MUNICIPAL SOLID WASTE MANAGEMENT: CONTRIBUTION AND CHALLENGES OF PRIVATE SOLID WASTE MANAGEMENT COMPANIES IN NAIROBI COUNTY, KENYA

PRISCILLA WANJIRU NGUNJU

STUDENT NUMBER: H57/79497/2012

A DISSERTATION SUBMITTED TO THE SCHOOL OF PUBLIC HEALTH IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PUBLIC HEALTH OF THE UNIVERSITY OF NAIROBI

2018

:

DECLARATION

UNIVERSITY OF NAIROBI

DECLARATION OF ORIGINALITY FORM

Name of Student: Priscilla Wanjiru Ngunju

Registration Number: H57/79497/2012

College: Health Sciences

School: School of Public Health

Course Name: Master of Public Health

Title of work: Municipal solid waste management: contribution and challenges of private solid waste management companies in Nairobi County, Kenya

Declaration

1. I understand what plagiarism is and I am aware of the University's Policy in this regard.
2. I declare that this dissertation is my original work and has not been submitted elsewhere for examination, the award of a degree or publication. Where other people's work or my own has been used, this has properly been acknowledged and referenced in accordance with the University of Nairobi's requirements.
3. I have not sought or used the services of any professional agencies to produce this work.
4. I have not allowed, and shall not allow anyone to copy my work with the intention of passing it off as his/ her own work.
5. I understand that false claim in respect of this work shall result in disciplinary action, in accordance with the university plagiarism policy.

Signature ……. **Date …….**

APPROVAL

This research proposal has been submitted for examination with the approval of the following supervisors:

Internal Supervisors

Ms. Mary Kinoti, BEd; MSc Human Ecology; MSc (Biostatistics and Epidemiology)

Lecturer

School of Public Health

College of Health Sciences

University of Nairobi

Signature: _____ Date: _____

Professor Mutuku A. Mwanthi, BSc; MSEH; PhD

School of Public Health

College of Health Sciences

University of Nairobi

Signature: _____ Date: _____

Approved by the director, School of Public Health, University of Nairobi

Professor Mutuku A. Mwanthi, BSc, MSEH, PhD

Director, School of Public Health

School of Public Health

College of Health Sciences

University of Nairobi

Signature: _____ Date: _____

DEDICATION

I dedicate this work to all the individuals, companies and governments who make a conscious effort to conserve the environment. I dedicate this work to all young people who campaign for a better earth for the generations to come. In addition, I dedicate this work to my son Fadhili Muchangi.

ACKNOWLEDGEMENTS

I am grateful to the Almighty God, for His grace throughout my studies. I am grateful to all the individuals who have encouraged me throughout my studies; my mother, father, sister and brother for their guidance and support. I thank Ms. Mary Kinoti and Prof. Mutuku A. Mwanthi for serving as my supervisors up to the completion of this work. I appreciate my supervisors' passion for environmental health.

I am grateful to Eric Gachau for being loving and supportive throughout my studies. I thank my friends for holding my hand as I finalized my thesis. I appreciate the support offered to me by all the managers of the private solid waste management companies in Nairobi.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AEPB	Abuja Environmental Protection Board
AMA	Accra Metropolitan Assembly
AOR	Adjusted Odds Ratio
CBD	Central Business District
CI	Confidence Interval
CCC	Community Communal Container
DoE	Department of Environment
EMCA	Environmental Management and Coordination Act
ERC	Ethics Research Committee
HtH	House to House
IEBC	Independent Electoral and Boundaries Commission
ISWM	Integrated Solid Waste Management
KMC	Kolkata Municipal Corporation
KNBS	Kenya National Bureau of Statistics
KNH	Kenyatta National Hospital
MSW	Municipal Solid Waste
NEMA	National Environmental Management Authority
NCC	Nairobi City County
PPP	Private Public Partnership
SAGA	Semi-Autonomous Government Agency
SPSS	Statistical Products and Service Solutions
SWM	Solid Waste Management

UNEP	United Nations Environmental Programme
UNH	United Nations Habitat
UON	University of Nairobi
USA	United States of America
US EPA	United States Environmental Protection Agency
WEMAK	Waste and Environment Management Association of Kenya

DEFINITION OF TERMS

Disposal: This refers to thermal, biochemical and physical means of waste disposal without creating nuisance or hazard to public health or the environment.

Disposal site: This refers to any area of land on which waste disposal facilities are physically located or final discharge point without the intention of retrieval but does not mean a re-use or re-cycling plant or site.

Medical waste: This refers to waste generated in health facilities, research institutions or during immunization of human beings and animals. It is not a composition of municipal solid waste.

Municipal solid waste: This is solid waste from houses, streets and public places, shops and offices, which are the responsibility of municipal or other governmental authorities.

Privatization: This denotes a reduction in government activity or ownership within a given service or industry.

Private sector: These are privately owned and formally registered enterprises that provide services as contractors, consultants or suppliers. These enterprises may vary greatly in size from single consultant or microenterprise to a large multinational corporation. They may be locally based or international.

Solid waste: Solid waste is material, which is not in liquid form, and has no value to the person who is responsible for it.

Solid waste management: This refers to ways of handling solid waste, it includes reduction and segregation at source, collection, storage, transfer, processing, treatment and disposal.

Transportation: This is the removal and carriage of waste in a conventional and prescribed manner under governing laws, by-laws and regulations.

ABSTRACT

Title: Municipal solid waste management: Contribution and challenges of private solid waste management companies in Nairobi County, Kenya

Introduction: Solid waste management is a major public health and environmental concern in urban areas of developing countries. The study was carried out to understand the current scenario of solid waste management by private companies in Nairobi, Kenya. Without an effective and efficient solid waste management program, the waste generated from various human activities result in health hazards and have a negative impact on the environment. Inadequate solid waste collection leads to dumping of waste in rivers, open spaces and on roads. Poorly disposed waste is a breeding site for vectors and insects like rats and houseflies. Decomposing organic waste release leachate which pollutes ground and surface water bodies. In addition, spilt garbage causes foul odor and traffic congestion when dumped on narrow roads.

Main Objective: To assess the contribution and challenges of private solid waste management companies in Nairobi County.

Methods: A cross sectional study was carried out among managers of private solid waste management companies in Nairobi County. The study adopted a quantitative data collection method approach. The sample size was fifty four (54) managers, forty four (44) mangers responded to the questionnaire representing 81% response rate. The data was collected using self-administered questionnaires. The data was analysed and descriptive statistics was used to report the frequency and percentage distributions, as well as the mean for the study variables and presented in the form of tables, bar graphs, as well as pie charts.

Results: The study established that 80% of the solid waste management workforce is made up of men. The study established that the private companies operated in high and middle income areas such as Westlands (63.3%) and Dagoretti (77.3%) constituencies. Ninety five (95%) of solid waste companies collect household waste while 2% collect medical waste. The most commonly owned waste transportation vehicle is the high-sided open-top vehicle that was owned by twenty eight (64%) companies. The most commonly used solid waste disposal method is dumping at a dumpsite (98%) and the most used dumpsite is the Dandora dumpsite (98%) followed by Mavoko dumpsite (5%). Lack of access to capital to start up, buy and maintain vehicles and equipment was a challenge (66.7%) and lack of enforcement of solid waste management laws by local government of the companies (64.3%) were the leading challenges faced by the companies.

Discussion by Objectives: The study established that waste collection by private waste management companies is concentrated in the high income areas. It further established that the vehicles used in waste transportation such as pick-ups are not the recommended type of vehicles. The study further established that dumping in Dandora open dumpsite is the common waste disposal method.

Conclusion: The study found out that the solid waste management process by private companies in Nairobi is similar to other African cities. Solid waste collection by private companies mainly concentrated in the middle and high income areas, leaving the low income areas unattended. The study established that the private companies were using unsuitable vehicles for waste collection such as pick-ups. The study further established that safer methods of disposal such as use of sanitary landfills were nonexistent. The most common challenge of private companies was lack of access to capital to buy and maintain vehicles.

Recommendations: The Nairobi City County and the National Environment Management Authority should develop strategies for waste collection in low income areas. They two bodies should monitor and enforce the use of the recommended solid waste transportation vehicles. In addition, credit facilities should provide low interest rate loans to private waste management companies to enable them purchase and maintain vehicles.

CHAPTER ONE: INTRODUCTION

The focus of this dissertation is to contribute to a limited but growing field of research on the role of private solid waste management companies in solid waste management in Nairobi, Kenya. It seeks to shed light on the contribution and challenges faced by private solid waste management companies, a unique group that has for a long time been under represented in research and policy in Kenya. This study will seek to articulate the status of solid waste management focusing on waste collection, transportation and disposal. It is hoped that its findings will find relevance in policy making, planning services and advancing research in the field.

Across the country strategies dealing with municipal solid management are not only limited but also poorly implemented. The few that exist fail to comprehensively address the unique environment of private solid waste actors in the context of devolution, where the county government is required to prioritize and champion solid waste management.

Solid waste management is mainly the responsibility of the local government. There have been failures in solid waste management by the national and local governments. These failures include corruption, insufficient resource allocation, low turnover, infrequent coverage as well as poor management. These failures led to private sector participation in providing public services to the citizens including solid waste management (Hoornweg and Bhada-Tata, 2012). Privatization of urban services is motivated by the following considerations; the local government is perceived as doing something about solid waste management by the public, the private sector is more efficient and more effective, there is increased coverage of waste management services as well as improved decision-making in selection and allocation of resources (Coad, 2005).

Privatization of solid waste management services was attempted in some American cities in the 1800s but failed. In 1965 privatization was revitalized by the approval of the United States solid waste disposal Act (Crooks 1993; cited by Anderson, 2011). An attempt to involve private garbage collection companies in solid waste management in Memphis City, USA in 1993 failed. In 2011, the Memphis City Council considered contracting private firms on solid waste management (Downs, 2011). In 2004, there were 12,000 private garbage collection firms in the United States of America. These firms carried out 80% of solid waste management services in the cities (Sanchez, 2004; sited in Bowan, 2013).

Private sector involvement in solid waste management in developing countries begun over 49 years ago. Doula a city in Cameron outsourced municipal solid waste management services from a private company in 1969. The city of Yaoundé involved the private sector 18 years later in 1987 (Gupta, 2012). In Nairobi County, the Department of Environment (DoE) offers solid waste management services to the residents. The department manages the municipal solid waste through its own resources consisting of work force and equipment. In addition, the local government contracts private garbage companies to provide solid waste collection, transport and disposal services (Environmental Audit Unit, 2007). The involvement of private garbage collectors in Nairobi began in 1986 due to a failure by the Nairobi City County to collect solid waste. There were two private companies in 1986 (Karanja, 2005; cited in Kasozi and Blottnitz, 2010). These had increased to an estimated 64 registered companies in 2012 according to Nairobi county records (Nairobi County, 2012). However, it is worth noting that different sources provide discrepant figures of registered companies.

Nairobi, the country's capital city, is a typical example of an African city that is growing at a rapid rate of over 4% per annum, with a population of 3.1 million in 2009 up from 2.1 million in 1999 (Kenya National Bureau of Statistics, 2010). At the same time, estimates indicate that Nairobi residents produce between 3,000 and 3,200 tons of solid waste (SW) each day while only 50% of this waste is collected, with about 25% of the produced waste reaching the city's municipal dumpsite at Dandora location (United Nations Environment Programme & City Council of Nairobi, 2010).

Solid waste production is directly proportional to population, and with an ailing public service, solid waste in Nairobi is largely managed by private actors. This study seeks to elicit the perceptions, contributions and challenges (which hitherto remain unknown) of these private waste management companies in Nairobi whose role remains integral role in the environment and public health of the population.

1.0 Background

Solid waste is any solid material discarded as being useless, worthless or in excess. It does not include solid, liquid, semi-solid or gaseous material resulting from industrial, mining and agricultural operations (Nemerow et al., 2009). According to Zurbrügg (2003), solid waste is also referred to as rubbish, garbage, trash and refuse. Municipal solid waste (MSW) is non-hazardous waste generated from households, commercial and government premises such as prisons, schools, hospitals as well as public places like markets, parks and streets (UN Habitat, 2010b). These non-hazardous waste include food waste, yard trimmings, furniture, metals, wood, glass, plastics, textiles, leather, rubber (US EPA, 2014).

