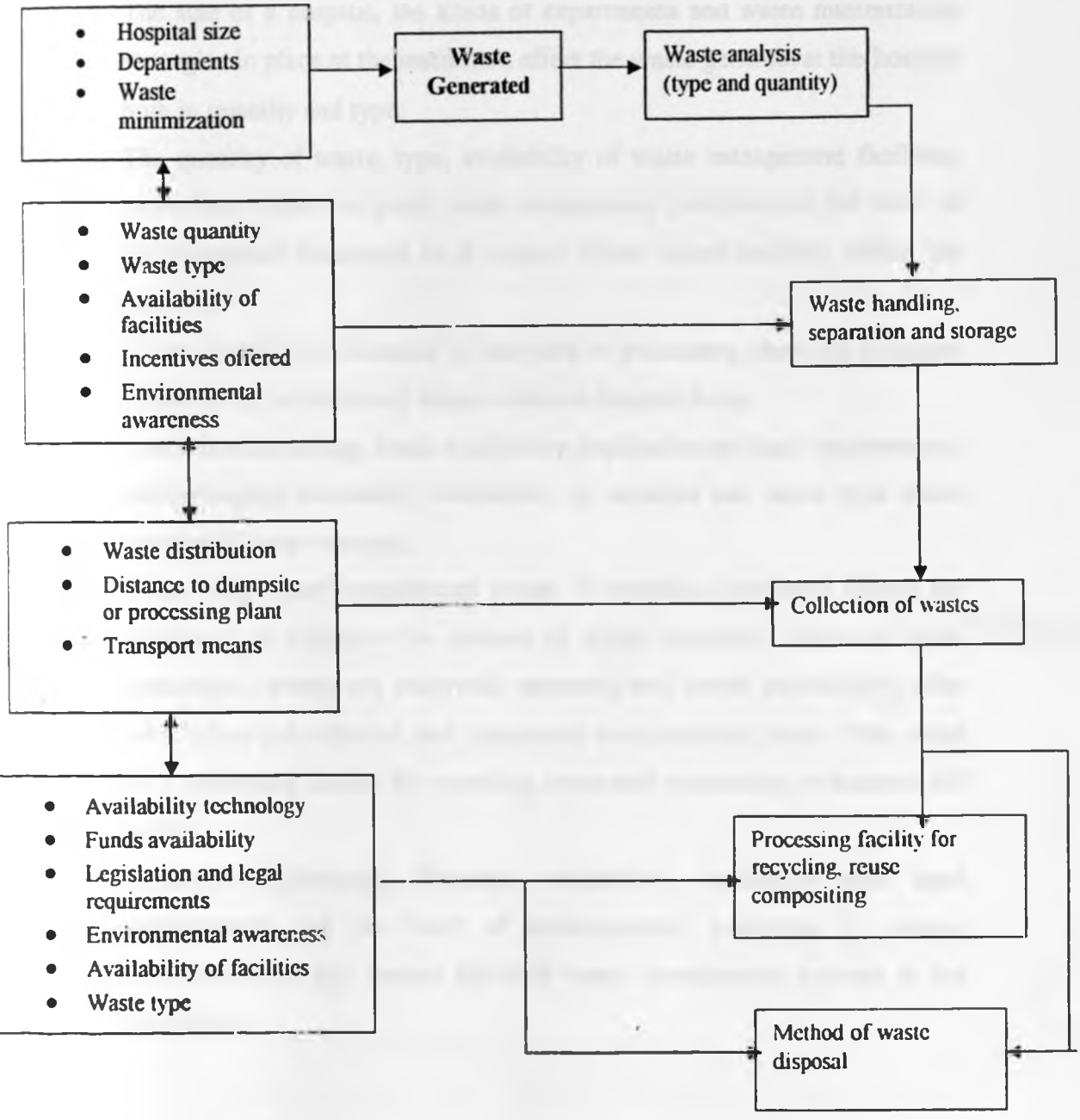
d) Transfer and transport

Transfer usually takes place at a transfer situation, cars, pickups, handcarts, and lorries are used to transport waste or recovered materials to appropriate places.

e) Disposal:

This is the final functional element. A disposal site should not be creating nuisance or hazard to public health or safety.

2.8 Conceptual Framework as relates to Hospital Waste Management System



Key

⟷ Inter-related impacts

⟶ Effects

Source: Tchobanoglous (1993), modified by Researcher (2005)

Explanation of the Conceptual Framework

The conceptual framework focuses on hospital waste management system, and specifically emphasises on the following aspects:

1. The size of a hospital, the kinds of departments and waste minimization strategies in place at the institution affect the waste generate at the hospital both in quantity and type.
2. The quantity of waste, type, availability of waste management facilities, incentives offered on good waste management practices and the level of environmental awareness in a hospital affect waste handling within the hospital.
3. Waste distribution, distance to dumpsite or processing plant and transport means affect collection of wastes within a hospital setup.
4. Available technology, funds availability, legislation and legal requirements, environmental awareness, availability of facilities and waste type affect method of waste disposal.
5. In an ideal waste management system in hospitals, maximum efforts are employed to minimize the amount of waste generated. However, upon generation, wastes are analyzed, separated and stored accordingly, after which they are collected and transported to appropriate points. This could be a processing facility for recycling, reuse and composting or disposed off safely.
6. Available technology, financial availability, legislation and legal requirements and the level of environmental awareness in various institutions are key factors affecting waste management systems at the institution.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This section describes the procedures that have been followed in conducting the study. Various techniques that will be used in obtaining and analyzing data are outlined. In deciding the best research method for this study, various factors have been taken into consideration including:

- The conditions and situations of respondent
- Time available
- The quickest way to obtain data

3.2 The Study Area

3.2.1 Historical Background and Introduction

The study is in Nairobi city, which is the capital city of Kenya. Nairobi was first established as a transportation centre by the Kenya Uganda Railway Constructors in June 1899 when they reached the site.

Nairobi was developed because of the following reasons:

- It was the last flat land before starting to climb the Kikuyu escarpment and thus was convenient for "rest" and construction of houses and storage of railway components such as rails and cross bars.
- There was an absence of most tropical diseases especially malaria due to reduced temperatures, which could not support most disease vectors like mosquitoes.
- There was clean fresh water from Nairobi River, which could be harvested for domestic use.

- It had a climate very similar to that of Britain hence adaptable by the Europeans.

By July 1899, the Kenya-Uganda Railway headquarters was moved from Mombassa to Nairobi thus increasing its potential for growth due to immigration by labour seekers. Initially, there was no permanent African settlement since the area was a dry season grazing land and a livestock watering point for the indigenous Maasai pastoralists, although seasonal barter trade between the Kikuyu, Dorobo and Maasai took place around this area. Once the railway depot was established, certain spatial structures emerged, such as a railway station, senior railway housing, shopping centre, and Indian Bazaar.

Nairobi is the smallest administrative province in Kenya (refer to figure 2). At present, Nairobi is a centre for economic, administrative, social and cultural functions. It is also the major industrial and commercial centre supported by an extensive transport and communication network, which connects it to all the other parts of the country.

Nairobi is also linked to the rest of the world by airlines through Jomo Kenyatta
International Airport (JKIA). Wilson Airport caters for local trips within the African region.

Nairobi continues to influence the rest of the country at large, especially its immediate catchment areas and districts. It attracts a large share of traders from the neighbouring towns like Kiambu, Limuru, Meru, Naivasha, Nyeri and Machakos among others. The trader's reasons for choosing Nairobi as their trading site include:

- Nairobi offers a large market area. It has a population of approximately 2.1 million (Population Census 1999).
- Nairobi is well linked in terms of communication lines to various parts of

the country. It thus enables movement of goods to and out of Nairobi.

- Increased social interaction with the hinterlands and the city.
- Surplus food crops and other items in the hinterlands of Nairobi find their way into the city.

3.2.2 Location

The area covered by this study (which is Nairobi city), lies within the latitudes $10^0 10'S$ and $10^0 251S$, and longitudes $36^0 40'E$ and $37^0 05'E$. The area is bound by Kiambu town and Kenyatta University in the North, by Ngong town and Ongata Rongai, to the West, by the Nairobi National Park and by the Athi River tributaries to the South and Koma Rock and Kateni area to the East (Refer to figure 1 & 2).

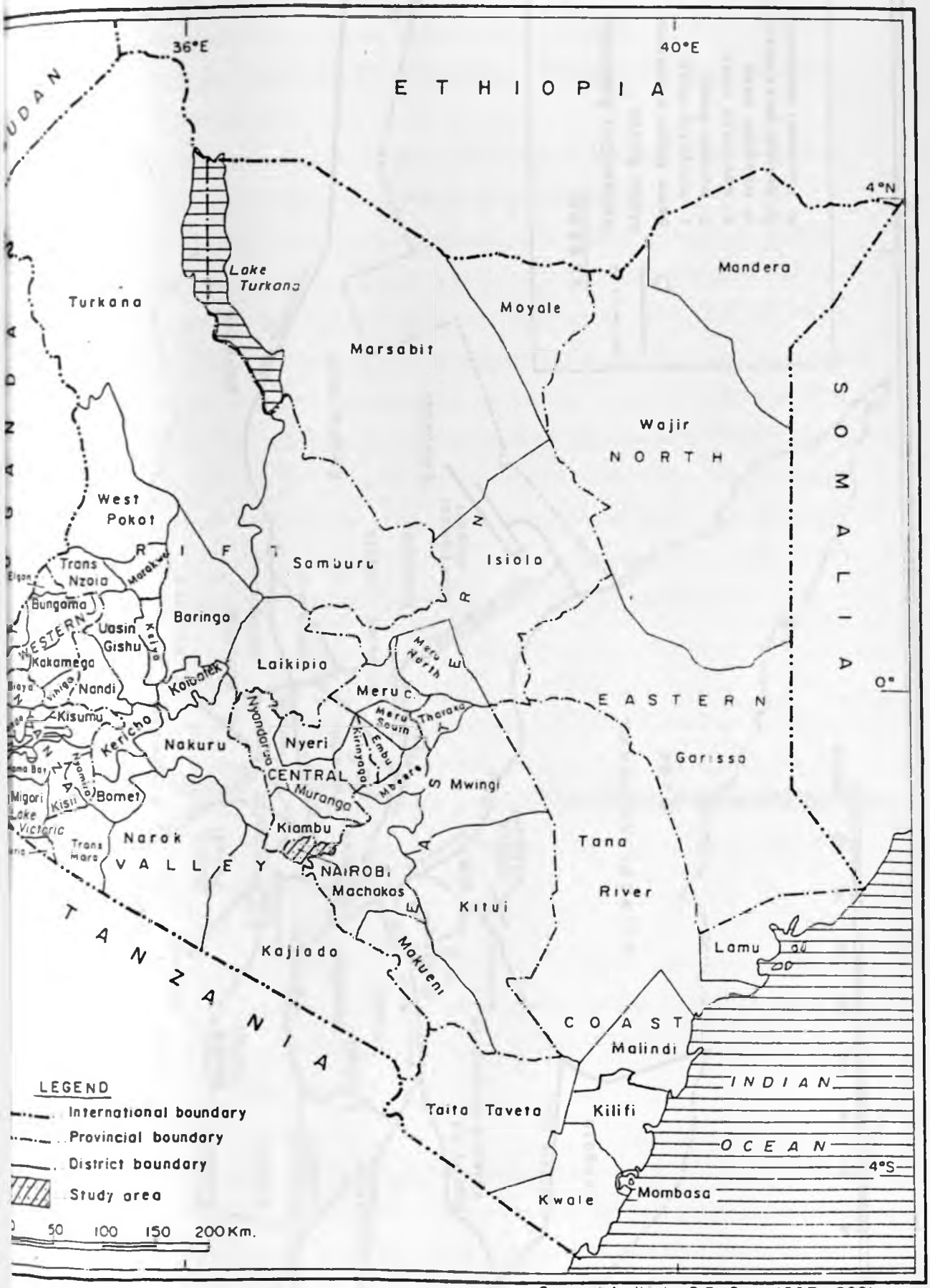
3.2.3 Land Use

Land use in any kind of permanent or cyclic human intervention to supply human needs from the complex of natural and artificial resources, which together area called land. It is the application of human controls in a relatively systematic manner to the key elements within any ecosystem for the purpose of deriving benefits from it and consequently, improving the social welfare of the people.