Municipal solid waste management involves solid waste collection, transportation, resource recovery, recycling and disposal in urban areas. The main target of municipal solid waste management is to protect public health, the environment, support the productivity of the economy as well as develop sustainability (Schübeler et al., 1996).

Waste mirrors the image of society as waste generation and disposal reflects its environmental, cultural, historical, and economic components. Some of the problems brought about by solid waste in developing countries include weak waste collection systems and inappropriate final disposal, resulting in environmental pollution (Sharma, 2012).

Continuous economic growth, urbanization, as well as industrialization have given rise to an increase in solid waste generation (UNEP, 2009). An increase in income leads to higher living standards, which in turn lead to high consumption of goods and services (Hoornweg and Bhada-Tata, 2012). In addition, high urban population growth leads to a high demand for public services and infrastructure namely sewerage, water supply and solid waste management. For instance, the urban population in India increased from 11% in 1901 to 26% in 2001. This lead to a higher demand for public services (Ghose et al., 2006).

The urban population produces twice as much waste as the rural population. In 2010, world cities had a population of 2.98 billion. The waste generated was about 3.5 million tonnes per day, which is about 1.3 billion tonnes of solid waste annually. This amount is estimated to rise by 0.9 billion tonnes to 2.2 billion tonnes by 2025 (Hoornweg and Bhada-Tata, 2012). The American population produced 250 million tonnes of waste in 2010 with an average of 4.43 pounds/ person/ day (US EPA, 2010).Waste generation in sub-Saharan Africa is approximately 62 million tonnes per year. Per capita waste generation spans from 0.09 to 3.0 kg per person per

day, with an average of 0.65 kg/capita/day (Hoornweg and Bhada-Tata, 2012). The total solid waste generated in Nairobi City in 2009 was estimated to be 1.1 million tonnes. The daily solid waste generated was between 3000 and 3200 tonnes per day. This was an increase from a generation of 1500 tonnes in 2008 (Blottnitz and Ngau, 2010). The current MSW produced in Nairobi County in 2017 is 4788 tonnes as projected by Kasozi and Blottnitz (2010). This waste is projected to increase to 7427 tonnes per day in 2030.

Problems of solid waste management lead to health risks, environmental pollution as well as aesthetic nuisance. Inadequate solid waste collection leads to dumping of waste in rivers, open spaces and on roads. Poorly disposed waste is a breeding site for vectors and insects like rats and houseflies. Decomposing organic waste release leachate, which percolates into soil, ground and surface water bodies leading to their pollution. The uncollected waste is dumped into drains leading to their blockage. The resulting stagnant water is a breeding site for mosquitoes, which are vectors for malaria and dengue fever (UN Habitat, 2010a). In addition, spilt garbage causes foul odor and traffic congestion when dumped on narrow roads (Ramos and Vicentini, 2012).

A cross-sectional study on the association of infantile diarrhea with presence of garbage in the environment was conducted in Salvador, Brazil. The prevalence of diarrhea was estimated to be 21.2%. The most important factor associated with diarrhea was garbage in the environment (Rego et al., 2005).

A study by Muniafu and Otiato (2010) on solid waste management in Nairobi showed the problems of poor solid waste management by focusing on the Dandora open dumpsite. The

problems included poor infrastructure, uncontrolled and discriminate dumping, pollution, health risks, security risks as well as lack of employment.

1.1 Statement of the problem

Municipal solid waste management is a major public health and environmental concern in urban areas of developing countries. The incidence of diarrhea, respiratory and skin conditions is higher in households exposed to dumpsites. In Nairobi only 50% of the 3000 tonnes of waste is collected by both public and private agencies. This leaves a backlog of 1500 tonnes of uncollected waste daily (Blottnitz and Ngau, 2010).

In spite of privatization of solid waste management services in many developing countries in over 30 years, problems of solid waste management services linger on (Oduro-Kwarteng, 2011). The problems of solid waste management services include irregular waste collection, inadequate coverage, spillage of waste from storage containers and garbage collection trucks, uncontrolled and discriminate dumping, poor infrastructure as well as limited access to capital (Oduro-Kwarteng, 2006; cited in Oduro-Kwarteng, 2011; Muniafu and Otiato, 2010; Alakinde, 2012).

It is in this view that the researcher seeks to assess, identify and inventorize the municipal solid waste management system by private solid waste management companies.

1.2 Research questions

1. What are the solid waste collection services offered by private companies in Nairobi County?

2. What are the preferred modes of transport for municipal solid waste by private companies in Nairobi County?

3. What disposal methods of solid waste do private companies in Nairobi County use?

4. What challenges do private companies face in municipal solid waste management?

1.3 Broad objective

To assess the role of private solid waste management companies in Nairobi County, Kenya, with a focus on their contribution and challenges.

1.3.1 Specific objectives

1. To describe municipal solid waste collection services offered by private companies in Nairobi County;
2. To determine the mode of transport of municipal solid waste by private companies in Nairobi County;
3. To determine the disposal methods of municipal solid waste used by private companies in Nairobi County;
4. To identify the challenges faced by private companies in municipal solid waste management in Nairobi County.

1.4 Justification

Effective management of solid waste reduces adverse effects on public health through good waste collection services, protects the environment during treatment and disposal, improves quality of life as well as support economic growth and development through resource management (UN Habitat, 2010b).

The findings of this study will provide information on the contribution of private companies in municipal solid waste management as well as the challenges they face. This knowledge will

assist policy makers and solid waste management planners to understand the prevailing trends in solid waste management leading to improved policy formulation and implementation. Should the recommendations of this study be adopted by the County government and its agents, they will inform the policy making process in addressing the challenges faced by the private companies in solid waste management. The findings will likely strengthen the contribution of private companies in solid waste management by inspiring development of enabling policies and regulatory frameworks.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

The purpose of this chapter is to reveal the relevant literature and rationale of examining the perceptions, contributions and challenges of private solid waste management companies. It contains a review of literature on different views and studies in relation to solid waste management. Peer reviewed databases were systematically searched using appropriate search terms. The search was focused on quantitative and qualitative article published in English language with no restrictions placed on time frame. Grey literature was sourced from relevant organizational websites and databases.

Empirical literature and data on solid waste management in Kenya is scarce. The few available studies for example focus predominantly on dumpsites leaving out other methods of disposal. There are hardly any studies focusing solely on the private players in solid waste management.

According to the National Solid Waste Management Strategy (2015), the fundamental aim for solid waste management is "safeguarding of human health and the environment in a manner that is affordable, environmentally friendly and socially acceptable". The adoption of the principle of integrated solid waste management is key towards achieving this objective. County governments are responsible for the management of waste in their jurisdictions.

The solid waste management hierarchy is an integrated approach to protecting and conserving the environment. It establishes a hierarchical order of solid waste management modalities as follows: waste reduction, reuse, recycling, resource recovery, incineration, and landfilling (NEMA, 2015).

Solid waste generation is as a result of human activities. Proper waste handling, storage, collection and disposal reduce the adverse effects of solid waste to the environment and human health (Zurbrügg, 2003). Private sector companies have a role in solid waste management which spans from collection, street sweeping, material recovery as well as treatment and disposal. They do not have a direct responsibility for ensuring public health and safety. Therefore, their participation is restricted to services that make profit (UNEP, 2005).

Solid waste management in Kenya is regulated by laws and regulations that are fragmented among several statutes (Environmental Audit Report, 2007). These statutes include the Environmental Management and Coordination (Amendment) Act, 2015, and Environmental Management and Coordination (Waste Management) Regulations 2006. In Nairobi County solid waste management is regulated by the Nairobi City County solid waste management bill, 2015. In addition, solid waste management by the private sector is regulated by the policy on private sector involvement in solid waste management, 2001.

2.1 Solid waste collection

Solid waste collection is defined as the collection of solid waste from place of generation to treatment or disposal site (Hoornweg and Bhada-Tata, 2012). The state of solid waste storage and collection are visible signs that indicate the success or failures of solid waste management systems. Proper public sanitation and a clean environment results from a successful solid waste management system. Where an unsuccessful solid waste management system is evident, there is poor public sanitation and a dirty surrounding. A well designed, planned and operated solid waste management system is the prerequisite to proper public health (UNEP, 2005).

2.1.1 Frequency of waste collection

Frequency of waste collection refers to the number of times in a week or month that waste is collected from the waste generators (UN-Habitat, 2010a). There is no prescribed waste collection frequency. Factors that influence waste collection frequency include, decay of waste that leads to breeding of flies, public expectations as well as cost of collection. Collection could be daily, that is, collection is done every day of the week or it is done six days in a week with one resting day. This collection requires a large work force of both waste loaders and supervisors. Collection could also be on alternate days, that is, three days between collections. In addition, collection could be done twice in a week, that is, waste is collected once after three days and once after four days. Waste collection is highly variable, in some cities it is done on the day of rest (Sunday or Friday) or at night, perhaps for cultural reasons, weather or traffic congestion (Hoornweg and Bhada-Tata, 2012).

A study by Kaseva and Mbuligwe (2005) on appraisal of solid waste collection following private sector involvement in Dar es Salaam investigated solid waste collection practices. The study showed private companies collected waste twice or thrice per week. The frequency of collection depended on the number of waste loaders and the mechanical condition of the garbage trucks. On observation, the average number of waste loaders per company was five. In another study by Kassim and Ali (2006) in Dar es Salaam, showed that 70% of households received waste collection services once or twice in a week. The collection depended on availability and condition of garbage trucks.

A study by Imam et al. (2008) on solid waste management in Abuja, Nigeria, showed that there were twelve private waste collection companies. These companies provided house-to-house and

kerbside waste collection services. In the house-to-house collection method, waste was collected once or thrice in a week. Kerbside collection was reported to be irregular. In addition, the informal sector also provided house to house collection. They sorted the recyclable waste and littered the point of collection with degradable waste. For this reason, the informal waste collectors were banned from some districts.

2.1.2 Point of collection

According to UN Habitat (2010a), the point of collection is the site at which the waste generator brings the waste for collection by the collection agency. There are different sites of waste collection. These sites include community containers, block collection, kerbside collection, door-to-door collection and collection from apartment buildings.

A study by Hazra and Goel (2009) on practices and challenges of solid waste management in Kolkata, India, showed the distribution of waste collection methods. The waste collection methods were door-to-door collection (61.2%) and roadside collection (6.8%), the uncollected waste ended up dumped in vacant lands (22.4%) and canals (8.2%). Waste was collected from various areas in Kolkata Municipality Corporation. These areas included standard residential areas, refuse colonies, registered slums and unregistered slums. The door-to-door collection coverage in these areas was 57.3% in standard residential areas, 70.9% in refuse colonies, 67.1% in registered slums and 13.3% in unregistered slums. The roadside collection coverage was 35.9% in standard residential areas, 1.8% in refuse colonies, 12.6% in registered slums and 6.8% in unregistered slums.

A study done in Accra, Ghana in 2002 established that the two methods of solid waste collection were House-to-House (HtH) system and Central Communal Container (CCC) system. Local

government and private operators ran the two systems. The high and middle-income households used the house-to-house system while the Central Communal Container system was used in low-income households. The house-to-house system covered 30% of the high and middle-income areas receiving solid waste collection services while the Central Communal Container system covered 70% of the low-income areas. In the Central Communal Container system, the Accra Metropolitan Assembly (AMA) provided waste bins and bore the collection cost. In the house-to-house system, the residents registered with the waste Management Department or a private waste collection company and paid a fee of US $ 2-2.5 monthly for garbage collection (Obirih-opareh and Post, 2002).

A study by Kassim and Ali (2006) on household perspectives on solid waste collection by private sector investigated the solid waste collection practices in Dar es Salaam. The study showed that 70% of households received waste collection services. The households that received door-to-door collection services were 57% and the remaining 13% used a communal container while 30% did not receive collection services.

2.2 Mode of transport of solid waste

Transportation involves the removal and carriage of waste in a conventional and prescribed manner under governing by-laws and regulations. Regular transportation of stored solid waste ensures that refuse containers do not overflow and streets are not littered with refuse (Ministry of Urban Development, 2000).

There are different types of vehicles used in solid waste collection, transportation and disposal. The garbage collection vehicles used in primary solid waste transportation include handcarts, animal carts, motorized tricycles, pedal tricycles as well as tractors (UNEP, 2005). The

recommended vehicles used in secondary solid waste transportation include non-compacting collection vehicles and compacting collection vehicles. Compacting vehicles reduce the volume of waste by compressing it hydraulically. They include rear-loading compaction plate compactor, screw compactor, rotating drum compactor, paddle compactor and front loading compactor. The non-compacting vehicles do not reduce the volume of waste by compression. These vehicles include high-sided open top vehicles, side loading 'roll-up' vehicle, front loading high-sided enclosed vehicle, side loading binlift system and crane tipper system (UN-Habitat, 2010). According to the World Bank (2004) the choice of waste collection and transportation vehicles depend on a couple of factors. These factors include method of solid waste collection, waste composition, topography of the city, stage of collection (primary or secondary stage) as well as distance of disposal site.

A study done by Imam et al. (2008) on solid waste management in Abuja Nigeria assessed the different types of garbage collection vehicles used by the Abuja Environmental Protection Board (AEPB) and the private sector. The vehicles included tippers, automated compactors, side loader trucks, tractors, roll-on roll-off skip vehicles and lorries. The Abuja Environmental Protection Board owned 36 vehicles and only 17 (47%) were operational. The private companies owned 71 vehicles and 52 (73%) vehicles were operational. Waste transportation challenges included poor traffic conditions and inadequate number of waste collection vehicles. The inadequacy of collection vehicles was due to poor funding and inadequate maintenance.

A cross sectional study on private sector participation and suitable solid waste management in Ibadan, Nigeria showed that access to capital was limited to many private companies. This limitation to capital lead to inability to employ more waste loaders, buy garbage trucks as well as

maintain the garbage vehicles. The firms therefore used the tipper trucks to transport construction materials in order for the company to make extra income. While the tipper trucks were used to transport construction materials, waste accumulated in the streets. In addition the tipper trucks were damaged and spilt waste on the roads during transportation due to poor maintenance (Alakinde, 2012).

For an individual to transport waste in Kenya section 7 (1) of the Environmental management and co-ordination (waste management) Regulations 2006 requires that the individual is given a license. Section 8 (1) of the regulations provide that during transportation there should be no scattering of waste. Section 8 (3) further states that the transport vehicle should follow scheduled routes approved by the city county of Nairobi. The policy on private sector involvement in solid waste management 2001, section 3.14 states that 'no waste shall be transported or disposed of between 6:00pm and 6:00am.'

A cross sectional study by Rotich et al. (2006), investigated the status of waste collection and disposal by local authorities in Nakuru, Nairobi, Eldoret, Kisumu and Mombasa, Kenya. The study showed that 33% of municipal solid waste collection vehicles were out of service. In addition, most of the vehicles were more than 10 years old and therefore inefficient. A survey of the roads leading to dumpsites in the municipalities showed that they were not all weather roads. This led to their destruction during rainy season and the dumpsites were inaccessible. The Central Business District (CBD) and affluent areas had accessible roads. The local authorities concentrated their services in the affluent areas and the CBD more than the less affluent areas. Illegal dumping of waste on road reserves, rivers and paths was attributed to the untimely waste collection by the local authorities.

A study by Environmental Audit Unit (2007) on management of solid waste in Nairobi County Nairobi showed that the trucks used for waste transportation by the city county of Nairobi did not conform to requirements set in the then Environmental Management and Coordination (waste management) regulations 2006 and the Environmental Management Act. The study showed that 90% of the trucks were not covered nor were they labeled as required by those provisions. In addition, rotting waste produced foul smell and spillage of waste was common during transportation of waste.

2.3 Solid waste disposal

In 2012, the World Bank categorized municipal solid waste disposal methods in five regions in the world. The disposal methods included recycling, sanitary landfilling, incineration, open dumping and open burning. The commonest method of waste disposal in Africa, Asia and Europe was open dumping at 47%, 51% and 33% respectively. In contrast, in North America only two types of municipal solid waste disposal existed. These methods were incineration (91%) and recycling (8%), other undefined methods accounted for 1% (Gupta, 2012).

Waste generation density in large cities in Japan such as Tokyo is high while land for dumpsites is scarce. Incineration is the treatment of choice as it reduces the volume of the waste and it is hygienic. In 2010 there were 1,221 incinerators in operation, 306 (25%) of these incinerators recovered energy from the waste. About 79% of the total municipal solid waste was incinerated. The ash from the incineration was taken to landfills for final disposal. There were 1,775 landfills in record in 2010 (Pariatamby and Tanaka, 2014).

Solid waste collected in Kolkata Municipal Corporation (KMC) in India was disposed in disposal sites in Dhapa, Garden Reach or Naopara. Over 95% of the waste was disposed in the

unsanitary landfill in Dhapa. On entry into Dhapa dumpsite the garbage trucks were weighed by computerized weighbridges. After unloading the waste, bulldozers were used to spread and compact it. Finally a layer of silt was used to cover the compacted waste (Hazra and Goel, 2009). In another study in India showed that Srinagar municipal city produces 530 tonnes of solid waste daily, 72% of this waste is disposed at the Syedpora Achan dumping site. The Syedpora Achan dumping site has been in existence since 1985 and covers 30.63 hectares of land. The remaining 28% of waste is illegally disposed in open areas, burnt or dumped in trenches (Khan, 2014).

A study by Abarca et al. (2013) on solid waste management challenges for cities in developing countries assessed the condition of disposal sites. The study showed that the disposal sites were unsanitary landfills. The landfills lacked leachate treatment, clay lined layer at the bottom, gas treatment and waste was not covered with a layer of soil after compression. Waste was also disposed illegally in rivers, oceans, drainage and roadsides. The distance from the city centers to the official dumpsites were assessed. The distance ranged from 3 km in Hambatonta (Sri Lanka) to 50 km in Beijing (China).

The designated disposal site for solid waste collected in Nairobi is the Dandora dumpsite. The dumpsite is 7.5km from the city center (Muniafu and Otiato, 2010). The Dandora dumpsite is unsanitary; solid waste is not covered with a layer of soil at the close of business, it does not have a liner that prevents leachate from polluting ground water. In addition, the dumpsite is not fenced. Besides the Dandora dumpsite, there is illegal dumping on roadsides and in rivers (Rotich et al., 2006).

2.4 Challenges faced by private waste management companies

Studies done previously in some African countries on solid waste management have shown that private waste management companies face challenges in the process. A cross sectional study done in Minna, Nigeria looked at capacity issues of private sector participation in urban solid waste management over 3 years (2001, 2005 and 2008). The study showed capacity problems to include insufficient vehicles, inadequate number of workers, lack of sanitary landfills, uncooperative clients and local governments, lack of capacity building initiative by local government as well as lack of enforcement of solid waste management laws. It was further noted that uncooperative residents did not support the private firms and they poorly paid them for waste management services (Sanusi, 2010).

A case study in Ibadan Metropolis identified some of the problems faced by the private sector in solid waste management. The first problem was lack of access to starting up capital of the business. The lack of capital led to the inability to buy and maintain garbage trucks, hire trained and experienced staff as well as pay salaries to the workers. Secondly, some household clients believed that the local government was responsible for solid waste management. They therefore did not see the need to pay a private collector since the local government taxed their wages. Thirdly, the private companies charged a small fee for waste collection. This fee was not adequate to run the business. Many clients defaulted paying the monthly fee and eventually discontinued the waste management service. Lastly, many households were inaccessible to collection services due to poor urban planning (Alakinde, 2012).

A case study done on Zoomline Ghana Limited a private company in Wa Municipality of Ghana showed challenges that hindered proper solid waste management. These challenges included lack

of enforcement of waste management by-laws, residents failed to take their waste to the specified collection points, the public's lack of knowledge about the negative impacts of increased waste generation on public health and environment, illiteracy as well as inadequate equipment particularly skip garbage trucks and communal containers (Yahaya and Owusu-Sekyere, 2012). In 2013, a cross sectional study was carried out on the capacity of Zoomlion Ghana Limited Company. The study showed that there were inadequate number of skilled workers particularly planning experts and engineers, inadequate garbage vehicles as well as lack of tractors, landfill compactors, front end loaders and tipper trucks (Bowan, 2013).

CHAPTER THREE: METHODOLOGY

3.0 Study area description

The study focused on Nairobi County, the capital city of Kenya. The city has been known as the 'Green city in the sun'. The name Nairobi is originally a Maasai term that means 'Stream of cool water' (Renuka, 2007). According to the Kenya National Bureau of Statistics (2009) the population of Nairobi was 3,138,369 million, with an annual increase of 4.1%. The estimated population in 2016 was 4,463,149**.** Nairobi is divided into the 17 constituencies: Westlands, Dagoretti North, Dagoretti South, Langata, Kibera, Roysambu, Kasarani, Ruaraka, Embakasi South, Embakasi North, Embakasi west, Embakasi Central, Embakasi East, Makadara, Kamukunji, Starehe and Mathare (IEBC, 2012; cited in Infotrack East Africa Limited, 2012).

Nairobi is Kenya's principal economic, administrative and cultural center and one of the largest and fastest growing cities in Africa. It is a regional hub for air, road and rail travel. Nairobi is Eastern and central Africa's hub for Financial, Communication and Transportation services. It is East Africa's most important commercial, manufacturing, financial and tourist center. Nairobi's manufacturing sector consists of small and medium-sized industries with products ranging from steel, plastics, consumer goods, horticulture and agricultural products. Nairobi also has a thriving informal sector locally known as the "Jua Kali" sector comprised of artisans and small scale business people. "Jua Kali" is a Swahili word for "hot sun" signifying outdoor exposure.

Nairobi houses Kibera, the largest informal settlement in the country among other slums. Garbage collection is non-existent in these informal settlements. With studies showing that solid waste generation is higher in urban areas than the rural areas, Nairobi was chosen due to its rapid urbanization and population growth.

3.1 Reasons for choice of study area

Nairobi County is the capital of Kenya and the largest administrative, commercial and industrial center of the country. The County therefore portrays the 'face' of Kenya to local and foreign visitors and is expected to set high standards for solid waste management for other urban authorities in the country to emulate. In addition, the city hosts the headquarters of the United Nations Environment Programme (UNEP) as well as United Nations Human Settlements Programme (UN-Habitat) and should take the lead in protecting the environment.

3.2 Study Variables

The proximate variables in the study were;

Solid waste collection

a. Frequency of solid waste collection: This is the number of times solid waste is collected.
b. Point of solid waste collection: This refers to the location of solid waste collection.

Solid waste transportation

a. Mode of transport: This is the method of conveying solid waste from place of generation to final disposal site.
b. Number and condition of transport vehicles: This refers to the amount and state of vehicles that are used in solid waste transportation.

Solid waste Disposal

a. Method of disposal: This refers to the process involved in discarding solid waste.
b. Site of disposal site: This refers to the place that solid waste is discarded.
c. Distance between point of service and disposal site: This is the length between the place of solid waste collection to the final place where solid waste is discarded.

Challenges faced by private companies in solid waste management

a. Availability of capital: This refers to available funds to run the private solid waste company.
b. Attitude of clients: This refers to the point of view of clients to solid waste management by private solid waste companies.
c. Number of vehicles: This refers to the amount of vehicles used to convey solid waste from the place of collection to the place of discarding.
d. Number of workers: This is the amount of employees within the private solid waste company.
e. Accessibility of households: This refers to the ability to reach households during solid waste collection and transportation.
f. Enforcement of solid waste management by local government: This refers to the implementation of solid waste management laws by the local government.

3.3 Study design

A cross sectional study was carried out among managers of private solid waste management companies in Nairobi County to determine their contribution and challenges in solid waste

management. A cross sectional design was most appropriate in providing a snap shot of the current solid waste management status and describing the characteristics of the private waste management companies.

3.4 Study population

The target population consisted of managers of private solid waste management companies in Nairobi County.

3.5 Sampling technique

The researcher sort to interview all the managers in the 64 private companies recorded at the Nairobi City County. This aligned with guidance provided by the ethics committee to include the entire universe given that the population was not only small but also easily accessible.

3.6 Selection of study participants

The inclusion criterion that was employed during the study is as follows;

Inclusion criteria

1. Managers of private solid waste management companies who had managed the company for more than 3 months.

2. Managers who gave consent to the study.

3.7 Sample size determination

The desired sample size was 64. This was the list of the total number of Private Solid Waste Management companies registered by the Nairobi City County in 2012 (Appendix D). The desire was to include this entire universe (population) of registered private companies into the study.