In Nairobi, land use is very diverse ranging from Central Business District uses, industrial uses, residential uses, recreational uses, transport uses and of interest to this research is institutional land uses.

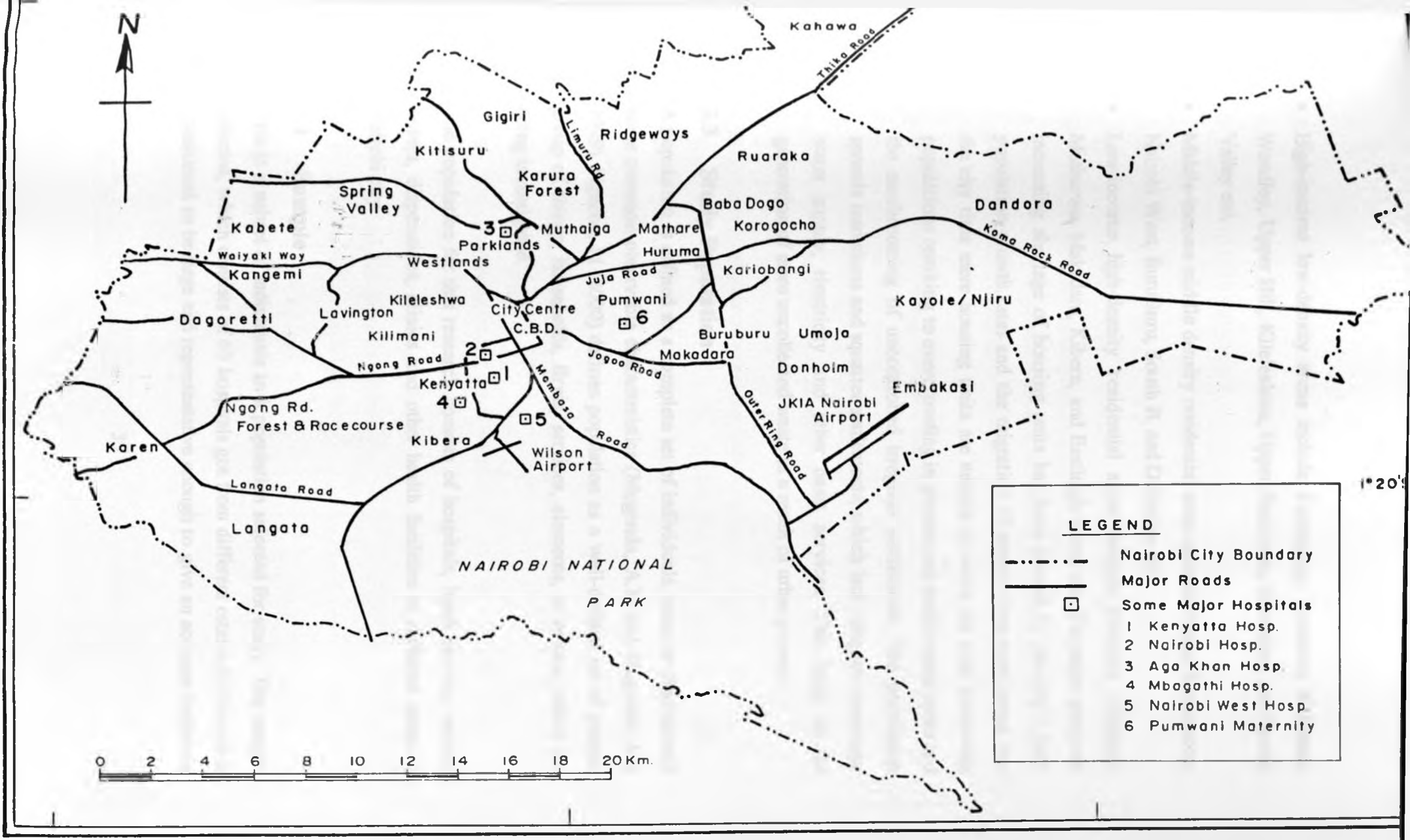
3.2.4 Population and Settlement

The current population of Nairobi is estimated at 2.1 million (Population Census, 1999). As thousands of immigrants stream into Nairobi, they are faced with lack of accommodation. The current population in the city is housed basically in the three main residential zones based on differences in income levels as follows:



0 Kenya: Location of Nairobi

Source: Laikipia D.D. Plan, 1997–2001.


N
Kahawa
Thika Road
Gigiri
Limuru Rd.
Ridgeways
Kitisuru
Ruaraka
Karura Forest
Spring Valley
Baba Dogo
Dandora
Kabete
3
Muthaiga
Mathare
Korogocho
Parklands
Huruma
Waiyaki Way
Westlands
Kangemi
Juja Road
Kariobangi
Komo Rock Road
Kileleshwa
City Centre
Pumwani
Kayole/Njiru
Dagoretti
Lavington
C.B.D.
6
Kilimani
Buruburu
Umoja
2
Jogoo Road
Makadara
Ngong Road
Donholm
Kenyatta
1
Membasa Road
Embakasi
4
5
Outer Ring Road
JKIA Nairobi Airport
Ngong Rd.
Forest & Racecourse
Kibera
Karen
Wilson Airport
Langata Road
Langata
NAIROBI NATIONAL
PARK
1°20'
LEGEND
Nairobi City Boundary
Major Roads
Some Major Hospitals
1 Kenyatta Hosp.
2 Nairobi Hosp.
3 Aga Khan Hosp.
4 Mbagathi Hosp.
5 Nairobi West Hosp.
6 Pumwani Maternity
0 2 4 6 8 10 12 14 16 18 20 Km.

- High-income low-density areas include Lavington, Thomson, Kilimani, Woodley, Upper Hill, Kileleshwa, Upper Parklands, Muthaiga, and Spring Valley etc.
- Middle-income middle density residential areas include Ngara, Racecourse, Nairobi West, BuruBuru, South B, and Donholm etc.
- Low-income high-density residential areas include Dandora, Mathare, Muthurwa, Makadara, Kibera, and Eastleigh South etc. The acute and ever increasing shortage of housing units has been caused by the city's high population growth rates and the migration of people from rural areas into the city thus more housing units are needed to settle the ever increasing populations resulting to overcrowding in private and public rental units and the mushrooming of uncontrolled irregular settlements. The population spreads into slums and squatter settlements, which lack adequate sewerage, water supply, electricity and other basic services. This leads to the generation of more uncollected waste as a result of urban poverty.

3.3 Study Population

A population is defined as a complete set of individuals, cases or objects with some common observable characteristics (Mugenda, A.M and Mugenda A.G 1999). Ngechu, M (2000) defines population as a well-defined set of people, group of things, households, firms, services, elements, or events, which are being investigated.

The population for this research consists of hospitals, heath centres, nursing homes, dispensaries, clinics and other health facilities in different areas in Nairobi city.

3.4 Sample

This is a subset of individuals in a population selected for study. The sample selected, which consists of 60 hospitals got from different estates in Nairobi is considered to be large and representative enough to give an accurate inference

to the entire population characteristics. The research would have wished to take a bigger sample size but due to limited time and resources, the chosen sample size is considered to be big enough.

3.5 Sampling Procedure

As has been mentioned, health facilities in Nairobi city form the population. Due to illegal sprouting up of health centres and private clinics especially in the slums, there is no updated complete list of hospitals, dispensaries, nursing homes, health centres or clinics in Nairobi.

Stratified random sampling has been employed in dividing Nairobi into three strata. This is to take care of the unequal income levels in the city's population. For the purpose of representations in the study, there are four strata from which "hospitals" in the sample have been randomly selected. The strata include:

i. **High Income Residential Areas**:

For the purpose of this study, estates and areas that are normally categorised as middle income residential areas have been considered as high-income residential areas. This is because health facilities in the typical high-income residential areas are very few and as such have been ignored for this study. Therefore the following estates have formed part of the sample from this area.

a Five hospitals from Buruburu Estate
b Five hospitals from Donholm
c Five hospitals from Langata
d Five hospitals from Parklands
e Five hospitals from Westlands

Total: Twenty-five hospitals

ii. **Low Income Residential Areas.**

In this study, the following samples have been drawn from the low-income residential areas.

a Five hospitals from Mathare Estate

b Five hospitals from Kibera

c Five hospitals from Kangemi

d Five hospitals from Kariobangi.

e Five hospitals from Dandora

Total: Twenty-five hospitals

iv. City Centre

Six hospitals drawn from the city centre have been included in the sample.

i. **Others:**

In addition to the already mentioned areas the following hospitals have also been included in the sample as special cases to make the sample as representative as possible: -

a) Kenyatta National Hospital

b) Nairobi Hospital

c) Pumwani Maternity Hospital

Hospitals from the city centre are part of the sample so that the research can capture management of hospital waste within the CBD or the city centre.

Kenyatta National Hospital has been handled as a special case in the research because it is a referral hospital and the biggest in Kenya with the highest population of patients and workers.

Nairobi hospital is considered because it is one of the biggest private hospitals in Kenya with patients from all over East Africa, while; Pumwani has been handled as a special case because it is the biggest low cost maternity hospital in Kenya.

Sample size: 60

3.6 Sampling Technique

The following methods of sampling were used to identify the health facilities that have formed the sample:

i) **Stratified Random Sampling**

This is a type of probability sampling whose goal is to achieve desired representation from various subgroups or characteristics in the population. In this type of sampling, subjects are selected in such a way that the existing subgroups/characteristics in the population are more or less reproduced in the sample. For the present study the main subgroups have been identified in the population depending on the income status of residents of Nairobi, location, and special characteristics that need to be represented for a representative research. From the strata, individual estates from which health facilities have been sampled were selected purposively. This technique was adopted by the researcher because these estates were perceived to have the required information with respect to the objectives of this study. The estates that were purposively selected by the researcher were believed to be informative and that they posses the required characteristics that would make the study as representative as possible.

ii) **Convenient Sampling/Accidental Sampling**

This is a non-probability sampling, which involves selecting cases or units of observations as they come available to the researcher. It is also called volunteer sampling. This method has been used to select individual health centres from the already selected strata. Though this method has a limitation of being a non-probability sampling method, it was adopted because of the nature of the study area, since some parts of the area are not easily accessible and insecure as well.

3.7 Data Collection

Type of Data Collected

The study relied on both primary and secondary data.

a) Primary Data

i) **Field Observation:** These include observations that the researcher makes as he/she carries out the study. General status of the hospital, the conditions of waste collection containers, and the status of the dumping site among other issues are part of data that have been collected through field observation.

ii) **Responses to the Interviews:** These include information that have been got from the senior medical staff (proprietors, doctors, clinical officers etc) of the health facilities during the interviews conducted by the researcher on issues related to hospital waste management that were not exhaustively covered in the questionnaire. Key-Informant Interviews such as with relevant staff at City Hall and the Provincial Medical Office belong to this group too.

iii) **Responses to the Questionnaires:** These include the written answers that the interviewees fill in the questionnaires depending on the requirements to specific questions. Most of the issues regarding waste collection, handling and disposal regarding individual health facilities were collected through this method.

iv) Apart from the above-mentioned sources, any of the first hand information relevant to the study topic has been regarded highly.

b) Secondary Data:

Various secondary data sources have been of use including literature review of published and unpublished works relevant to the study problem, study of

demographic and health surveys and other relevant reports, review of population census and other government reports such as the National Development Plan and Economic Surveys, Hospital reports including admission records etc and relevant baseline map of the study area, figures and photographs.