Before embarking on the data collection, the researcher sought to confirm the number of active private Solid Waste Management companies in Nairobi County as at 2015; the year of data collection. The researcher got in touch with an officer from the Nairobi City County who was able to provide an updated status of active private companies. From the initial list of 64 registered companies, only 39 companies were found to be still operational, all were sampled. Twenty five (25) companies were struck from the list for various reasons, as follows, ten (10) were no longer operating as waste management companies, one (1) was closed and the garbage trucks destroyed and sold as scrap metal, two (2) were no longer licensed by the Nairobi City County, one (1) was a construction company, two (2) offered cleaning services only, one (1) was an oil refinery company, one (1) was a bakery, four (4) did not offer sold waste management services, two (2) were industries and one (1) was not traceable physically.

Further, the researcher was introduced to the association of private solid waste management companies in Nairobi named Waste and Environment Management Association of Kenya (WEMAK). The researcher was able to obtain a list of additional companies that were not in the revised list from Nairobi City County. This list had an additional fifteen (15) companies. Combining the two lists gave a total of 54 private solid waste management companies in Nairobi. Fifty-four (54) was the final sample size (Appendix D).

3.8 Data collection procedure

Data was collected using a structured questionnaire (Appendix C). The tool consisted of five parts; demographic data (section A), solid waste collection services (Section B), mode of transport for solid waste (Section C), solid waste disposal methods (Section D) and challenges faced by private solid waste management companies (Section E).

After approval from Kenyatta National Hospital/University of Nairobi-Ethics and Research Committee (APPENDIX E), the researcher delivered introduction letters as well as consent forms to the managers of the identified private solid waste management companies.

The researcher explained the purpose of the study, which was to investigate the current state of municipal solid waste management and the challenges faced by private solid waste management companies. Informed consent was obtained from them before data was collected. The data was collected within the managers' offices and the WEMAK office for confidentiality purposes.

3.9 Pre-test

A pilot survey was carried out in Kiambu County. The questionnaire was pre-tested for quality control. Kiambu County was selected as it had strong interactions with Nairobi and the characteristics of the area were similar to those of Nairobi. It was expected that the pre-test would be able to assess the validity, reliability, practicability and sensitivity of the questionnaire. The questionnaire was administered to 15 managers of private solid waste management companies within Kiambu County in two days. A discussion of their experience as they answered the questionnaire was held. This discussion yielded the modifications in the questionnaire. Some questions were removed from the questionnaire as they were not relevant in the study. The pilot established that all the managers of the private companies did not have an education background in solid waste management. All the managers were running the companies as businesses for profit.

3.10 Minimization of errors and bias

By choosing to include the entire universe of private solid waste management companies (54) in Nairobi, the researcher was able to minimize the potential of selection bias associated with

sampling techniques. In addition, self-administered questionnaires are prone to information bias, where respondents may feel persuaded to give socially acceptable responses and not the actual truth. Following the pilot, the researcher introduced several validation questions into the questionnaire to mitigate this risk.

3.11 Ethical considerations

Ethical clearance was obtained from the Kenyatta National hospital/University of Nairobi -Ethics and Research Committee. After this clearance informed consent was obtained from the managers by the researcher before data was collected. Each of the managers was given a consent form that they read through before signing.

All data collected was kept strictly confidential. The researcher stored the coded questionnaires in a locked room in her home. The electronic data was stored in a computer with a secret lock password.

3.12 Data processing and analysis

All filled questionnaires were cleaned to ensure completeness, accuracy and consistency in answering of questions. All the answers given in the questionnaires were coded using numbers for ease of data entry. Data was entered into Microsoft Excel, cleaned, verified and analyzed using Statistical Packages for the Social Sciences (SPSS) version 21.0. Descriptive data was tabulated into means, frequencies and percentages and presented in the form of tables, bar graphs, line graphs as well as pie charts.

3.13 Limitations of the study

It was difficult to physically locate a company office and find a manager at the office. Some of the locations that had been recorded at the Nairobi City County for licensing purposes were

nonexistent. Some companies had phone numbers that were no longer functional. Some companies were no longer operational and they had not been removed from the Nairobi City County's list of 2012. This led to a delay in data collection.

The respondents thought that the researcher was a Nairobi City County employee purporting to be a student with the aim of investigating their operations. This led to mistrust of the researcher this led to decline of some managers in giving any information about the company and picking the researchers phone calls.

CHAPTER FOUR: RESULTS

4.0 Introduction

This chapter gives a detailed analysis of the data collected and presents results collected in relation to the study objectives through structured questionnaires. Forty four (44) questionnaires were completed and analysed; this presented an 81.4% response rate.

4. 1 Company characteristics

The company characteristics captured in the questionnaire included the age of the company in years, year the company was licensed to partner with the Nairobi City County in municipal solid waste management, the year the company was licensed by NEMA, characteristics of employees, as well as, the area of operation in Nairobi County.

The oldest waste company had been in existence for 31 years with average years of existence being 12.4 years while the mean years since being licensed by NEMA was 9.6 years. A majority (93.2%) of the companies had been in existence for less than 20 years. A majority of the companies 79.6% and 91% had obtained licensure to partner with the NCC and NEMA respectively within the last 15 years (Table 1).

Table 1: Company characteristics

Company Characteristics		
	All: N= 44	
Years a company was licensed to partner with the NCC: Mean (SD)	12.4(6.3)	
Years since licensed by NEMA Mean (SD).	9.5(4.8)	
	Frequency	**Percentage**
Years of existence		
< 10 years	16	36.4
11-20 years	25	56.8
21-30 years	3	6.8
Total	44	100
Duration company licensed to partner with the NCC		
< 5 years	2	4.5
5-10 years	16	36.5
11-15 years	17	38.6
16-20 years	2	4.5
21-25 years	5	11.4
>25 years	2	4.5
Total	44	100
Duration since licensed by NEMA		
< 5 years	3	6.8
5-10 years	27	61.5
11-15 years	10	22.7
16-20 years	2	4.5
>20 years	2	4.5
Total	44	100

4.1.1 Number of employees by gender and employment category

The study sought to identify the gender composition of employees. Majority (80%) of the employees in all the companies were male (Figure 1). In addition, the employees were further categorized into drivers, loaders and sweepers. The employees were further grouped according to full time, part time and causal employees.

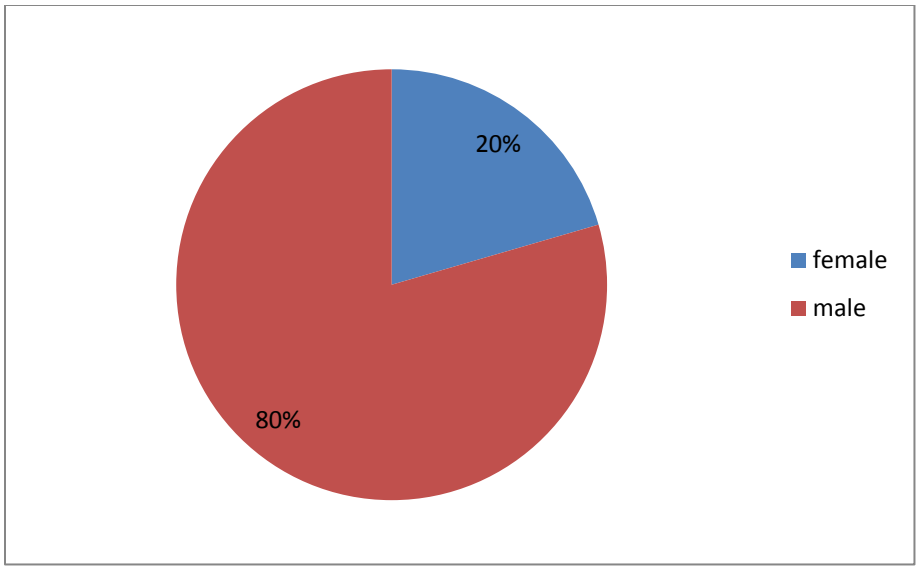


Figure 1: Percentage of employees by gender

4.1.2 Area of Operation

This was a multiple choice question allowing respondents to select multiple responses. Nairobi County constitutes 17 constituencies. Majority of the companies operated in Dagoretti (77.3%) and Embakasi (63.7%) constituencies. Others were Westlands (63.6%) and the least was Ruaraka (6.8%) and Roysambu (4.5%) constituencies (Figure 2).

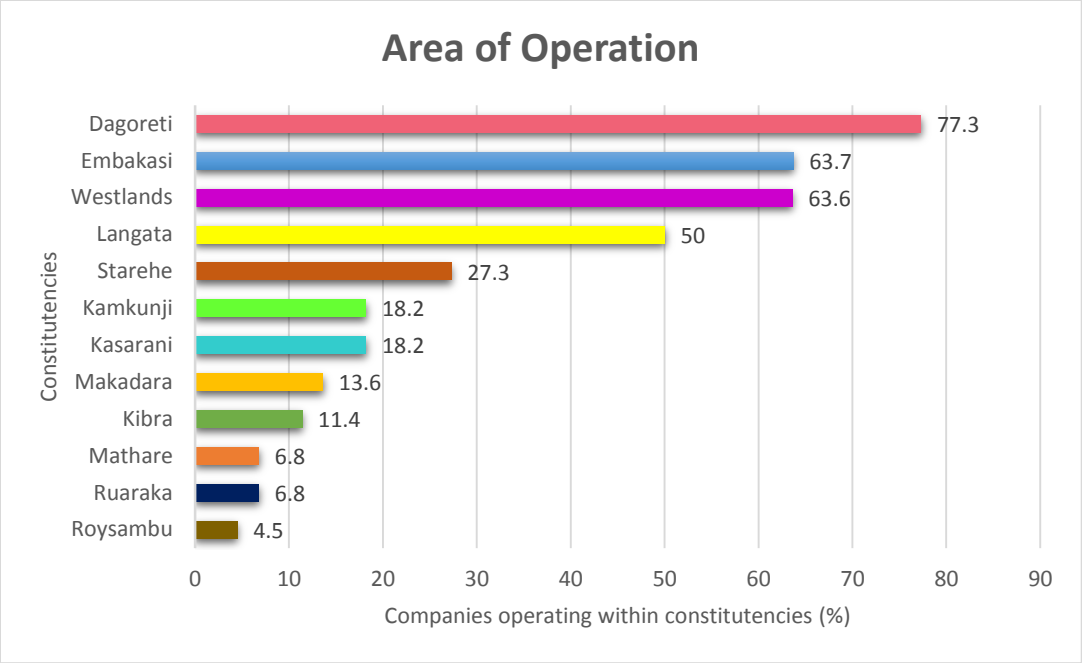


Figure 2: Areas of operation

4. 2 Solid waste collection

The study sought to establish the methods of solid waste collection. The respondents were asked about the type of solid waste they collected and mode of collection.

4.2.1 Type of solid waste collected

Household waste remains the largest (95.5%) type of waste collected followed by trade waste (59.1%) (Figure 3). The collection points vary from one company to the other; however, the door to door collection represented the commonly used collection point at 85.7% while Kerbside collection (7.1%) was the least used collection point (Figure 4).

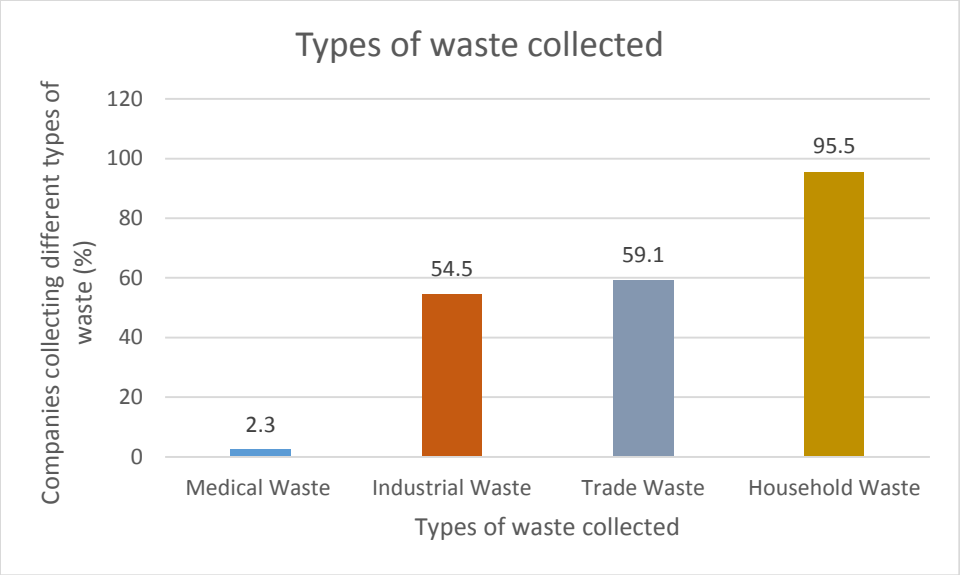


Figure 3: Type of waste collected by private solid waste management companies in Nairobi

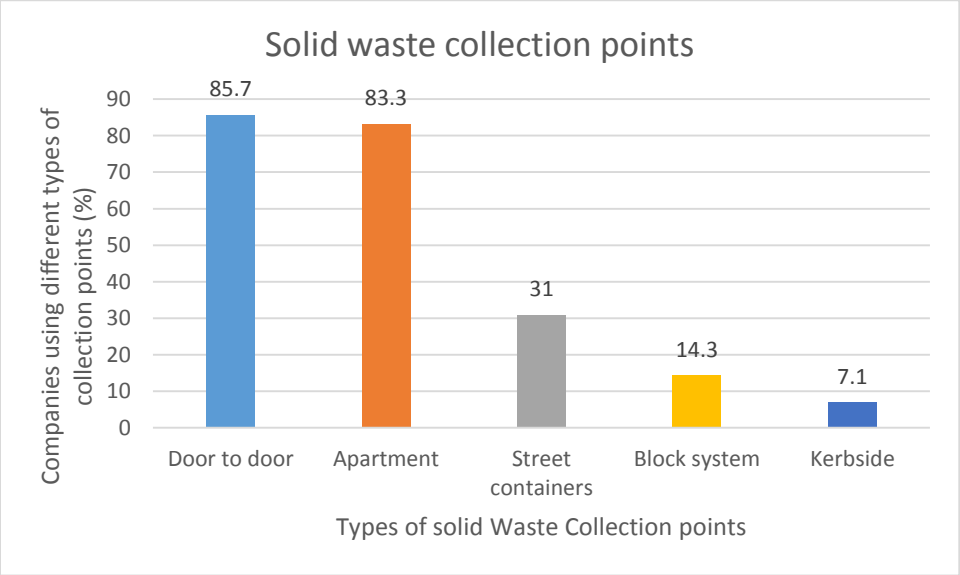


Figure 4: Solid Waste Collection points

4.2.2 Cost of waste collection on the client

The study sought to identify the amount of money charged by the waste management companies for solid waste collection and disposal. The study showed that half (50%) of the companies charged less than Ksh. 500 while the other half charged more than Ksh. 500.

4.3 Waste collection and transportation

The study aimed at identifying the equipment used for primary solid waste collection, as well as, the type of vehicles used to transport the solid waste from the collection points to the place of disposal.

Waste is first collected in different types of equipment before it is transported to the final disposal site in vehicles. Wheelbarrows (64%) and push carts (40%) were the most used primary waste collection equipment (Figure 5).

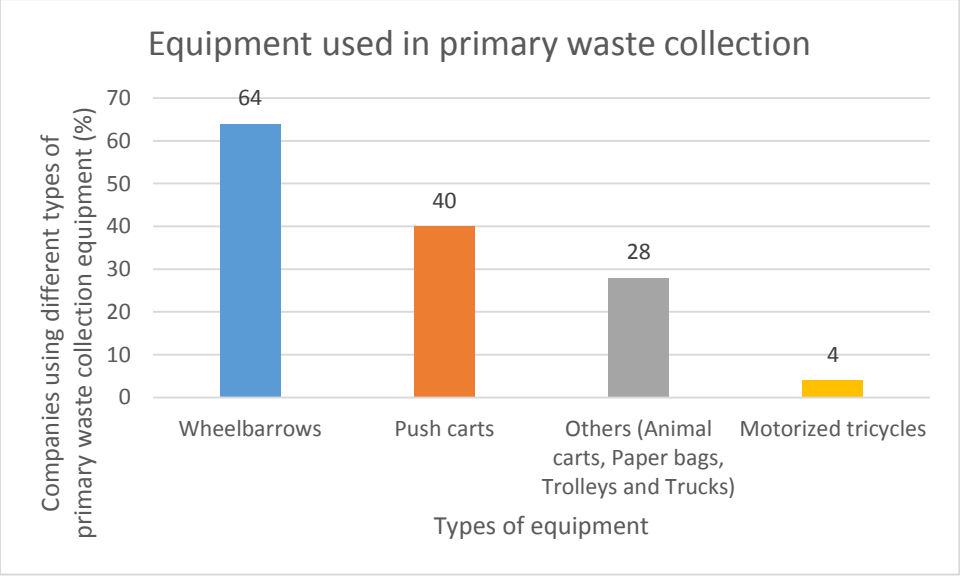


Figure 5: Equipment used for primary waste collection

4.3.1 Types of vehicles used in secondary transportation of waste

Waste is transported from the source of production to the disposal site in different kinds of vehicles. Twenty eight companies owned and hired high sided open-top vehicles with more than half (53.9%) of them having being in existence for less than 2 years. Other types of vehicles used for solid waste collection included canters, pick-ups and lorries (Table 2).

Table 2: The most commonly used vehicle for secondary solid waste collection and their age

Characteristics	**Type of vehicle**			
	High sided open-top vehicle	Canter	Pick-up	Lorries
Frequency of companies	28	20	7	9
	%	**%**	**%**	**%**
Status				
Owned	77.8	100	100	100
Hired	22.2	0	0	0
Duration				
<2 years	53.9	0	0	0
2-5 years	25.6	88.9	100	50
>5 years	20.5	11.1	0	50

4.4 Solid waste disposal methods

The study aimed to identify the different methods used by private solid waste management companies to dispose the waste. The disposal methods that the researcher sought to identify in Nairobi County were dumping in dumpsite, dumping in drainages, burning, dumping on roadsides, dumping in rivers, sanitary landfill and incineration.

The study found out that private companies used different types of disposal. Solid waste disposal in a dumpsite remains the major (98%) waste disposal method. Other unconventional solid waste disposal methods used were dumping in drainages (16%), dumping in rivers (5%) and dumping

on road sides (2%). Burning in open air constituted 2% of the solid waste disposal methods used by the private solid waste management companies (Figure 6).

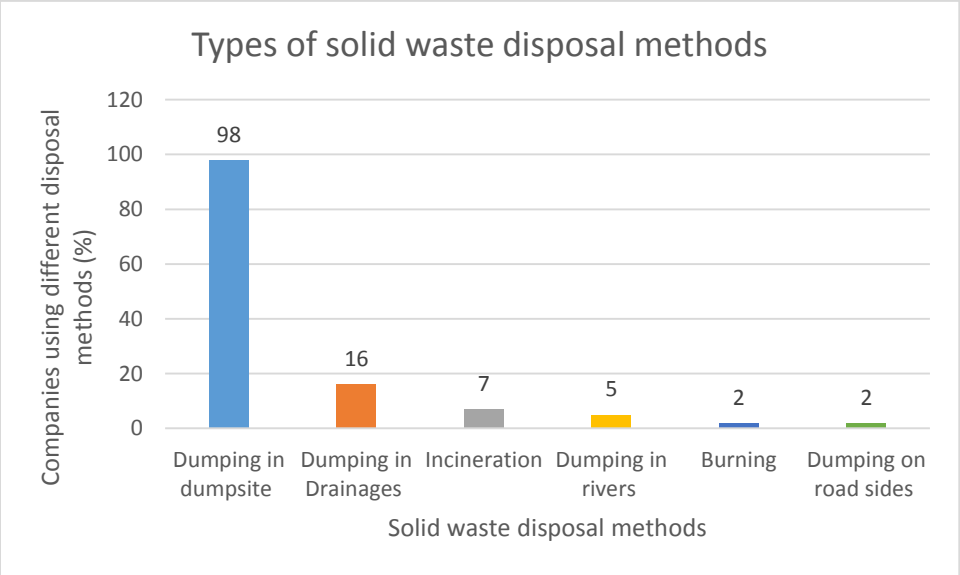


Figure 6: Waste disposal methods used by the private companies

A majority (97.7%) of companies indicated that they disposed their waste in Dandora dumpsite in Nairobi. Overall, 95.5% stated that they pay a fee for dumping at the Dandora dumpsite with 66% stating that they pay between Ksh 100-199. More than three quarters (77.3%) travelled for 16 to 20 kms from the place of waste collection to the dumpsite (Table 3).

Table 3: Amount paid for solid waste collection and distance covered from area of service and disposal site

Characteristics		
	All: N= 44	
	Frequency	**Percentage**
Do you pay fee		
Yes	42	95.5
No	2	4.5
Total	44	100
How much do you pay (KSH)		
< 99	1	2.3
100-199	29	66
200-299	4	9.1
300-399	2	4.5
400-499	2	4.5
>499	6	13.6
Total	44	100
Distance		
< 5 KM	1	2.3
6-10 KM	6	13.6
11-15 KM	3	6.8
16-20 KM	34	77.3
Total	44	100

4.5 Challenges faced by private companies in solid waste management

Solid waste management has its challenges within Nairobi County. The private companies cited several challenges that they face among them being lack of access to capital to start up (66.7%), lack of enforcement of solid waste management laws (64.3%) and refusal of clients to pay for services (59.5%) among others (Figure 7).

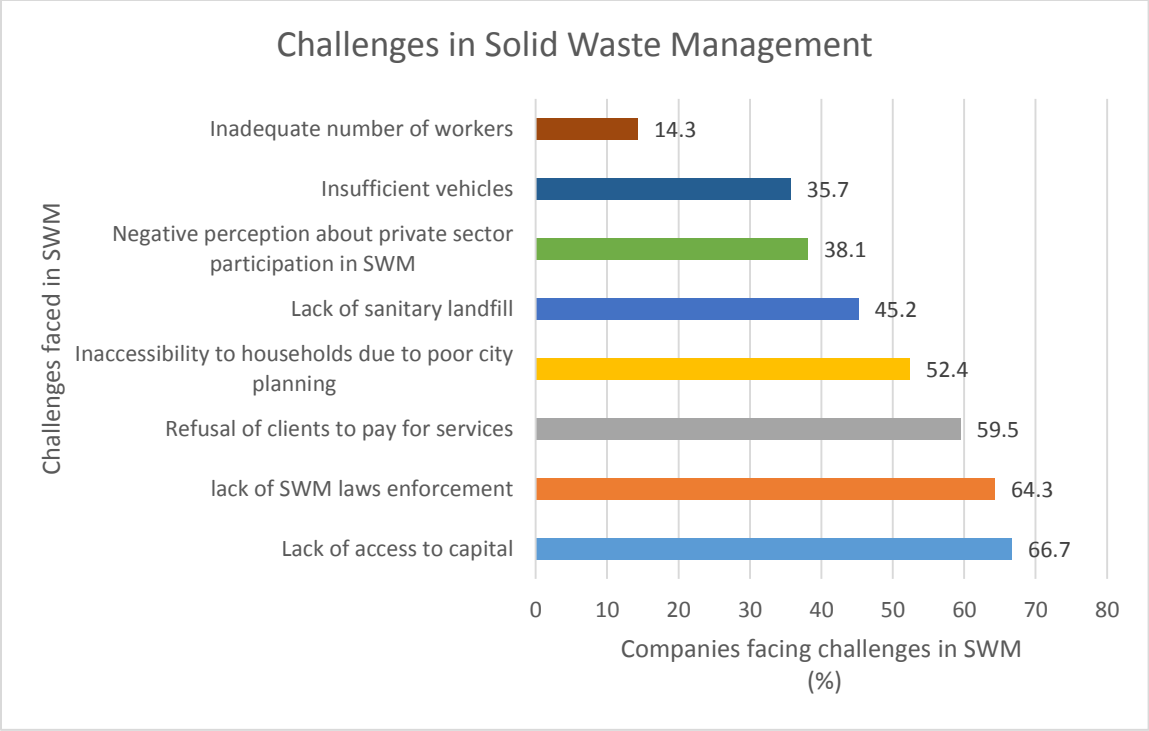


Figure 7: Challenges faced by the private companies

CHAPTER FIVE: DISCUSSION

5.0 Introduction

In this chapter, the results of the study are discussed. The results obtained from the managers of private solid waste management companies in Nairobi are discussed under various sections which address the specific objectives of the study. These sections are company characteristics, solid waste collection services, mode of solid waste transportation, solid waste disposal methods and challenges faced by private solid waste management companies.