3.8 Methods of Data Collection

Various methods have been used to collect data during the study, including note taking of observed situations, use of questionnaire, use of key informant interviews and use of photograph among others.

3.9 Nature of Data Collected

The study had five objectives, and data collection was focussed to achieving these objectives.

Objective1: To identify major types of wastes generated by hospitals in different parts of Nairobi city

To achieve this objective a thorough literature review was done to find out the internationally accepted categorisation of hospital wastes. Upon finding out the seven categories of hospital wastes, namely, general wastes, pathological wastes, infectious wastes, radioactive wastes, chemical wastes, sharps and pharmaceutical wastes (as put forward by the World Health Organisation), the research investigated the generation of these types of hospital wastes in the individual health facilities that formed the sample drawn from different areas of Nairobi city. The data collected for this objective stated whether all the hospitals or health facilities drawn from different estates within the city generated all the seven types of wastes or whether some types of wastes are not generated in certain hospitals.

Objective 2: To find out the methods of waste collection in hospitals

To achieve this objective, data was collected on the different waste collection

containers used in the individual health facilities in the sample to collect the various types of wastes. Data on who handles the different types of wastes within the facility was considered too. This was based on the assumption that good management of wastes requires appropriate handling of the same beginning from generation to disposal, and as such, containers used for waste collection and the personnel who handles the wastes at the facility level form important consideration.

Objective 3: To investigate the various methods of waste disposal in different hospitals within the city.

To achieve this objective, data was collected on how the individual health facilities dispose the different types of wastes generated within them. The data collected for this objective specified whether disposal is done within the hospital set up or outside the hospital, and in case of the latter where and how? The research also found out the various private firms, which assist the Nairobi City Council in disposal of wastes within the city.

Objective 4: To establish the environmental implications associated with various hospital waste handling methods

Having collected data on generation of different types of wastes, collection, and disposal methods, the research examined how these practices would impact negatively on the environment in totality. Data on the observed state of the dumping site at Dandora and other illegal dumping sites created especially in the low income residential areas in Nairobi, the physical state of the waste collection containers, the frequency of waste removal from within the facilities, separation of wastes or its absence at the hospitals, and the state of incinerators and other on-site waste disposal devices at the time of the research, among other issues, were all focussed to establishing the environmental implications associated with various hospital waste handling methods.

Objective 5: To suggest appropriate recommendations for policy makers on sustainable management of hospital waste, and suggest areas for further research

Having reviewed literature and thoroughly analysed data on the research topic, the research investigated the knowledge gaps that need to be explored in research. These have been put later in report as areas for further studies. Results of the research have also assisted in providing appropriate recommendations for policy makers and other agencies concerned with waste management. These recommendations are related to sustainable management of waste in general, and to hospital waste in particular. Therefore the mentioned objective has been achieved through a thorough process of study and research.

3. 10 Data Processing and Analysis

Various methods of data analysis and presentation have been used to facilitate interpretation of data. There has been use of both qualitative and quantitative data analysis techniques. In addition, other cartographic methods have been employed.

Preliminary data operations entailed processing of data, cleaning and data reduction. Data was coded for easy capturing using computer-based technique, namely; the Statistical Package for Social Sciences (SPSS)

Data analysis was objective based. Both the quantitative and qualitative techniques have been applied to objectives i, ii, and iii. Verbatim and indirect reporting was used for objective iv and v.

Quantitative analysis entailed use of descriptive statistics; summary counts (frequencies), means and variances. Cartographic presentations such the use of graphs and pie carts has been used to achieve set objectives and afford data

greater meaning. This is largely based on what Bailey calls the theoretical principle; driven by the researchers goals and theory (Bailey 1978). Further data analysis entailed subjecting data to statistical tests with the aim of making inference on relationship between data sets or variables.

3.11 Hypothesis Testing

The statistical theory of probability allows us to prove the hypothesis within a margin of error. Parametric and non-parametric tests have been used to prove whether actual hypothesized relationships between variables really exist. It has also included testing of null hypotheses to test validity of the data. The statistical tests that have been used include Friedman's test and Kruskal – Wallis H test. These have been used to test the general difference in the collection and disposal of the different categories of hospital waste, and to test for difference of hospital waste management in different parts of Nairobi, namely, high income residential areas, low income residential areas, the city centre and in the special cases category which include Kenyatta National Hospital, Pumwani Maternity Hospital and Nairobi Hospital.

CHAPTER FOUR

4.0 MAJOR TYPES OF WASTES, THEIR MANAGEMENT AND IMPACTS

4.1 Introduction

Discussion in this section entails testing of the hypotheses, reporting on research findings and discussions based on the objective.

4.2 RESEARCH FINDINGS

Major Types of Hospital Wastes in Nairobi

Hospital waste is generally defined as any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals, including *but not limited to*:

- Blood-soaked bandages
- Culture dishes and other glassware
- Discarded surgical gloves - after surgery
- Discarded surgical instruments - scalpels
- Needles - used to give shots or draw blood
- Cultures, stocks, swabs used to innoculate cultures
- Removed body organs - tonsils, appendices, limbs, etc.
- Lancets - the little blades the doctor pricks your finger with to get a drop of blood

The amount and type of waste generated by health care activities depends on several factors, including the nature of the operations, the type and size of the facility, and the effectiveness of minimization efforts.

There are seven major classes of hospital wastes. These include:

- General wastes
- Pathological wastes
- Infectious wastes
- Radioactive wastes
- Chemical wastes
- Sharps
- Pharmaceutical waste

First Hypothesis Testing (Ho)

Ho: Generation of hospital wastes in selected health facilities in Nairobi is not significantly different.

H_1: Alternative.

This hypothesis is tested by descriptive statistics as shown in the table below:

Table: 4. Hospital waste generation in Nairobi

Type of Waste	Frequency of Generation	Percentage
General Waste	60	100.0%
Pathological Wastes	42	70.0%
Infectious Wastes	51	85.0%
Radioactive Wastes	6	10.0%
Chemical Wastes	38	63.3%
Sharps	56	93.3%
Pharmaceutical Wastes	51	85.0%

Source: Researcher, 2005

Interpretation

The generation of these wastes in Nairobi is not the same as shown in the table above. General waste is evident in every health facility in Nairobi (100.0%) followed closely by sharps (93.3%). The generation of infectious waste and pharmaceutical wastes is equal at 85.0%. These are followed by pathological waste at 70.0% and chemical waste at 63.3%. The generation of radioactive waste is almost insignificant in the city hospitals (10.0) %.

Therefore, the null hypothesis is rejected as the alternative hypothesis is adopted that the generation of different types of hospital wastes in Nairobi is different.

1) The General Waste

General waste includes all other waste and materials, which have not been exposed to human infectious agents. They are also referred to as solid wastes and they are items that may be recycled or disposed in the trash. Examples are domestic type of waste, packing material, waste water from laundries, and waste from the offices, kitchens, rooms, including bed linen, utensils, paper, drug sachets, etc.

General waste is generated by any health facility in the city as shown in the table above. Its generation depends on the operations of the health facility and the number of departments in the hospital. The composition of general waste varies from plastics, discarded paper from office operations, drug packets and food remains from the kitchen just to mention but a few.

General waste Collection methods

From the study, collection of this type of waste varies a lot especially on the container used for its collection and storage within the health facility before being disposed. Different kinds of containers were found to be used for collection of the general waste.

Table 5: Containers for general waste collection

Container code	Frequency	Percent
1.00	7	11.7
2.00	35	58.3
3.00	5	8.3
5.00	6	10.0
7.00	2	3.3
10.00	5	8.3
Total	**60**	**100.0**

Key

1– Waste paper basket

2 – Dustbin

3 – Pedal bin

5 – Bucket

7 – Carton

10 – Polythene bag

Interpretation of the Table

It is evident from the table that a variety of containers are used for the collection of general waste in different health facilities in Nairobi. The most widely used collection containers for general waste is dustbin (58.3%). The others are waste paper basket (11.7%), bucket (10.0%), pedal bin and polythene bag (each at 8.3%), and lastly carton (10.0%).

The person responsible for the handling of this type of waste in the health facilities also varies depending on the size of the facility. Generally in the bigger facilities (hospitals) there are the domestic staff (cleaners), who are responsible for the emptying of the waste collection containers and subsequently transferring the wastes to a central collection point awaiting disposal. However in the smaller clinics, handling of wastes is a responsibility of the medical staff.

The frequency of emptying the container for the waste collection also varies

depending on the size of the health facility and on the number of patients attended to in the hospital. The larger hospitals with very many patients to attend to per day get their waste collection containers emptied as high as four times per day, while in the smaller clinics they can take up to two weeks before being emptied.

General Waste Disposal

From the study health facilities employ various agencies and methods to dispose the general wastes. So far these agencies and the methods of waste disposal employed by the facilities also vary depending mostly on size of the facility and the location. The agencies for the disposal of general wastes in the city include:

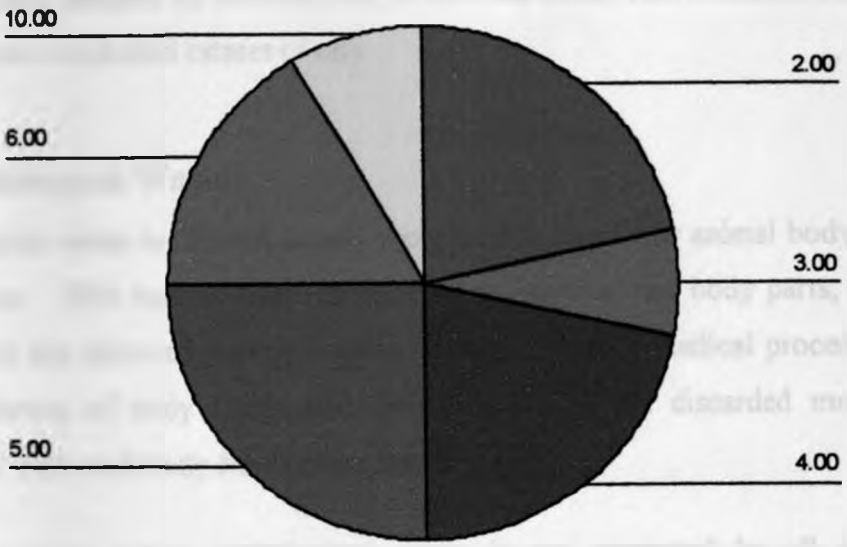
- City Bins
- Green City
- Local (estate based) Youth groups
- Nairobi City Council

The methods of general waste collection adopted by the city health facilities include:

- Incineration
- Open burning

Table 6: General Waste Disposal

Disposal code	Frequency	Percent
2.00	13	21.7
3.00	4	6.7
4.00	13	21.7
5.00	15	25.0
6.00	10	16.7
10.00	5	8.3
Total	60	100.0



Graph 1: Waste Collection Containers

KEY

2 – City Bins	3 – Green City	4 – Local (estate based) Youth Groups
5 – Incineration	6 – Open Burning	10 – Nairobi City Council

Interpretation of the Table & the Graph

From the table and graph above on general waste disposal in the city hospitals, the most method adopted is incineration (25.0%). City Bins and Local (estate based) Youth Groups are widely adopted waste disposal agencies by the city hospitals (each at 21.7%) for those health facilities that do not have incinerators. Open burning is another widely use waste disposal method in Nairobi (16.7%). Other agencies for waste disposal in Nairobi include Nairobi City Council (8.3%) and Green City (6.7%).