5.1 Characteristics of the companies

The company attributes studied include, age of the company, licensing by NCC and NEMA, employee characteristics (their number, category of employment and their training on solid waste management) and area of operation of the company.

5.1.1 Age of company and licensing by NCC and NEMA

The involvement of private garbage collectors in Nairobi began in 1986. There were two private companies in 1986 (Karanja, 2005; cited in Kasozi and Blottnitz, 2010). The study established that one of the two oldest private solid waste management companies was still operational. The company has been in operation for 31 years. The study further established that the average number of years the companies were in operation were 12 years.

The Nairobi City County through the Department of Environment offer licenses to private solid waste management companies (Environmental Audit Unit, 2007). The Nairobi City County regulates solid waste management through the Nairobi solid waste management bill, 2015. The study established that all the companies were licensed by NCC.

The National Environment Management Authority (NEMA) was established under the Environmental Management and Co-ordination Act No. 8 of 1999 (EMCA). The Authority's mandate was to implement policies relating to the environment. It has been in operation since 1st July 2002 as a Semi-Autonomous Government Agency (SAGA) in the Ministry of Environment, Water and Natural Resources (NEMA, 2017). The authority issued regulations on solid waste management to all stake holders handling all types of waste in Kenya in September 2006 (Environmental Audit Unit, 2007). At the time of the study, majority (83.8%) of companies were licensed by NEMA. This shows that the companies operate under the stipulated laws by NEMA on environmental management.

5.1.2 Employee characteristics

The study sort to establish the employee characteristics to include the gender, number of employees based on their category of employment (full time, part time and causal) and whether they were trained on solid waste management. The study established that majority (80%) of employees in the private solid waste management companies were male. These findings are similar to studies carried out in Canada (Environmental Careers Organisation Canada, 2010) and Nigeria (Muhammad and Manu, 2013).

A study carried out in SWM industries in Canada showed that male employees accounted for 77% of the employment positions as permanent (93%) and full-time (96%) positions. The study further showed that female employees (23%) were more likely to work in administration department in SWM industries and not in areas directly related to SWM like loading waste (Environmental Careers Organisation Canada, 2010).

A study conducted in Nigeria on gender roles in informal solid waste management in cities of northern Nigeria: a case study of Kaduna metropolis showed that more women (55%) were involved in waste collection and recycling at the household level. On the contrary it was observed that only men were involved in collection and transportation of waste at the dumpsites (Muhammad and Manu, 2013).

5.1.3 Area of operation

The study sought to establish the area in which the companies collected solid waste. The study established that 77% and 63.6% of companies operated in Dagoretti and Westlands constituencies respectively which are high income areas. Fewer companies operated in low income high density areas such as Kibra (11%) and Mathare (6.8%).

This finding is in congruence to a finding in a study conducted by Karanja, 2005 in Nairobi that showed that 45% of respondents in high and middle income areas received waste collection services from private companies. Another study conducted in 2010 in Nairobi showed that only half of the waste generated was collected (Ngau and Blottnitz, 2010). It further showed that the waste collection was higher in middle and high income areas. Collection of solid waste was low in low income areas.

This finding is likely to suggest that in the last ten years' strategies to improve solid waste collection in low income areas have not been effected despite recommendations given by previous researchers.

5.2 Types, points and mode of solid waste collection

The study sought to find out the type of solid waste collected, the collection points as well as the cost of waste collection to the client. The different solid waste collection points that the

managers were asked about include street containers, kerbside, block system, door to door and collection from apartment buildings.

5.2.1 Type of solid waste collected

The study established that the most common type of waste collected was household waste (95.5%) and the least being medical waste (2.3%). Medical waste is mainly disposed through incineration in hospitals, clinics and licensed incinerators although some of it gets to the Dandora dumpsite (NEMA, 2015). The study shows that 2.3% of companies collect and dispose medical waste by dumping it in the Dandora dumpsite. This medical waste even though small is a health hazard to employees who collect the waste and waste handlers at the dumpsite.

5.2.2 Solid waste collection point

The study further showed that the commonly used waste collection point is the door to door collection. Similar studies conducted in Kolkata, India (Hazra and Goel, 2009) and Dar es Salam, Tanzania (Kassim and Ali, 2006) showed that door to door collection was the most common solid waste collection point which accounted for 61.2% and 57% respectively.

5.2.3 Mode of solid waste transportation

The study established that 63% of companies owned (77.8%) or hired (22.2%) high-sided open-top vehicles for solid waste transportation from point of generation to the disposal site. The Environmental Management and co-ordination (Waste Management) Regulations (2006) recommends that vehicles used for waste transportation should be covered at the top to prevent scattering of waste during transit. The study established that other types of vehicles used for

waste transportation were canters, pick-ups and lorries which are not recommended for waste transportation.

According to UN-Habitat (2010a), the selection of a solid waste transportation vehicle is determined by the rate of waste generation, waste density, components of waste, loading heights of vehicles, traffic conditions and restrictions, transport distance and road conditions, local manufacture and sustainability, level of service and willingness to pay for solid waste management by clients.

Compaction vehicles are used to transport low density waste which is generated in developed countries such as the USA. Solid waste generated in developing countries such as Kenya is dense. The study established that 95.5% of the private solid waste management companies collect household waste. Household waste or domestic waste is composed mainly of biodegradable waste that is kitchen and food waste and non-biodegradable such as glass and plastics bottles (NEMA, 2015). Transportation of this type of waste requires non compacting vehicles such as the high sided open-top vehicles (UN-Habitat, 2010a).

5.2.4 Solid waste disposal

The study established that the most common solid waste disposal method is dumping (100%). The study further established that majority of the companies (97.7%) dumped their waste at the Dandora dumpsite. The Dandora dumpsite covers 30 acres of land and is situated in Dandora, Korogocho, Mathare and Baba Ndogo slums in Nairobi. It was opened in 1975, it was considered full in 2001 yet it is still operational 16 years later (Barczak, 2015). The study is similar to several studies conducted in Africa and Asia that showed that open dumping accounted for 47% and 51% respectively of waste disposal methods (Gupta, 2012).

The study further established that other disposal methods used by the private companies included dumping in drainages (16%), dumping in rivers (5%), dumping on road sides (2%).and burning (2.3%). These unlawful disposal methods such as dumping in drainages lead to their blockage leading to stagnant water which is a breeding site for disease vectors such as malaria (UN Habitat, 2010a). On the contrary, in developed countries such as North America there are only two disposal methods, that is, incineration (91%) and recycling (8%) (Gupta, 2012). In Japan, 79% of their total municipal solid waste was incinerated (Pariatamby and Tanaka, 2014).

5.3 Challenges faced by solid waste management companies

The study sought to establish the challenges faced by solid waste management companies. The top five challenges identified in the study include lack of access to capital to start up, buy and maintain vehicles and equipment (66.7%), lack of enforcement of solid waste management laws by local government (64.3%), refusal of clients to pay for services (59.5%), inaccessibility to households due to poor city planning (52.4%) and lack of sanitary landfill (45.2%).

Several studies conducted in African countries show similar challenges faced by private solid waste management companies. A cross sectional study done in Minna, Nigeria identified the challenges as lack of sanitary landfills, insufficient vehicles, lack of capacity building initiatives and enforcement of solid waste management laws by local government and poor pay by clients (Sanusi, 2010). Similar challenges as those identified in the study have been reported by NEMA (2015).

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

In conclusion, the study found that the private solid waste management companies are important stakeholders in solid waste management in Nairobi. Their services supplement efforts by the Nairobi City County toward a healthy and safe environment. The study further found out that the solid waste management process by private companies in Nairobi is similar to other African cities such as Abuja, Nigeria.

The study established that collection of waste by private solid waste management companies in Nairobi County is concentrated in the high income areas. The study further shows that there is low collection of solid waste in low income areas such as the slums, Kibra. This waste poses environmental and human health challenges. Uncollected solid waste ends up in drainages causing their blockage which further causes flooding as observed in the resent years in Nairobi.

The study further established that majority of the companies use non-compaction vehicles (high-sided open top vehicles, canters, pick-ups and lorries) to transport waste. According to the recommended solid waste transportation vehicles most of the companies use vehicles such as canters and pick-ups which are not the recommended types of vehicles for solid waste transportation. They are often not covered at the top as recommended by NEMA and may lead to spewing of waste on roads during transportation.

The study found out that the private solid waste management companies use open dumping at the Dandora dumpsite as their main disposal method. The study established that safer disposal

methods such as use of sanitary landfills and incineration that pose lesser environmental harm are not available.

The study further established that the top three challenges faced by private solid waste management include lack of access to capital to buy and maintain vehicles and equipment, lack of a level playing ground for all companies and refusal of clients to pay for services.

6.2 Recommendations

The following are recommendations by objectives that can ameliorate the solid waste management in Nairobi County;

1. The Nairobi City County and National Environment Management Authority should monitor and enforce the use of the recommended MSW transportation vehicles.

2. The Nairobi City County should adopt and invest in mass waste to energy strategies for example by building incinerators that would convert the solid waste generated within the city to energy which can be fed into the national grid.

3. Financial organisations should provide low interest rate loans to private solid waste management companies. This will enable the companies to purchase additional vehicles and equipment, which will improve the efficiency of services.

REFERENCES

Abarca, L., Maas, G. and Hogland, W., 2013. Solid waste management challenges for cities in developing countries. *Waste Management*, 33(1), pp.220–232. Available at: http://dx.doi.org/10.1016/j.wasman.2012.09.008.

Alakinde, M., 2012. Private Sector Participation and Sustainable Solid Waste Management in Ibadan South West Local Government, Nigeria, 3(6), pp.887–892. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.300.4197&rep=rep1&type=pdf

Anderson, B., 2011. *A Formula for Provision or Perversion of Municipal Solid Waste Management?*, Available at: www.cprindia.org/.../privatisation-formula-pr....

Barczak, P., 2015. Dandora Landfill in Nairobi, Kenya. European Environmental Bureau. Available at: https://ejatlas.org/conflict/dandora-landfill-in-nairobi-kenya

Blottnitz, H. and Ngau, P., 2010. *Integrated Solid Waste Management Plan for the City of Nairobi*, Nairobi. Available at: www.unep.or.jp/.../IS_6_4_Nairobi_ISWMpl..

Bowan, P.A., 2013. Private Sector Capacity in the Management of Urban Solid Waste in Ghana – A Study of Zoomlion in the Wa Municipality Patrick Ninemenga Bowan. , 5(2), pp.352–364. Available at: *infinitypress.info/index.php/jsss/article/download/437/236*

Coad, A., 2005. *Private sector involvement in Solid waste management. Avoiding problems and building on successes*, Available at: www.skat.ch/publications/prarticle.2005-09-29.7288084326/.../file.

Downs, P., 2011. Past experiences of many cities suggest privitizing sanitation services wasn't a panacea. Available at: http://www.commercialappeal.com/news/2011/jul/10/no-quick-fix/.

Environmental Audit Unit, 2007. *Nairobi City County : Managing solid waste in Nairobi city*, Available at: www.environmental auditing.org/.../AuditFiles/Full Managing so.

Environmental Careers Organisation Canada, 2010. Solid Waste Management. Labour research market study. Available at: http://www.eco.ca/ecoreports/pdf/Solid-Waste-Management-Labour-Market-Research-2010.pdf

Environmental Management and co-ordination (Waste Management) Regulations, 2006. *Waste Management Regulations License Application and Renewal as per Legal Notice 121*, Kenya. Available at: *https://www.nema.go.ke/.../Regulations/Waste%20Management%20Regulations-1.pdf*

Ghose, M.K., Dikshit, A.K. and Sharma, S.K., 2006. A GIS based transportation model for solid waste disposal – A case study on Asansol municipality. *Waste Management*, 26(11), pp.1287–1293. Available at: http://dx.doi.org/10.1016/j.wasman.2005.09.022.

Gupta, K. and Ymele, 2012. Waste: the challenges facing developing countries. Private Sector and Development. , (October), pp.17. Available at: http://www.proparco.fr/jahia/webdav/site/proparco/shared/PORTAILS/Secteur_prive_developpement/PDF/SPD14/revue_SPD15_UK.pdf

Hazra, T. and Goel, S., 2009. Solid waste management in Kolkata , India : Practices and challenges. *Waste Management*, 29(1), pp.470–478. Available at: http://dx.doi.org/10.1016/j.wasman.2008.01.023.