Most of the waste disposal agencies transfer the general waste and dispose them at Dandora dump site while some, especially the estate based youth

groups do not have machineries to always transfer the wastes to the dump site, as such some of the wastes are burned in the open, dumped in undeveloped plots of land, dumped by the river and, at the road sides. This is common in the low-income residential estates of city.

2: Pathological Waste:

Pathological waste is defined as any recognizable human or animal body part and tissue. This type of waste include tissue, organs, and body parts, body fluids that are removed during surgery, autopsy, or other medical procedures, or specimens of body fluids and their containers, and discarded material saturated with such body fluids other than urine.

Unlike general waste, pathological waste is not generated by all health facilities in the city as shown in table 4(for waste generation) above. In fact of the 60 health facilities sampled only 36 were found to be generating this type of waste accounting to 60%. Its generation depends on the operations of the health facility and the departments in the hospital.

Pathological Waste Collection

From the study, collection of this type of waste varies a lot especially on the container used for its collection and storage within the health facility before being disposed. Different kinds of containers were found to be used for collection of the pathological waste.

Plate 2: A bucket used as a waste collection container in one of the city health facilities

The different containers used by the different health facilities for collection of pathological waste include

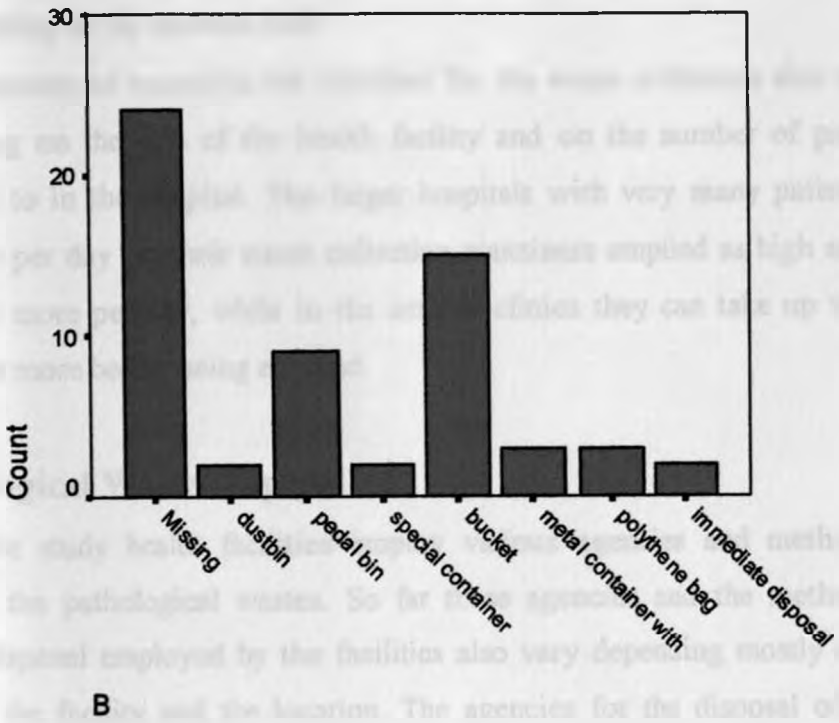
- Dustbin
- Pedal bin
- Special container
- Bucket
- Metal container with lid
- Polythene bag

The use of these containers is as shown in the table 7and graph 2 below.

Table 7: Pathological waste collection containers

Type	Frequency	Percent
Dustbin	2	5.6
Pedal bin	9	25.0
Special container	2	5.6
Bucket	15	41.7
Metal container with lid	3	8.3
Polythene bag	3	8.3
Immediate disposal	2	5.6
Total	**36**	**100.0**

Graph 2: Pathological waste collection containers



Interpretation of Table 7 and Graph 2

It is evident from the table that a variety of containers are used for the collection of pathological waste in different health facilities in Nairobi. The most widely used collection container is a bucket (41.7%), followed by pedal bin at 25.0%. The others are metal container with lid (8.3%), polythene bag (8.3%) and dustbin (5.6%). In some health facilities, pathological waste is disposed immediately it is generated as such they lack containers for waste collection. These account for 5.6% of the health facilities.

As is the case in general waste, the person responsible for the handling of this type of waste in the health facilities also varies depending on the size of the facility. Generally in the bigger facilities (hospitals) there are the domestic staff (cleaners) who are responsible for the emptying of the waste collection containers and subsequently transferring the wastes to a central collection point

awaiting disposal. However in the smaller clinics, handling of wastes is a responsibility of the medical staff.

The frequency of emptying the container for the waste collection also varies depending on the size of the health facility and on the number of patients attended to in the hospital. The larger hospitals with very many patients to attend to per day get their waste collection containers emptied as high as four times or more per day, while in the smaller clinics they can take up to two weeks or more before being emptied.

Pathological Waste Disposal

From the study health facilities employ various agencies and methods to dispose the pathological wastes. So far these agencies and the methods of waste disposal employed by the facilities also vary depending mostly on the size of the facility and the location. The agencies for the disposal of these wastes in the city include:

- City Bins
- Green City
- Local (estate based) Youth groups

The methods of general waste collection adopted by the city health facilities include:

- Incineration
- Open burning
- Open dumping
- Pit disposal (placenta pits and pit latrine)

Table 8: Pathological Waste Disposal

Method	Frequency	Percent
1.00	3	5.0
2.00	10	16.7
3.00	1	1.7
4.00	7	11.7
5.00	19	31.7
6.00	1	1.7
7.00	1	1.7
Total	**42**	**70.0**

KEY

1 – Pit disposal 2 – City Bins 3 – Green City

4 – Local (estate based) Youth Groups 5 – Incineration 6 – Open Burning

7 – Open dumping

Interpretation of Table 8

From the table above on pathological waste disposal in the city hospitals, the most method adopted is incineration (31.7.0%). City Bins and Local (estate based) Youth Groups are widely adopted waste disposal agencies by the city hospitals (16.7% and 11.7% respectively) for those health facilities that do not have incinerators. Open burning and open dumping are also disposal methods employed by some health facilities in the city. They each account for 1.7%. Another agency for pathological waste disposal in Nairobi is Green City (1.7%). This is not a widely used mode in the health facilities.

Most of the waste disposal agencies transfer the general waste and dispose them at Dandora dump site while some, especially the estate based youth groups do not have machinery to always transfer the wastes to the dump site, as

such some of the wastes are burned in the open, dumped in undeveloped plots of land, dumped by the river and, at the road sides. This is common especially in the low-income residential estates of city.

3: Infectious Waste

This is material containing pathogens in sufficient concentrations or quantities that, if exposed, can cause disease. It includes tissue cultures and stocks of infectious agents from laboratories, waste from survey and autopsy on patients in isolation wards and dialysis from infected patients. Hospital waste is considered capable of producing an infectious disease if it has been, or is likely to have been, contaminated by an organism likely to be pathogenic to healthy humans, if such organism is not routinely and freely available in the community, and such organism has a significant probability of being present in sufficient quantities and with sufficient virulence to transmit disease.

Just like the pathological waste, this type of waste is not generated in all the health facilities in the city. In the sample 49 out of the 60 health facilities generate it. This accounts for 85%. This is shown in the table 4 for waste generation. Its generation as is the case with other types of wastes depends on the size of the health facility and the operations in the facility including the number of patients attended to.

Infectious Waste Collection

From the study, collection of this type of waste varies a lot especially on the container used for its collection and storage within the health facility before being disposed. Different kinds of containers were found to be used for collection of the infectious waste.

The different containers used by the different health facilities for collection of infectious waste include

- Dustbin
- Pedal bin
- Special waste paper basket
- Bucket
- Metal container with lid
- Polythene bag

The use of these containers is as shown in the table below.

Table 9: Infectious Waste Collection Containers

Type	Frequency	Percent
Dustbin	4	8.2
Pedal bin	10	20.4
Bucket	25	51.0
Metal container with lid	2	4.1
Special waste paper basket	2	4.1
Polythene bag	5	10.2
Immediate disposal	1	2.0
Total	**49**	**100.0**

Interpretation of Table 9

It is evident from the table that a variety of containers are used for the collection of infectious waste in different health facilities in Nairobi. The most widely used collection containers is bucket (51.0%), followed by pedal bin at20.4%. The others are polythene bag (10.2%) dustbin (8.2%). metal container with lid (4.1%), and special waste paper basket (4.1%). In some health facilities, infectious waste is disposed immediately it is generated as such there are no containers for waste collection. These account for 2.0% of the health facilities.

As is the case in general and pathological wastes, the person responsible for the

handling of this type of waste in the health facilities also varies depending on the size of the facility. Generally in the bigger facilities (hospitals) there are the domestic staff (cleaners) who are responsible for the emptying of the waste collection containers and subsequently transferring the wastes to a central collection point awaiting disposal. However in the smaller clinics, handling of wastes is a responsibility of the medical staff.

The frequency of emptying the container for the waste collection also varies depending on the size of the health facility and on the number of patients attended to in the hospital. The larger hospitals with very many patients to attend to per day get their waste collection containers emptied as high as four times or more per day, while in the smaller clinics they can take up to two weeks or more before being emptied.

Infectious Waste Disposal

From the study health facilities employ various agencies and methods to dispose the infectious wastes. These agencies and the methods of waste disposal employed by the facilities also vary depending mostly on the size of the facility and the location. The agencies for the disposal of these wastes in the city include:

- City Bins
- Green City
- Local (estate based) Youth groups

The methods of general waste collection adopted by the city health facilities include:

- Incineration
- Open burning
- Open dumping
- Pit disposal (placenta pits and pit latrine)

Table 10: Infectious Waste Disposal

Method	Frequency	Percent
1.00	1	2.0
2.00	14	27.5
3.00	1	2.0
4.00	9	17.6
5.00	23	45.1
6.00	2	3.9
7.00	1	2.0
Total	**51**	**100.0**

KEY

1 – Pit disposal 2 – City Bins 3 – Green City

4 – Local (estate based) Youth Groups 5 – Incineration 6 – Open Burning

7 – Open dumping

Interpretation of Table 10

From the table above on infectious waste disposal in the city hospitals, the most method adopted is incineration (45.1%) followed by City Bins and Local (estate based) Youth Groups (27.5% and 17.6 %) for those health facilities that do not have incinerators. Open burning and open dumping are also disposal methods employed by some health facilities in the city. They each account for1.7%. Another agency for pathological waste disposal in Nairobi is Green City (1.7%). This is not a widely used mode in the health facilities.

Most of the waste disposal agencies transfer the general waste and dispose them at Dandora dump site while some, especially the estate based youth groups do not have machineries to always transfer the wastes to the dump site,

as such some of the wastes are burned in the open, dumped in undeveloped plots of land, dumped by the river and, at the road sides. This is common especially in the low-income residential estates of city.

Plate 3: an incinerator in operation at the uon health services clinic at main campus

4: **Radioactive Waste:**

Includes solid, liquid and gaseous wastes contaminated with radioactive substances used in diagnosis and treatment of diseases. Radioactive wastes have some of the possible combination of protons and neutrons in their atomic nuclei that are basically unstable and sooner or later decay to release radiation, which includes alpha particles, beta particles, and gamma rays. There are two types of theses wastes; low-level (LLW) and high-level (HLW) radioactive wastes. Low level radioactive waste are defined as radioactive materials that contain only small amounts of radioactivity and generally consist of a wide variety of items such as residuals or solutions from chemical processing; solid or liquid plant waste, sludges, and acids; and slightly contaminated equipment,

tools, plastic, glass, wood, fabric and other materials.

Most of the LLW generated by health facilities and hospitals falls into several general waste streams: dry solids, organic liquids, aqueous liquids, biological wastes, halogenated compounds, liquid scintillation wastes, and sealed sources

Dry solid wastes consist of contaminated laboratory trash and apparatus, protective clothing, towels, paper, sharps, and packaging materials. Biomedical research facilities may also generate contaminated solid wastes from patient care.

Organic liquids include radioactive wastes that may contain alcohols, ethers, aldehydes, ketones, toluene/benzene/xylene, and other aromatic compounds. Many of these wastes are considered low-level mixed wastes, a category of multihazardous wastes.

Aqueous liquids include washings from contaminated glassware, cell culture media, buffers, and nonhazardous reagents contaminated with radioactive material.

Biological wastes include animal carcasses, human and animal tissues, bedding, excreta, and clinical samples. Radioactive biological wastes that are infectious are considered multihazardous wastes.

Halogenated wastes refer to radioactive wastes that contain regulated concentrations of one or more halogenated organic compounds such as polychlorinated biphenyls, or chloroform. These wastes are classified as mixed wastes, a category of multihazardous waste,

Liquid scintillation wastes are generated when samples containing radioactive materials are analyzed using an organic substance which, when excited by the ionization of the molecules due to interaction with the radiation, emits flashes of light as the molecules fluoresce.

Significant generation of this type of waste is very low in the city. Only 6 out of the 60 health facilities in the sample were found to be generating radioactive

waste in significant quantities. This accounts for only 10% of hospital waste generation in the city. In the health facilities where this type of waste is generated, it is mostly collected in a pedal bin or in bucket. Radioactive wastes from the health facilities are in most cases disposed together with other hospital; waste. As such they can end up being handled by the waste disposal agencies (the City Bins, the Green City, the Nairobi City Council or the local estate based youth groups), or be incinerated, burned in the open, dumped in a pit or openly dumped. In most of the health facilities in the city, the generation of this type of waste is very insignificant and therefore do not see the need for specialised treatment.

5: Chemical Waste:

This comprises of discarded solid, liquid and gaseous chemicals e.g. from diagnosis, experimental work, cleaning, house keeping and disinfecting procedures.

Classification: Chemical wastes may be divided into the following groups:

- Hazardous wastes e.g., flammable solvents, acids, bases, toxic metals.
- Special wastes regulated under other laws e.g. polychlorinated biphenyls, used oil.
- Non-regulated hazardous wastes e.g., ethidium bromide, aflatoxin.
- Chemically contaminated laboratory materials e.g. papers, gloves, glassware
- Non-hazardous chemical wastes e.g., sugars, buffers.

Sources: As a broad generalization, health facilities produce smaller amounts and a larger variety of chemical wastes and mixtures than industry, which produces large amounts of a small number of chemical wastes. The regulated hazardous and special wastes produced by medical laboratories are primarily

mixtures of organic solvents, with lesser amounts of other materials such as used oil, contaminated lab ware, and miscellaneous chemicals.

Activities that result in chemical wastes primarily include

- Disposal of excess, outdated, and off-specification chemicals;
- Molecular biology procedures (e.g., extraction, purification and sequencing of nucleic acids, proteins).
- Analytical procedures (e.g., assays, gel electrophoresis).
- Histological procedures (e.g., fixatives, stains).
- Other experimental uses of chemicals.
- Cleaning and disinfection;
- Care and maintenance of laboratory animals.
- Film processing.
- Facility operations (e.g., paint, floor cleaners, floor strippers, batteries, fluorescent light tubes, and ballasts).
- Disposal of contaminated lab ware and spill clean-up residues.

Chemical waste is not significantly generated in some of the city hospitals. For instance out of the 60 health facilities sampled for the study, this type of waste is present in only 37 facilities, accounting for 63.3%.

Chemical Waste Collection

The chemical wastes in aqueous or liquid form are in most cases poured in special sinks, flushed in the toilet or poured in pit latrines to join the sewage system. In most of these cases, the disposal is immediate and as such there is no need for waste collection container.

In other cases where the waste is in the form of solid or semi solid, a variety of containers are used for its collection. These include the following as shown in the table below.

waste in significant quantities. This accounts for only 10% of hospital waste generation in the city. In the health facilities where this type of waste is generated, it is mostly collected in a pedal bin or in bucket. Radioactive wastes from the health facilities are in most cases disposed together with other hospital; waste. As such they can end up being handled by the waste disposal agencies (the City Bins, the Green City, the Nairobi City Council or the local estate based youth groups), or be incinerated, burned in the open, dumped in a pit or openly dumped. In most of the health facilities in the city, the generation of this type of waste is very insignificant and therefore do not see the need for specialised treatment.

5: Chemical Waste:

This comprises of discarded solid, liquid and gaseous chemicals e.g. from diagnosis, experimental work, cleaning, house keeping and disinfecting procedures.

Classification: Chemical wastes may be divided into the following groups:

- Hazardous wastes e.g., flammable solvents, acids, bases, toxic metals.
- Special wastes regulated under other laws e.g. polychlorinated biphenyls, used oil.
- Non-regulated hazardous wastes e.g., ethidium bromide, aflatoxin.
- Chemically contaminated laboratory materials e.g. papers, gloves, glassware
- Non-hazardous chemical wastes e.g., sugars, buffers.

Sources: As a broad generalization, health facilities produce smaller amounts and a larger variety of chemical wastes and mixtures than industry, which produces large amounts of a small number of chemical wastes. The regulated hazardous and special wastes produced by medical laboratories are primarily

Table 11: Chemical Waste Collection

Type	Frequency	Percent
Pedal bin	4	10.8
Specimen container	2	5.4
Bucket	14	37.8
Metal container with lid	1	2.7
Special waste paper basket	1	2.7
Polythene bag	1	2.7
Immediate disposal	14	37.8
Total	**37**	**100.0**

From the above table, the most commonly used container for waste collection is the bucket (37.8%). Other containers for waste collection include pedal bin (10.8%), specimen container (5.4%), metal container with lid (2.7%), special waste paper basket (2.7%) and polythene bag (2.7%).

Chemical Waste Disposal

As has been mentioned a variety of chemical wastes in the form of liquids and aqueous solutions are disposed to join the sewage system through flush toilets and sinks. Other forms of the chemical wastes were found to be disposed in a variety of ways including the use of waste disposal agencies and methods as outlined in the table below.

...Table 12: Chemical Waste Disposal

Method	Frequency	Percent
1.00	3	7.9
2.00	7	18.4
3.00	1	2.6
4.00	2	5.3
5.00	16	42.1
6.00	1	2.6
8.00	8	21.1
Total	**38**	**100.0**

KEY

1 – Pit disposal (pit latrine, placenta pit, etc.) 2 – City Bins

3 – Green City 4 – Local (estate based) youth groups

5 – Incineration 6 – Open burning

8 – Toilet or sink disposal

From the table above on chemical waste disposal, the widely adopted method for chemical waste (in the form of solids and semi solids) disposal is incineration (42.1%), followed by flash toilet & sink disposal (21.1%), pit disposal (7.9%), and open burning (2.6%). Waste disposal agencies are also contracted by certain health facilities to assist in the disposal of these types of wastes. These include the City Bins (18.4%), the Local (estate based) Youth Groups (5.3%), and the Green City (2.6%).

6: Sharps:

This waste include discarded unused sharps and sharps used in animal or human patient care, medical research, or clinical or pharmaceutical laboratories, hypodermic, intravenous, or other medical needles, hypodermic or intravenous syringes to which a needle or other sharp is still attached, Pasteur pipettes, scalpel blades, or blood vials. This waste also includes other types of broken or unbroken glass (including slides and cover slips) in contact with infectious agents or any other item that could cause a cut. The single most important aspect of sharps which gives rise to fear and apprehension is their inherent ability to cause puncture, wounds and/or lacerations, which may create a portal of entry for infectious agents.

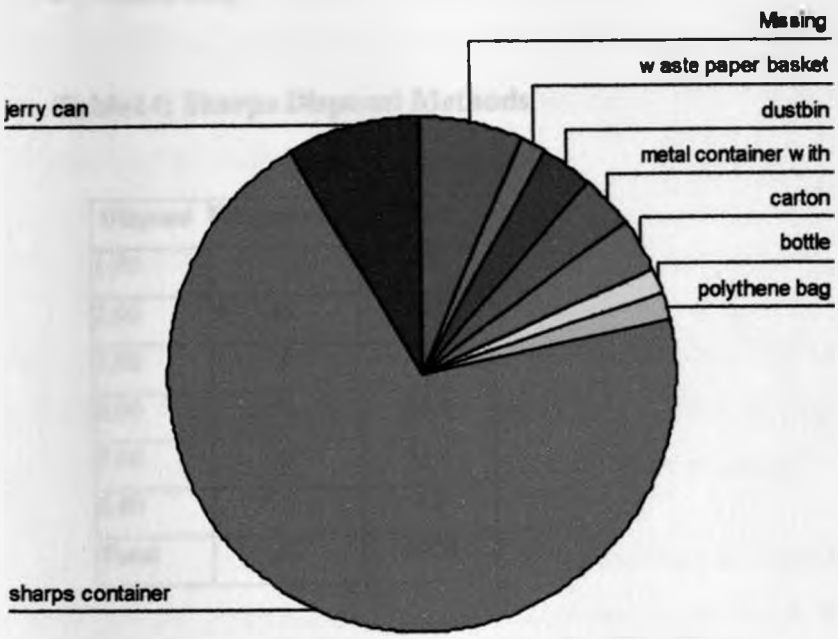
Almost all the health facilities in Nairobi according to this research were found to be generating sharps with the exceptions of strict pharmaceutical shops or retail chemists. From this study, 56 out of the 60 health facilities in the sample generate wastes in the form of sharps in their premises.

Collection of Sharps

As is the case with the other types of wastes in a hospital set up, a number of containers are used in the collection of sharps most of which are not recommended by the Ministry of Health. This is especially evident in the small clinics mostly operated in the low-income residential areas such as in the slums. Nevertheless, most health facilities regardless of their size and areas of operation use the recommended sharps (75.0%) container as illustrated in the table and graph below.

Table 13: Containers for Sharps Collection

Type	Frequency	Percent
Waste paper basket	1	1.8
Dustbin	2	3.6
Metal container with lid	2	3.6
Carton	2	3.6
Bottle	1	1.8
Polythene bag	1	1.8
Recommended Sharps container	42	75.0
Jerry can	5	8.9
Total	**56**	**100.0**



Graph 3: sharps collection containers

Other containers used for sharps collection in the health facilities include:

- Jerry can
- Dust bin
- Metal container with lid
- Carton
- Waste paper basket
- Bottle
- Polythene bag.

However, the use of these containers in the collection of wastes in the form of sharps is low and as such insignificant.

Disposal of Sharps

Different firms are involved in the disposal of sharps within the city of Nairobi. These waste disposal agencies involved in the disposal of sharps include:

- City Bins

- Local Youth Groups
- Green City

Table14: Sharps Disposal Methods

Disposal	Frequency	Percent
1.00	1	1.8
2.00	15	26.8
3.00	1	1.8
4.00	9	16.1
5.00	29	51.8
6.00	1	1.8
Total	56	100.0

KEY

1 – Pit disposal (pit latrine and placenta pit) 2 – City Bins

3 – Green City 4 – Local (estate based) Youth Groups

5 – Incineration 6 – Open burning

The most commonly used method of disposing the sharps from the health facilities in Nairobi is through incineration. The other method for disposal of sharps, which is most likely used in the small clinics especially in the low-income areas is open burning. Some of the waste disposal agencies (e.g. the local youth groups) adopt this method. In this case they employ the use high burning fuels like diesel and petrol to aid in the burning of this type of waste.