Hoornweg, D. and Bhada-Tata, P. 2012, 2012. *What A Waste A Global Review of Solid Waste Management*. Available at: web.worldbank.org › Topics › Urban Development.

Imam, A. et al., 2008. Solid waste management in Abuja, Nigeria. *Waste management (New York, N.Y.)*, 28(2), pp.468–72. Available at: http://www.ncbi.nlm.nih.gov/pubmed/17379496

Infotrack East Africa Limited, 2012. Nairobi County. , p.2. Available at: http://www.infotrackea.co.ke/services/leadership/countyinfo.php?cinf=constituenciesandt=47

Kaseva, M.E. and Mbuligwe, S.E., 2005. Appraisal of solid waste collection following private sector involvement in Dar es Salaam city , Tanzania. , 29, pp.353–366. Available at: *https://pdfs.semanticscholar.org/a42d/53f66e1e5cda292bafca750c18ecf312d913.pdf*

Kasozi, A. and Blottnitz, H., 2010. *Solid waste Management in Nairobi: A situation analysis. Report for City Council of Nairobi, contract for UNEP. Available at: http://www.ecopost.co.ke/assets/pdf/nairobi_solid_waste.pdf.*

Kassim, S. and Ali, M., 2006. Solid waste collection by the private sector : Households ' perspective — Findings from a study in Dar es Salaam city , Tanzania. , 30(4), pp.769–780. Available at: https://www.infona.pl/resource/bwmeta1.element.elsevier-9b2905db-a6c0-3a50-83fd-dbbf65df28e0

Kenya National Bureau of Statistics, 2009. *Kenya 2009 population and housing census highlights.* Available at*: https://www.knbs.or.ke › KNBS News*

Khan, N. A., (2014). Perspectives of Transport and Disposal of Municipal Solid Waste in Srinagar City. *International Journal of Engineering Research and General Science* Volume 2, Issue 4, ISSN 2091-2730. Available at: http://ijergs.org/files/documents/PERSPECTIVES29.pdf.

Ministry of Urban Development, 2000. Transportation of waste 13.1. In *Solid Waste Management Manual*. pp. 228–242. Available at: http://urbanindia.nic.in/publicinfo/swm/chap13.pdf.

Muhammad, M. N. and Manu, H. I., 2013. Gender roles in informal solid waste management in cities of northern Nigeria: a case study of Kaduna metropolis. *Academic Research International,*

ISSN-L: 2223-9553, ISSN: 2223-9944 Vol. 4 No. 5. Available at: http://www.savap.org.pk/journals/ARInt./Vol.4 (5)/2013(4.5-16).pdf.

Muniafu and Otiato, 2010, 2010. Solid Waste Management in Nairobi, Kenya. A case for emerging economies. 2(1), pp.342–350. Available at: *https://www.ajol.info/index.php/jolte/article/view/52009*

Nairobi County, 2012. List of private collectors. , p.5.

National Environment Management Authority (NEMA), 2017. Establishment. Available at: https://www.nema.go.ke/index.php?option=com_content&view=article&id=1&Itemid=136

NEMA, 2015. National Solid Waste Management Strategy. Avilable at: *https://www.nema.go.ke/.../National%20Solid%20Waste%20Management%20Strateg.*

Nemerow, N.L., Argardy, F. J., A. and Salvato, J.A., 2009. Environmental Engineering: Environmental health and safety for Municipal infrastructure, Land use and planning and industry. *John Willey and Sons.* Available at: books.google.com/books?isbn=0470083050.

Obirih-opareh, N. and Post, J., 2002. Quality assessment of public and private modes of solid waste collection in Accra , Ghana. , 26, pp.95–112. Available at: *www.bvsde.paho.org/bvsacd/cd43/post.pdf*

Oduro-Kwarteng, S. 2011, 2011. *Private Sector Involvement In Urban Solid Waste Collection*. Erasmus University, Rotterdam. Available at: *https://repository.tudelft.nl/assets/uuid:e6910e93.../PhD_ODURO_KWARTENG.pdf*

Pariatamby, A. and Tanaka, M., 2014. *Municipal Solid Waste Management in Asia and the Pacific Islands* A. Pariatamby and M. Tanaka, eds., Singapore: Springer Singapore. Available at: http://link.springer.com/10.1007/978-981-4451-73-4.

Pieter van Dijk, M. and Oduro-Kwarteng, S., 2007. Urban management and solid waste issues in Africa. A contribution to the ISWA World congress in September 2007 in Amsterdam. Available at: http://www.iswa.org/uploads/tx_iswaknowledgebase/599763_Paper.pdf

Ramos, C. and Vicentini, A., 2012. Challenges and Opportunities of Waste Collection in Caracas : Sucre Municipality Case Study. , 7(July 2009), pp.115–129. Available at: *https://journals.cdrs.columbia.edu/wp-content/uploads/sites/25/.../233-554-3-PB.pdf*

Rego, R.F., Moraes, L.R.S. and Dourado, I., 2005. Diarrhoea and garbage disposal in Salvador, Brazil. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 99(1), pp.48–54. Available at: http://www.sciencedirect.com/science/article/pii/S0035920304001968

Renuka, S., 2007. Nairobi. , p.3. Available at: http://www.notoiletpaper.com/articles/76/1/Nairobi---Green-City-in-the-Sun/Page1.html

Rotich, Zhao and Dong, 2006. Municipal solid waste management challenges in developing countries--Kenyan case study. *Waste management (New York, N.Y.)*, 26(1), pp.92–100. Available at: http://www.ncbi.nlm.nih.gov/pubmed/16006111

Sanusi, A., 2010. Capacity issues of private sector participation in Urban Solid Waste Management in Nigeria. *Humanity and Social Sciences Journal*, 5(1), pp.07–18. Available at: https://www.researchgate.net/profile/Yekeen_Sanusi2/publication/292403688_%27Capacity_Issues_of_Private_Sector_participation_in_Urban_Solid_Waste_Management_in_Nigeria%27_Humanity_and_Social_Sciences_journal_Pakistan_vol_5_No_1pp_7-18/links/56ae4b7508ae43a3980e7956/Capacity-Issues-of-Private-Sector-participation-in-Urban-Solid-Waste-Management-in-Nigeria-Humanity-and-Social-Sciences-journal-Pakistan-vol-5-No-1-pp-7-18.pdf

Schübeler, P., Christen, J. and Berne, C.-, 1996. *UNDP / UNCHS (Habitat)/ World Bank / SDC Collaborative Programme on Municipal Solid Waste management in Low-Income Countries Urban Management And Infrastructure Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries*, Available at: www.worldbank.org/urban/solid_wm/.../Annex 4B.3.pdf.

Sharma, H.K., 2012. Solid Waste Management: A Problem to the Capital City of Nepal. Available at: www.researchgate.net/.../Solid_Waste_Management_A_Problem_to_...

UN Habitat, 2010a. *Collection of municipal solid waste in developing countries*, Available at: http://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/E-Learning/Moocs/Solid_Waste/W1/Collection_MSW_2010.pdf

UN Habitat, 2010b. *Solid Waste Management in the World's cities. Water and Sanitation in the World's cities 2010*, London, Washington DC: Earthscan. Available at: www.unhabitat.org/.../get....

UNEP, 2009. *Developing I Ntegrated Solid Waste Management P Lan*, Osaka/ Shiga, Japan: United Nations Environment Programme. Available at: *www.unep.or.jp/Ietc/Publications/spc/ISWMPlan_Vol1.pdf*

UNEP, 2005. *Solid Waste Management*, Available at: www.unep.or.jp/.../solid_waste_management/....

US EPA, 2014. Municipal solid waste. Available at: http://www.epa.gov/epawaste/nonhaz/municipal/.

US EPA, 2010. *Municipal Solid Waste Generation , Recycling , and Disposal in the United States : Facts and Figures for 2010*, Available at: http://www.epa.gov/waste/nonhaz/municipal/pubs/msw_2010_rev_factsheet.pdf.

World Bank, 2004. *Planning guide for MSWM,* Available at: www.worldbank.org/.../The Planning Guide.pdf.

Yahaya and Owusu-Sekyere, 2012. Challenges of Privatizing Waste Management in the in Wa Municipality Of Ghana : A Case of Zoomlion Ghana Limited. , 2(11). Available at: https://www.researchgate.net/publication/267028318_Challenges_of_privatizing_waste_management_in_the_Wa_municipality_of_Ghana_A_case_of_Zoomlion_Ghana_Limite

Zurbrügg, C., 2003. How to Cope with the Garbage Crisis., (February), pp.1–13. Available at: https://www.researchgate.net/publication/267028318_Challenges_of_privatizing_waste_management_in_the_Wa_municipality_of_Ghana_A_case_of_Zoomlion_Ghana_Limited

APPENDICES

APPENDIX A: INTRODUCTION LETTER

To: THE MANAGER

_____ Company

P.O. Box _____

Nairobi

Dear Sir/ Madam,

Re: Research Project on status of solid waste management by private companies in Nairobi County

I am undertaking a research project in partial fulfillment of the requirements for award of the degree in Master of Public Health, University of Nairobi.

You have been selected as an appropriate respondent for this study. Please note that your responses will be treated with strict confidence and used for this research purpose only. Your cooperation in this regard will be highly appreciated.

Thank you in advance.

Sincerely,

Priscilla Wanjiru Ngunju

University of Nairobi

APPENDIX B: CONSENT FORM

Introduction

My name is Priscilla Wanjiru Ngunju, a nurse and postgraduate student in the School of Public Health from the University of Nairobi. I am conducting a study among managers of private solid waste management companies on **Municipal Solid Waste Management: Status and challenges faced by private solid waste management companies.**

Purpose of the study

The purpose of the study is to investigate the current state of municipal solid waste management and the challenges faced by private solid waste management companies.

Objectives

The overall objective of carrying out this study is to assess the contribution of and challenges faced by private solid waste management companies in Nairobi County, Kenya.

Specifically, the study will aim to:

1) Evaluate municipal solid waste collection services offered by private companies in Nairobi County.
2) Determine the mode of transport of municipal solid waste by private companies in Nairobi County.
3) Establish the disposal methods of municipal solid waste used by private companies in Nairobi County

4) Identify the challenges faced by private companies in municipal solid waste management in Nairobi County

Procedure

On voluntarily agreeing to take part in the study, a questionnaire will be administered to you by a research assistant. The research assistant will be present throughout the filling in process for any question where you do not clearly understand a particular question.

Your name or that of the company will not appear anywhere. The information you will give will be confidential and will only be accessible to the interviewer and principal investigator.

The data collection will take 20-30minutes.

Benefits of the study

The findings of this study will provide information on the current situation of solid waste management by the private companies. This knowledge will assist policy and solid waste management planners to understand the prevailing trends in solid waste management leading to improved policy formulation and implementation

Risks

Your participation in this study may involve the risk of fear of divulging information. To counter this risk be ensured that all the information you give will be kept strictly confidential. All the filled questionnaires will be kept under lock and key by the principal investigator. All information that will be stored in a computer will be secured using a secret code by the principal investigator.

Compensation

The study is voluntary, no monetary compensation or any form of favors will be given for you to participate in the study**.**

Rights

Your participation in this study is entirely voluntary and you have the right to refuse to participate or not to answer any questions that you feel uncomfortable with. If you change your mind about participating during the course of the study, you have the right to withdraw at any time. The decision not to participate or to withdraw will not affect any aspects of your life. If there is anything that is unclear or you need further information, I shall be delighted to provide it.

Contacts

For any enquiries, please contact:

Priscilla Wanjiru Ngunju (Principal Investigator) on 0716 814 569 or priscillangunju@yahoo.com

For further enquiries, please contact:

Kenyatta National hospital/University of Nairobi -Ethics and Research Committee P. O. Box 20723, Nairobi; Telephone: 020-2726300 extension 44355; 726300-9

INFORMED CONSENT

The study topic, objectives and purpose have been explained to me and I have understood them. I understand that the study will enable solid waste managers to improve solid waste management services and strengthen public private partnerships in Nairobi County. I understand that this exercise is voluntary and that I do not have to answer questions that I am not comfortable with. I have also understood that I can withdraw from the study anytime during the interview.