7: Pharmaceutical Waste:

This includes pharmaceutical products, drug and chemicals that have been returned from wards, spilled, outdated, contaminated, or are no longer required.

Health facilities directly dispose of small quantities of unused drugs and wastes contaminated with drugs in the course of their operations. The total

amount of drugs disposed of by medical facilities is negligible when compared with that disposed of by society. The pace of biomedical research and development is increasing rapidly, and this has the potential to significantly increase the generation of waste drugs, manufacturing intermediates, and wastes contaminated by these substances.

Sources of Pharmaceutical Wastes

The primary sources of drug wastes are pharmaceutical research, development, and manufacturing, and the use of drugs by patients. Only a very small percentage of the drugs disposed of by facilities and patients is unused.

Pharmaceutical research and development: The quantities and compositions of drug-related wastes generated as s result of activities in the health facilities depend on many factors, including the type of facility.

Drug wastes may be in several forms: unused, expired, and residual drugs as solids and liquids; wastewater from cleaning areas contaminated during the mixing and administration of pharmaceuticals; and solid wastes contaminated with drugs.

Patient excreta: Patient excreta are the primary source of drug contaminants in the environment. A big percentage of a patient's intake of a drug is excreted as unmetabolized drug or active metabolites.

Disposal via wastewater systems: Unused drugs and drug-contaminated liquids such as wastewater from mixing drugs and cleaning areas contaminated with drugs are usually discharged to the sanitary sewer. In most biomedical facilities, wastewater from the preparation of cytotoxic agents is an exception, because it is usually managed and disposed of as medical waste or hazardous waste.

Disposal with general solid wastes: Unused drugs and materials contaminated with drug residues may also be discarded with other solid wastes. Municipalities dispose of these wastes in sanitary landfills or by incineration.

Disposal of unused drugs by patients: Patients accumulate excess, outdated, or unused drugs at home. These are usually disposed of via the sanitary sewer or household trash.

Pharmaceutical waste is generated in almost all the health facilities, which have pharmacies or dispensing chemists. Out of the 60 health facilities sampled for this study in Nairobi, 51 are generating wastes of pharmaceutical origin accounting for 85% of the health facilities.

Pharmaceutical waste Collection

As has been the case with the types of hospital wastes, different containers are adopted by different health facilities for waste collection, some of which might not be recommended by the relevant Ministry. In some health facilities, wastes of pharmaceutical nature are gotten rid of immediately and therefore they don't have container for waste collection of the same as there is no need for it.

Table 15: Pharmaceutical Waste Collection Containers:

Type	Frequency	Percent
Waste paper basket	1	2.0
Dustbin	2	4.0
Bucket	11	22.0
Metal container with lid	3	6.0
Carton	25	50.0
Polythene bag	2	4.0
Immediate disposal	6	12.0
Total	**50**	**100.0**

From the table above the widely used pharmaceutical waste collection container in the health facilities in Nairobi is carton. The use of bucket is also notable in a number of the health facilities. Apart from the two other containers include; dustbin, polythene bag, and waste paper basket in that order.

Pharmaceutical Waste Disposal

Different firms and groups are engaged by different health facilities for the disposal of these types of wastes and the others that have already been discussed. These agencies include:

- City bins
- Local Youth Groups
- Green City

Apart from these agencies, some health facilities prefer to return their wastes of pharmaceutical nature to the manufactures or suppliers of the same.

In addition, pharmaceutical waste is disposed within the facilities through the following methods:

- Flash toilets and sinks
- Incineration
- Pit disposal
- Open burning

Table 16: Means of Pharmaceutical Waste Disposal

Means	Frequency	Percent
1.00	4	7.8
2.00	6	11.8
3.00	2	3.9
4.00	4	7.8
5.00	7	13.7
6.00	3	5.9
8.00	21	41.2
9.00	4	7.8
Total	**51**	**100.0**

KEY

1 – Pit disposal 2 – City Bins 3 – Green City

4 – Local Youth Groups 5 – Incineration 6 – Open burning

8 – Flash toilets and sink 9 – Returned to manufactures and suppliers.

Second Hypothesis Testing:

H_o: Containers for collection of different types of wastes from health facilities are not significantly different.

H_1: Alternative

As has been discussed earlier various containers are used for collection of different types of hospital waste. The present test wants to find out if different containers used for collection of different types of hospital waste in the health facilities.

For this analysis Friedman test is used.

Friedman Test

Friedman's test is a nonparametric test to compare the distributions of two or more quantitative variables. Friedman's test does not treat the two factors symmetrically and it does not test for an interaction between them. Instead, it is a test for whether the columns are different after adjusting for possible row differences. The test is based on an analysis of variance using the ranks of the data across categories of the row factor. This test has been used to test the general difference in the collection and disposal of the different types of hospital waste.

Assumptions of the Friedman Test

- The data is from a small sample.
- The data is importantly non-normally distributed

- The measurement scale of the dependant variable is ordinal (not interval or ratio).

The Test Analysis

This test analysis has been aided by SPSS

Descriptive statistics

	N	Mean	Std. Deviation	Minimum	Maximum
A	6	2.17	0.408	2	3
B	6	3.50	0.837	3	5
C	6	3.50	0.837	3	5
D	6	3.65	1.033	3	5
E	6	5.33	3.882	3	13
F	6	11.00	0.000	11	11
G	6	7.00	0.000	7	7

Ranks

	Mean Rank
A	1.08
B	3.33
C	3.33
D	3.33
E	4.25
F	6.83
G	5.83

Test Statistics

N	6
Chi-Square	31.500
df	6

Interpretation

From the analysis above, the **calculated value** is **31.500**, and the degree of freedom (**df**) is **6**, the **critical value** from the **Chi-Square table** at **0.05 significance level** is **12.59**. Therefore, the calculated value is **greater** than the critical value; hence, the $\mathbf{H_o}$ is **rejected**. The $\mathbf{H_1}$ is thus **adopted** that "Containers for collection of different types of wastes from health facilities are significantly different".

The result implies that the health facilities in Nairobi use different waste containers for collection of different types of wastes.

Third Hypothesis

Ho: Methods of hospital waste collection are similar in different parts of Nairobi.

$\mathbf{H_1}$: Alternative

As was discussed in the methodology section, health facilities in Nairobi were stratified into four strata. These are:

- The low income residential areas
- The high income residential areas
- The City Centre
- The special cases

In this analysis, waste collection method has been considered in the context of the containers used for waste collection. **Kruskal-Wallis H Test** has been used for the analysis.

The Kruskal-Wallis H Test

This is a non-parametric test for deciding whether there is a significant difference between or among three or more samples. This type of data is applied to ordinal data (ranked). The test is used to test the null hypothesis that

K independent random samples come from identical universe against the alternative hypothesis that the means of these universes are not equal.

This test is analogous to the one-way Analysis of Variance (ANOVA), but unlike the latter it does not require the assumption that the samples come from approximately normal populations or the universe having the same standard deviation.

In this test the data are ranked jointly from low to high or high to low as if they constituted a single sample. The test statistics is H, which is worked out as under:

$$H = \frac{\frac{12}{N(N+1)} \sum \frac{R_i^2}{N_i} - 3(N+1)}{1 - \frac{\sum (T_i^3 - T_i)}{(N^3 - N)}}$$

Where

k = number of categories
N = number of cases in the sample
N_i = number of cases in the i-th category
R_i = sum of the ranks in the i-th category
T_i = ties in the i-th category

The critical value of H can be referred to in a table of the chi-square distribution with k-1 degrees of freedom, for a test of the hypothesis that all k population distributions are identical.

The Test Analysis

	N	Mean	Std. deviation	Minimum	Maximum
A	60	3.10	2.482	1	10
B	36	5.22	2.727	2	13
C	50	5.16	2.411	2	13
D	7	3.86	1.069	3	5
E	37	8.00	4.137	3	13
F	56	10.21	2.410	1	12
G	50	7.02	2.737	1	13
Group	60	1.87	0.965	1	4

Group	N	Mean Rank
A: Low income	25	38.64
High income	25	26.28
Special Group	3	25.00
City Centre	7	18.86
Total	60	
B: Low income	15	24.47
High income	15	15.83
Special Group	3	7.00
City Centre	3	13.50
Total	36	
C: Low income	22	30.07
High income	23	23.57
Special Group	3	9.50
City Centre	2	21.50
Total	50	
D: High income	3	4.83
Special Group	2	2.50
City Centre	2	4.25
Total	7	
E: Low income	13	22.77
High income	20	17.05
Special Group	2	2.50
City Centre	2	30.50
Total	37	
F: Low income	24	29.13
High income	24	29.38
Special Group	3	30.50
City Centre	5	20.10
Total	56	
G: Low income	20	22.75
High income	22	27.61
Special Group	2	30.00
City Centre	6	25.42
Total	50	

Test statistics (calculated values of H)

	A	B	C	D	E	F	G
Chi-Square	12.908	11.000	7.312	1.917	10.249	2.556	1.582
df	3	3	3	2	3	3	3

The Chi-square table is then used to read the critical values against the respective category's df at 0.05 significance level, and the H_o is either rejected or otherwise as shown in the table below:

	A	B	C	D	E	F	G
df	3	3	3	2	3	3	3
Critical value	7.82	7.82	7.82	5.99	7.82	7.82	7.82
State of H_o	Rejected	Rejected	Rejected	Not rejected	Rejected	Not rejected	Not rejected

Key

A – General waste B – Pathological waste C – Infectious waste D – Radioactive waste E – Chemical waste F – Sharps G – Pharmaceutical waste

Interpretation

From the analysis above, the H_o has been **rejected** for types **A, B, C** and **E**, thereby adopting the H_1 that "methods of hospital waste collection for types A, B, C and E are not similar in different parts of Nairobi". This means that the area in which a health facility is located within the city is one of the factors that determine in one way or the other, which containers to be used for collection of general, pathological, infectious, and chemical wastes. However, there could be other factors that determine the waste collection containers for the mentioned waste types in the health facilities, which this study did not investigate.

For the wastes types **D, F** and **G** the H_o is **not rejected**. This implies that the data from the study does not provide enough evidence to reject the H_o that "the methods of hospital waste collection for **radioactive, sharps,** and **pharmaceutical** waste types are similar in different parts of Nairobi". Therefore, the location of a health facility in any part of Nairobi per se may not determine the type of containers used for the collection of the mentioned waste types within the health facility. As such, there could be other factors that determine the type of waste collection container adopted by health facilities for the collection of radioactive, sharps and pharmaceutical wastes, but, were not

investigated by this study.

Hypothesis 4

H_o: Methods of disposal of different categories of hospital waste are not significantly different.

H_1: Alternative.

This hypothesis is tested by use of the Friedman Test (the Friedman Test has already been discussed).

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
A	5	3.80	1.643	2	5
B	5	3.80	1.643	2	5
C	5	3.80	1.643	2	5
D	5	3.80	1.643	2	5
E	5	4.40	2.510	2	8
F	5	3.80	1.643	2	5
G	5	8.00	.000	8	8

The Test Analysis (Ranks)

	Mean Rank
A	3.40
B	3.40
C	3.40
D	3.40
E	4.10
F	3.40
G	6.90

Test Statistics

N	5
Chi-Square	25.765
df	6

Interpretation

From the analysis above, the **calculated value** of **F** is **25.765**, and the degree of freedom **(df)** is **6**, the **critical value** from the **Chi-Square table** at **0.05 significance level** is **12.59**. Therefore, the calculated value is **greater** than the critical value; hence, the H_o is **rejected** and the H_1 is **adopted** that "methods of disposal of different categories of hospital waste are significantly different.

The result implies that the health facilities in Nairobi use different disposal methods and/ or agencies for different types of wastes.

Hypothesis 5

H_o: Waste disposal methods in hospitals in Nairobi are not significantly different.

H_1: Alternative.

This hypothesis is tested by Kruskal-Wallis H Test (Kruskal-Wallis H Test has already been discussed elsewhere in this chapter).

As has already been mentioned, the health facilities in Nairobi were divided into four strata as below:

- Low income residential areas
- High income residential areas
- The City centre
- The special cases

Below were the outputs of the analysis by SPSS

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
A	60	4.58	2.162	2	10
B	42	3.86	1.555	1	7
C	51	3.96	1.455	1	7
D	6	3.67	1.506	2	5
E	38	4.68	2.243	1	8
F	56	3.95	1.367	1	6
G	51	5.78	2.663	1	9
Group	60	1.87	.965	1	4

The Test Analysis (Ranks)

	Group	N	Mean Rank
A	Low Income	25	35.96
	High Income	25	24.26
	Special	3	38.00
	City Centre	7	30.07
	Total	**60**	
B	Low Income	20	19.95
	High Income	16	19.88
	Special	3	31.00
	City Centre	3	31.00
	Total	**42**	
C	Low Income	23	24.98
	High Income	23	24.63
	Special	3	37.00
	City Centre	2	37.00
	Total	**51**	
D	High Income	3	2.67
	Special	2	5.00
	City Centre	1	3.00
	Total	**6**	
E	Low Income	13	17.42
	High Income	21	18.55
	Special	2	28.00
	City Centre	2	34.50
	Total	**38**	
F	Low Income	24	27.21
	High Income	24	26.96
	Special	3	41.00
	City Centre	5	34.60
	Total	**56**	
G	Low Income	21	19.95
	High Income	23	28.37
	Special	2	37.00
	City Centre	5	36.10
	Total	**51**	

Test Statistics

	A	B	C	D	E	F	G
Chi-Square	6.459	4.720	3.447	2.278	5.960	3.373	8.071
df	3	3	3	2	3	3	3

The Chi-square table is then used to read the critical values against the respective category's df at 0.05 significance level, and the H_o is either rejected or otherwise as shown in the table below:

	A	B	C	D	E	F	G
df	3	3	3	2	3	3	3
Critical value	7.82	7.82	7.82	5.99	7.82	7.82	7.82
State of H_o	Not rejected	Not rejected	Not rejected	Not rejected	Not rejected	Not rejected	Rejected

Key

A – General waste B – Pathological waste C – Infectious waste D – Radioactive waste E – Chemical waste F – Sharps G – Pharmaceutical waste

Interpretation

From the analysis above, the H_o has been **rejected** for type G **(Pharmaceutical waste)** thereby adopting the H_1 that "methods of hospital waste disposal for type G are not similar in different parts of Nairobi". This means that the health facilities in different parts of the city adopt different methods when it comes to disposing of their pharmaceutical wastes. The methods applied in the High-income residential areas are different from the ones used in the low-income residential areas, the city centre and in the special cases. That is, there are differences in the disposal of pharmaceutical wastes depending on which are of the city the health facility is located.

For the waste types A, B, C, D, E and F the **H_o is not rejected**. This implies that the data from the study does not provide enough evidence to reject the H_o that "the methods of hospital waste disposal for types A, B, C, D, E and F are similar in different parts of Nairobi". The variables can therefore be investigated further by adoption of a bigger sample.

4.3 ENVIRONMENTAL IMPACTS OF HOSPITAL WASTE

After extensive studies conducted in different parts of the world, (most of which under provisions of the Medical Waste Tracking Act of 1988 (*25*) of the United States of America) Environment Protection Agency, EPA of the United States concluded that the disease-causing potential of hospital waste is greatest at the point of generation and naturally tapers off after that point, thus presenting more of an occupational concern than a generalized environmental concern. Risk to the public of disease caused by exposure to hospital waste is likely to be much lower than risk for the occupationally exposed

4.3.1: What Are the General Risks Posed by Hospital Waste?

The concern created by medical / hospital waste is that it can cause infection and/or disease. In order for this to happen, several things must occur. First, infectious agents (for example, viruses) must be present in the waste. It is important to keep in mind that certain types of materials are classified as hospital waste because they might cause disease. Blood, for example, is considered infectious because it might contain viruses. Any given sample of blood or blood-soaked material may, in fact, be harmless.

Not only must infectious agents be present in the waste for it to cause disease, they must also survive in the waste in large enough quantities to be able to cause infection if an exposure occurs. The hepatitis B virus (or "HBV"), for example, is usually present in the blood of persons infected with hepatitis B in higher quantities than the AIDS virus (or "HIV") is in persons infected with

HIV. For this reason, it is much easier to contract hepatitis than AIDS from exposure to infected blood. Further, HIV normally does not survive for very long outside a living organism. Therefore, the chance of contracting AIDS from contact with hospital waste outside a health care setting is considered to be remote.

Second, an exposure has to occur in a manner that will be effective in transmitting the disease. There are four basic ways that a person can be exposed to infections: through the skin; through mucous membranes in the eyes, nose, and mouth; by inhaling infectious agents; and by swallowing them. Not all of these "routes" of infection will actually transmit a given disease. For example, AIDS can only be transmitted by sexual contact; by contact with the blood of an infected person on mucous membranes, broken skin, or through needle sticks; or from a pregnant woman to her fetus. It cannot be transmitted by inhalation or by touching an infected person.

Plate 4: Wastes, some of which are medical in nature are dumped outside a building in one of the residences in the low income residential estate in Nairobi

Finally, in order for the exposure to cause disease, enough of the infectious agent must be transmitted to the person who is exposed so that his immune

system cannot effectively protect him or her from the disease. Even if the waste does contain a large enough concentration of a disease-causing agent and exposure does occur in a way that could transmit the disease, disease may or may not develop. For example, AIDS can be transmitted through being stuck by a needle that contains the blood of an HIV-infected person. However, the chance of contracting AIDS from a single needle stick, even if the needle does contain HIV-infected blood, has been investigated to be very low. The chances of becoming infected with hepatitis B from a single needle-stick, even if the needle contains blood of an infected person, is also very low. A person's chances of not contracting the disease from an exposure are usually better if he or she receives prompt medical attention.

4.3.2: What Are the Specific Risks to "Refuse" Workers (or "Scavengers") from Hospital Wastes?

The risk to dumpsite workers / scavengers from hospital waste is that of contracting hepatitis B or AIDS from needle-sticks or from infected blood or blood-containing fluids being splashed or rubbed into open wounds, non-intact skin, or mucous membranes.

Some of the other diseases that could be transmitted through both hospital waste and ordinary household waste include the common cold, (bacterial conjunctivitis), chicken pox, and flu-all of which can be transmitted by mucous membrane exposure, inhalation of airborne particles from soiled articles, or inadvertent swallowing of particles after handling soiled articles. Bacterial infections are less common communicable diseases that can potentially be transmitted through cuts or abraded skin, following handling of contaminated articles.

Plate 5: Hospital Waste inside an Incinerator. Some of the wastes are not completely incinerated.

4.3.3: Potential Impacts of Hospital Wastes on the Environment

a) Hazardous substances used by health facilities are stored and handled in small containers and apparatus, and points of use for these substances are usually scattered among the numerous separate departments, laboratories and buildings. The probability of a catastrophic event resulting in the uncontrolled release of large quantities of hazardous substances is low.

b) Because the quantities of hazardous substances in use and disposed of by health facilities are usually small, uncontrolled releases would be likely to impact only localized areas, not the general environment. The specific characteristics and management requirements for the various types of hazardous constituents commonly present in hospital waste tend to reduce the potential for releases and adverse impacts even if they are released.

c) Indirect impacts from waste treatment and disposal operations. Incineration and other medical waste treatment processes can generate secondary wastes and pollutants if treatment facilities are not designed, constructed, and operated properly. These pollutants may have adverse environmental impacts, including:

I. ***Air emissions***. Polychlorinated dioxins and dibenzofurans, toxic heavy metals (mercury and cadmium), and corrosive gases (hydrogen chloride) may be produced by medical waste incinerators. Varying levels of pollutants may also be emitted from alternative (non-incineration) treatment processes, depending on the method used for pathogen inactivation and the type of waste being treated. Whether these pollutants are released into the environment or contained depends on a number of operational factors and the level of technological advancement inherent in the treatment system.

II. ***Wastewater effluents***. Another potential source of indirect impacts is the use of chemical disinfectants that may be regulated as toxic pollutants. Phenolic disinfectants are of particular concern because they may disrupt wastewater treatment processes or result in discharges of toxic effluents.

d) Pharmaceuticals which are not destroyed by incineration or other effective treatment processes are eventually disposed of and released to the environment. Drugs have characteristics that increase their potential to be significant pollutants. Most drugs are biologically active at low dose levels. They are relatively stable under environmental conditions, and their use is increasing rapidly with a population that is growing. The fate and effects of drugs on the environment are largely unknown, because monitoring for drug contaminants in environmental media is very limited. There is no routine testing for pharmaceuticals in wastewater and drinking water, and analytic methods are either rarely available or deemed not cost effective. However, it has been suggested that many drugs may present potentially significant environmental impacts, for example:

I. Many types of drugs are not degraded or removed by wastewater treatment systems or passage through soil.

II. Some drugs are already ubiquitous, mobile, and persistent in the environment. For example, clofibrate, a lipid-lowering drug, and its derivative, clofibric acid (CA), have been found in surface water, groundwater, and marine environments. In fact, the concentrations of CA found in the North Sea in the United States and samples from other environmental sources are found at the same levels as other classic environmental pollutants such as hexachlorocyclohexane

III. Drinking water treatment systems may not degrade or remove drug contaminants as has been discovered by researches that have been done in other parts of the world. For example, in a recent sampling survey, 100% of 64 samples of drinking water samples collected in Berlin, Germany, contained clofibric acid (CA)

Plate 6: A river bank converted to a dump site in one of the Low Income residential areas of Nairobi

IV. The discharge of antibiotics with wastewater may favor growth of multiple antibiotic-resistant strains of bacteria and have adverse impacts on biological wastewater treatment processes. Antibiotics such as the fluoroquinolones may be primary sources of genotoxicity in wastewater from hospitals.

V. Drugs known to be hormonally active agents may act as endocrine disruptors and are found in environmental media and drinking water.

4.4 MANAGEMENT OPTIONS FOR HOSPITAL WASTES

4.4.1 General Hospital Waste Management Options

- Volume reduction, release to sanitary sewer systems, direct releases to the environment, decay-in-storage, and land disposal are common components of radioactive waste management programmes at that should be adopted in health facilities.
- Health facilities can also compact wastes to reduce the volume of waste that must be transferred off-site.
- Industrial super compactors may be used by waste processing companies to further reduce the volume of waste before burial.
- Several facilities utilize incinerators to treat radioactively contaminated biological wastes, liquid scintillation vials, and dry solid wastes.
- **Vitrification** of radioactive waste is an area that can also be exploited in the Developing world, since it is now commercially available in the Developed world. This method can be used to achieve great volume reductions in the waste stream in the range of 200:1.
- Other waste treatment methods such as **alkaline hydrolysis freeze drying**, and **dry distillation** may be performed on certain waste types. Aqueous liquid wastes containing by-product materials may be discharged to the sanitary sewer.

4.4.2 Reuse and Recycling Options

The preferred disposition of unwanted items is transferring them to others for reuse or other uses that do not require reprocessing. Reuse, as compared to reclamation of materials from waste (recycling), conserves the most value, usually requires the least amount of energy, and generates less pollution and secondary waste.

Health care facilities can develop successful solid waste recycling programs, particularly for commodities such as aluminum, cardboard, paper, and glass that are commonly recovered from the general waste (Municipal Solid Waste). Although the prices paid for such materials are usually not a major source of income to facilities, diversion of these materials from the solid waste stream eliminates disposal charges, which may be significant. Recycling of materials from the harmful and infectious hospital waste is more problematic and may not be successfully practiced:

CHAPTER FIVE

5.0 SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Findings

- There are seven categories of wastes that can be generated in a hospital set up. These include; general waste, pathological waste, infectious waste, radioactive waste, chemical waste, sharps and pharmaceutical waste. Generation of these waste types is different; for example, radioactive waste is not significantly present in most of the city health care facilities.
- The health care facilities in Nairobi use a variety of containers for collection of their wastes within the facilities, some of which are not be recommended by the Ministry of Health. The commonly used containers are: dust bin, waste paper basket, pedal bin, buckets, recommended sharps container, jerry can, bottle, specimen containers, special waste paper basket and polythene bags among others.
- In most cases the type of waste collection container used in a health facility will vary depending on among other factors not investigated by this research, the part of Nairobi in which the facility is located. For example, crude and un-recommended waste containers are evident in the small heath care facilities in the low-income residential areas especially in the slums.
- Most of the health facilities in Nairobi which understand incineration to be a disposal method of waste rather than a treatment method adopt it to get rid of their waste after which the remains (whether completely burnt or not) are transported to the dumpsite in Dandora.
- Health care facilities, which do not have incineration facilities, opt to

take their waste to neighbouring institutions with the facilities for incineration, but this is at a small fee. Others however, contract waste disposal agencies such as City Bins, Green City, and local (estate based) youth groups.

- Many health care facilities in the city prefer to return their pharmaceutical waste to the suppliers for professional handling and disposal
- Some of the waste disposal firms, which claim to be having the necessary machinery for waste disposal, still take the harmful wastes to the dumpsite at Dandora, sometimes in the raw form. The estate based youth groups, however, are notorious for collecting the wastes and transferring them in hand carts just to dump them by the nearby rivers or in undeveloped plots at night, where sometimes the neighbouring residence wake up in the morning to find big smoke rising from the burning waste.
- Treatment of waste by health facilities before disposal or collection by the disposing agencies is very minimal. For the hospitals, which adopt it, **JIK** disinfection and autoclaving are the most common methods adopted.

5.2 Conclusion

Hospitals, clinics, nursing homes, laboratories, doctors' and veterinarians' offices, private households-and many other places have to dispose of materials that have been used in medical care or treatment. Some of this material is infectious-that is, it has the potential to cause some kind of infection and/or disease. Examples of medical wastes are used "sharps"-hypodermic needles and syringes, IV needles, scalpel blades, and glass items; items containing or soaked with blood or certain other body fluids; human or animal organs or body parts; lab cultures that may contain disease-causing agents; and things

like gloves, bedding, dressings, sponges, and other items that have been used in surgery, autopsy, or treatment of patients with certain contagious diseases.

It is possible for hospital waste to cause infection and/or disease if it enters the body through broken skin or puncture wounds; if it splashes into the eyes, nose, or mouth; if it is inhaled; or if it is swallowed.

Hospital wastes may be dangerous for other reasons besides the risk of disease-for example, sharps can cause cuts. Some of the material disposed of by hospitals and other health care facilities may be hazardous for other reasons. It may contain hazardous chemicals, or low-level radioactive wastes. If the hospital waste contains hazardous waste or radioactive waste, it should not go to solid waste landfills.

On the other hand, not all waste created at such facilities is dangerous. Hospitals contain offices and cafeterias that create waste that is not dangerous, and much of the waste generated by patient care poses no threat at all to landfill workers. Even materials that have been classified as hospital waste will not always cause disease-they merely pose a risk that must always be considered in handling, storage, transportation and disposal.

Apart from hospital wastes being a health risk, their collection, handling, treatment transportation and disposal contributes significantly to environmental degradation. For example, incineration, open burning and even their decomposition release various harmful gases to the atmosphere, thereby changing the gases composition in the atmosphere.

The required disposal methods for hospital waste depend on the type of waste and on the nature of the facility that created it. "Sharps" (needles and syringes, scalpel blades, etc.), for instance should be placed in closed, leak proof containers (though these do not have to be puncture-resistant). This type of container must be labeled. Typically, hospitals use hard plastic containers for "sharps," and trash bags for other hospital waste; however, it is important to

- Youth groups, which lack the necessary machinery, should be outlawed and banned from engaging in waste management activities.

5.3.2 Future Researchers

- Many diabetics, allergy sufferers, dialysis patients, and other people who receive medical care at home (not to mention users of illegal intravenous drugs) have to dispose needles and syringes and other wastes of medical nature. There is therefore, need to carry out a detailed research on the management of these household based hospital waste.

look at the labeling or identification on the container. Another indicator of the presence of hospital waste, which may be used, is the **"BIOHAZARD"** symbol.

Hospital waste from health care facilities must be treated in a way that destroys its potential for causing disease, prior to disposing it in a landfill. Acceptable treatment methods may include incineration, steam sterilization (or autoclaving), and chemical disinfection. Incinerated waste would not be recognized as hospital waste.

5.3 Recommendation

5.3.1 Policy Makers

- The government should set aside a central dumping site under strict professional management solely for wastes of hospital nature due to their uniqueness from the ordinary wastes.
- The Government through the Ministry of Health should carry out thorough inspection of health facilities to ensure that they are using the right containers and techniques for collection and handling of the waste generated in them.
- Health care facilities should make sure that they label their various containers for waste collection. This would decrease cases of mistaken mixing of wastes and improve sanitation in the health facilities, in addition to decreasing possible accidents associated with these wastes.
- The Government through the relevant Ministry should investigate the operations of waste collection and disposal firms to ensure that they are handling and disposing the wastes in the right way safe to human health and the environment.

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APPENDIX: I

QUESTIONNAIRE TO HEALTH FACILITIES OPERATORS (MEDICAL OFFICERS / STAFF)

Introduction and Background

Recently, there has been an interest in waste management in the city of Nairobi. This questionnaire is part of a research inquiring on issues related to handling and management of hospital wastes in the city. The researcher is a post-graduate student at the University of Nairobi undertaking a Master of Arts Degree in Environmental Planning and Management. You are kindly requested to assist in this research by responding accurately to the questions therein to the best of your knowledge. All your responses will be treated in confidence and will be used only for this research inquiry.

Identification

1. Respondents' code_____
2. Name of health facility_____
3. Estate _____
4. Type of health facility
    i) Clinic
    ii) Dispensary
    iii) Health Centre
    iv) Nursing home
    v) Referral hospital
    vi) Other specify
5. Ownership of the facility

i) Private (individual)

ii) Central government

iii) Local authority (NCC)

iv) Community

v) Missionary

6. Capacity of the facility

i) Less than 30 patients

ii) 30 to 50 patients per day

iii) 51 to 100 patients per day

iv) Over 100 patients per day

7. Number of beds in the facility (for inpatients)

i) Less than 20 beds

ii) 20 to 50 beds

iii) 51 to 100 beds

iv) Over 100 beds

8. Number of employees in the facility

i) Less than 5

ii) 5 to 15

iii) 16 to 50

iv) More than 50

9. For how long has the facility been in operation?

i) Less than 5 years

ii) 6 to 10 years

iii) 11 to 20 years

iv) Over 20 years

10. Which of the following sections/departments are present in the facility?

i) Reception
ii) Consultation
iii) Injection room
iv) Pharmacy/dispensing chemist
v) Laboratory
vi) Theatre
vii) General ward
viii) Maternity ward
ix) X-Ray room
x) Ultra sound department
xi) Physiotherapy department
xii)Psychiatrist room
xiii) Health record store
xiv) Drug store
xv) Administration offices
xvi) Kitchen
xvii) Toilets
xviii) Washrooms
xix) Laundry facilities
xx) Others

11. Waste Management

Type of waste	Container for waste collection	Frequency of emptying collection container	Responsibility/handler	Transportation or transfer means	Treatment method	Disposal
1. General waste e.g. office, laundry, dirty and linen, domestic, from kitchen						
2. Pathological waste e.g. tissues, organs, body parts, human foetuses, blood and body fluids						
3. Infectious wastes e.g. cultures and stocks of infectious agents from laboratories, waste from survey and autopsy and dialysis from infected patients						
4. Radioactive wastes i.e. solids, liquids and gases wastes contaminated with radionucleides generated in vitro and vivo testing						
5. Chemical wastes e.g. discarded solids, liquid chemicals, e.g. from diagnosis, experimental work, cleaning etc						
6. Sharps e.g. needles, blades, broken glass etc						
7. Pharmaceutical wastes e.g. drug and chemicals that have expired						

Example

Container for waste collection: 1. Litter bins, 2. Waste paper basket, 3. Container with lid

Frequency of emptying Collection container: once a week

Responsibility/ handler: Hospital steward

Transportation/ transfer means: In garbage trolley

Treatment method: No treatment

Disposal: NCC

12. Are there separate containers for different types of wastes?
    i) Yes
    ii) No

13. Are the waste collection containers enough?
    i) Yes
    ii) No

14. Are the waste collection containers suitably located
    i) Yes
    ii) No

15. Are the containers above labelled appropriately?
    i) Yes
    ii) No

16. Are the waste collection containers above in good condition?
    i) Yes
    ii) No

17. Are wastes separated before disposal?
    i) Yes
    ii) No

18. If wastes are disposed by NCC or other firms, does the facility know where and how they are disposed off?

i) Yes

ii) No

State and explain_____

_____

_____

19. Why does the facility prefer the methods of waste disposal stated above?

i) _____

ii) _____

iii) _____

iv) _____

20. Has the institution any complaints from the general public about waste disposal method used?

i) Yes

ii) No

21. If yes in 20 above how are they affected?

i) _____

ii) _____

iii) _____

iv) _____

22. If yes in 20 above, then what measures is the institution taking to address the complaints?

i) _____

ii) _____

iii) _____

iv) _____

General Environmental Health and Awareness

23. What is your general opinion of the impacts of the disposal methods employed by the institution in?

i) Sanitary condition _____

ii) The environment _____

24. Do you think the current waste management by the institutions poses a major environmental problem?

i) Yes

ii) No

25. If yes in 24 above how

i) _____

ii) _____

iii) _____

iv) _____

26. What problem/obstacles have you encountered in trying to achieve the best method of waste management?

i) _____

ii) _____

iii) _____

iv) _____

27. Suggest ways of improving the current situation of waste management within the city hospitals

i) _____

ii) _____

iii) _____

iv) _____

28. Does the institution participate in the general improvement of environment in the surrounding area?

i) Yes

ii) No

29. If yes in 28 above how?

i) _____

ii) _____

iii) _____

iv) _____

30. Is there a department within the institution responsible for general environmental health?

i) Yes

ii) No

31. What is the level of environmental awareness by the staff of the institution?

i) High

ii) Medium

iii) Low

iv) None at all

32. How can you rate the current situation of waste management within the institution?

i) Very good

ii) Good

iii) Fair

iv) Bad

v) Very bad

33. What is the general environmental state of the institution?

i) Very good

ii) Good

iii) Fair

iv) Bad

v) Very bad