I have not been promised any material gain to be included in this study. I therefore voluntarily consent to participate in this study.

Signature of respondent_____ Date: _____

Signature of Principal Researcher_____ Date: _____

APPENDIX C: MANAGERS' QUESTIONNAIRE

This is not a test. There is no right or wrong answers. Your responses will be kept strictly confidential. No names are required.

Questionnaire Number: _____ Date: _____

Section A: Demographic data

1. How old is the company (in years)?

   0 – 10 ☐

   11- 20 ☐

   21-30 ☐

2. Which year was the company licensed to partner with the Nairobi City County in municipal solid waste management? _____

3. Which year was the company licensed by NEMA? _____

4. a) How many workers has the company employed to deal with solid waste management?

   Females ☐ Males ☐

   b) Please give the number of employees and their category of employment:

	Full time	Part time	Casual	Total
Drivers				
Loaders				
Sweepers				

c) Are the employees trained in solid waste management?

Yes ☐ No ☐

5. Which is your area of operation in Nairobi County? (Tick where applicable)

Westlands:	Kitisuru [ ] · Parklands/Highridge [ ] ·Kangemi [ ] · Mountain View[ ]
Dagoretti North:	Kilimani [ ] · Kawangware [ ] · Gatina [ ] · Kileleshwa [ ] · Kabiro [ ]
Dagoretti South:	Mutu-ini [ ] · Ngand'o [ ] · Riruta [ ] · Uthiru/Ruthimitu [ ] · Waithaka[]
Langata:	Karen [ ] · Nairobi West [ ] · Karura [ ] · South C [ ] Nyayo Highrise [ ] Langata estate [ ]
Kibra	Laini Saba [ ]· Lindi [ ] · Makina · Woodley/ Kenyatta Golf Course [] ·Sarang'ombe []
Roysambu	Githurai [ ]· Kahawa West [ ] · Zimmermann [ ]· Roysambu [ ]· Kahawa [ ]
Kasarani	Clay City [ ] · Mwiki [ ]· Kasarani [ ] · Njiru [ ] · Ruai [ ]
Ruaraka	Babadogo [ ] · Utalii [ ] · Mathare North [ ] · Lucky Summer [ ] Korogocho [ ]
Embakasi South	Imara Daima [ ] · Kwa Njenga [ ] · Kwa Reuben [ ] · Pipeline [ ] · Kware [ ]·
Embakasi North	Kariobangi North [ ] · Dandora Area I [ ]· Dandora Area II [ ]· Dandora Area III [ ] Dandora Area IV [ ]
Embakasi Central	Kayole North [ ] · Kayole NorthCentral [ ]· Kayole South [ ]· Komarock [ ]· Matopeni/ Spring Valley [ ]·
Embakasi East	Upper Savanna [ ] · Lower Savanna [ ]· Embakasi [ ]· Utawala [ ]· Mihang'o [ ]
Embakasi West	Umoja I [ ] · Umoja II [ ] · Mowlem [ ] · Kariobangi South [ ] ·
Makadara	Maringo/ Hamza [ ] · Viwandani [ ]· Harambee[ ] · Makongeni [ ]
Kamukunji	Pumwani [ ] · Eastleigh North [ ]· Eastleigh South [ ] · Airbase [ ] · California [ ]
Starehe	Nairobi Central [ ] · Ngara [ ] · Pangani [ ] · Ziwani/ Kariokor [ ] · Landimawe [ ] · Nairobi South [ ]
Mathare	Hospital [ ]· Mabatini [ ] · Huruma [ ] · Ngei [ ] · Mlango Kubwa [ ]· Kiamaiko [ ]

Section B: Solid waste collection

6. a) What type of solid waste does the company collect? (Tick all applicable)

Trade waste ☐ Medical waste ☐

Industrial waste ☐ Household waste ☐

Other (specify)…….

b) Are all types of waste collected on the same day?Yes

No ☐ ☐

c) If No, please specify the days of collection:

Trade waste		**Medical**		**Industrial**	
Monday	☐	Monday	☐	Monday	☐
Tuesday	☐	Tuesday	☐	Tuesday	☐
Wednesday	☐	Wednesday	☐	Wednesday	☐
Thursday	☐	Thursday	☐	Thursday	☐
Friday	☐	Friday	☐	Friday	☐
Saturday	☐	Saturday	☐	Saturday	☐
Sunday	☐	Sunday	☐	Sunday	☐

Household waste		**other types of waste**	
Monday	☐	Monday	☐
Tuesday	☐	Tuesday	☐
Wednesday	☐	Wednesday	☐
Thursday	☐	Thursday	☐
Friday	☐	Friday	☐

Saturday ☐ Saturday ☐

Sunday ☐ Sunday ☐

7. Which point of solid collection does your company use to collect waste from the generator?

Street containers ☐ Kerbside ☐

Block system ☐ door to door ☐

Collection from apartment buildings ☐

Other (specify)……

……

8. How much do you charge each client per month for waste collection?

Below 500 ☐ Above 500 ☐

Section c: Mode of Solid waste transport

9. Equipment for primary collection (collection of solid waste from households to communal bin for subsequent collection by collection vehicles). Please tick the equipment used.

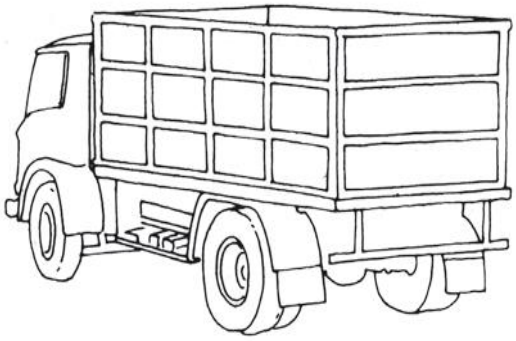
Equipment	**Tick applicable**
Wheelbarrows	
Push carts	
Animal carts	
Motorized tricycles	
Others (specify)	

10. Please indicate which of the following vehicles the company owns or hires. Please refer to page to view type of vehicles. (For each type of vehicle, please indicate the **number** that the company owns or hires).

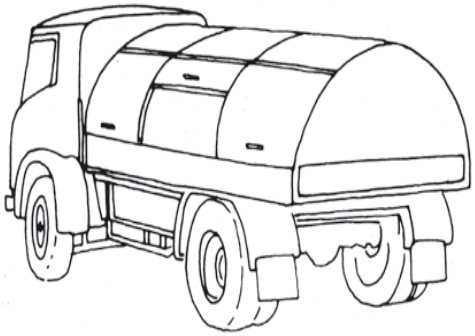
Vehicle type		**High sided open-top vehicle**	**Side loading 'roll-top' vehicles**	**Front – loading high sided -vehicles**	**Side loading bin lift system**	**Crane tipper system**	**Rear-loading compaction plate vehicle**	**Screw compactor**	**Rotating drum compaction**	**Paddle compactor**	**Front loading compactor**
No. and ownership status	**Owned (O)**										
	Hired (H)										
No.	**Good (G)**										
of vehicles by condition	**Fair (F)**										
	Bad (B)										
No. of vehicles by age (years)	**>10**										
	5-10										
	2-5										
	<2										

TYPES OF WASTE COLLECTION VEHICLES

1. High-sided open top vehicle

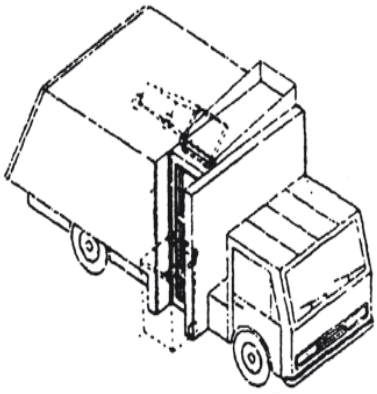


2. Side loading 'roll-top' vehicle



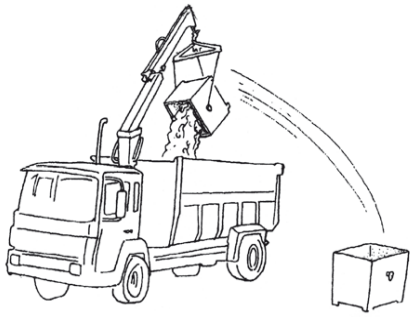
3. Front-loading high-sided enclosed vehicle

4. Side loading bin lift system



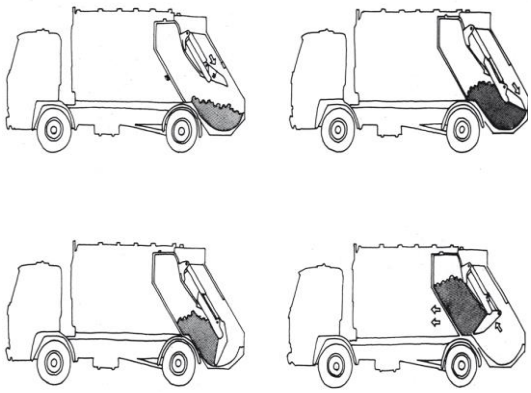
5. Crane-tipper system

6. Screw Compactor

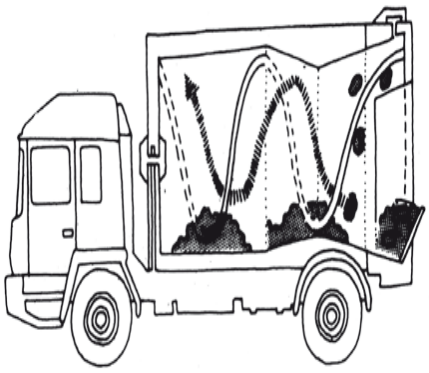


7. Rear-loading compaction

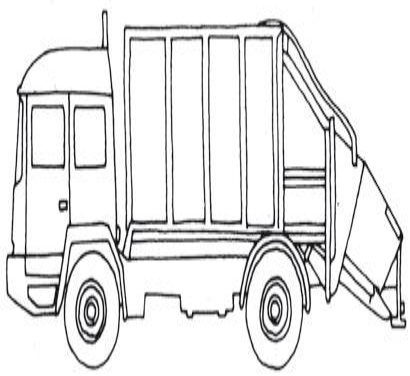
8. Rotating drum compactor

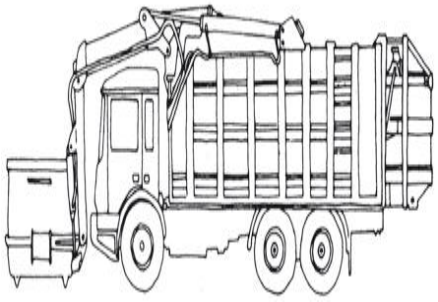


9. Paddle compactor



10. Front loading compactor





b) If the company does not own or hire any of the above vehicles. Which other types of vehicles that the company owns or hires.

Type of vehicle (Specify)		**Canter**	**Pick ups**	**Lorries**
Number and ownership status	Owned			
	Hired			
Number of vehicles by condition	Good			
	Fair			
	Bad			
Number of vehicles by age	>10			
	5-10			
	2-5			
	<2			

Section D: Solid waste disposal Methods

11. Which of the following disposal method(s) does the company use?

Dumping in dumpsite ☐ Dumping in Drainages ☐

Burning ☐ Dumping on road sides ☐

Dumping in rivers ☐ Sanitary landfill ☐

Incineration ☐

Other (Specify)……

……

12. Which disposal site do you take the solid waste collected?

.....

13. a) Do you pay any fees to the disposal site managers for transporting waste to the disposal site? ☐ ☐ No

b) If yes, how much do you pay (in shillings) per tonne of waste delivered?

0 -99	☐	300-399	☐
100- 199	☐	400-499	☐
200-299	☐	500-599	☐

c) What is the approximate distance between the service area and the disposal site in kilometers?

0-5	☐	11-15	☐
6-10	☐	16-20	☐

Section E: Challenges faced by private companies in solid waste management

14. Please indicate the challenges that you face in solid waste management:

- Lack of access to capital to start up, buy and maintain vehicles and equipment ☐
- Negative perception about private sector participation in solid waste management by clients ☐
- Refusal of clients to pay for services ☐

- Inaccessibility to households due to poor city planning ☐
- Insufficient vehicles Inadequate number of workers ☐
- Lack of sanitary landfill ☐
- Lack of enforcement of solid waste management laws by local government ☐

Others(Specify)……

……

……

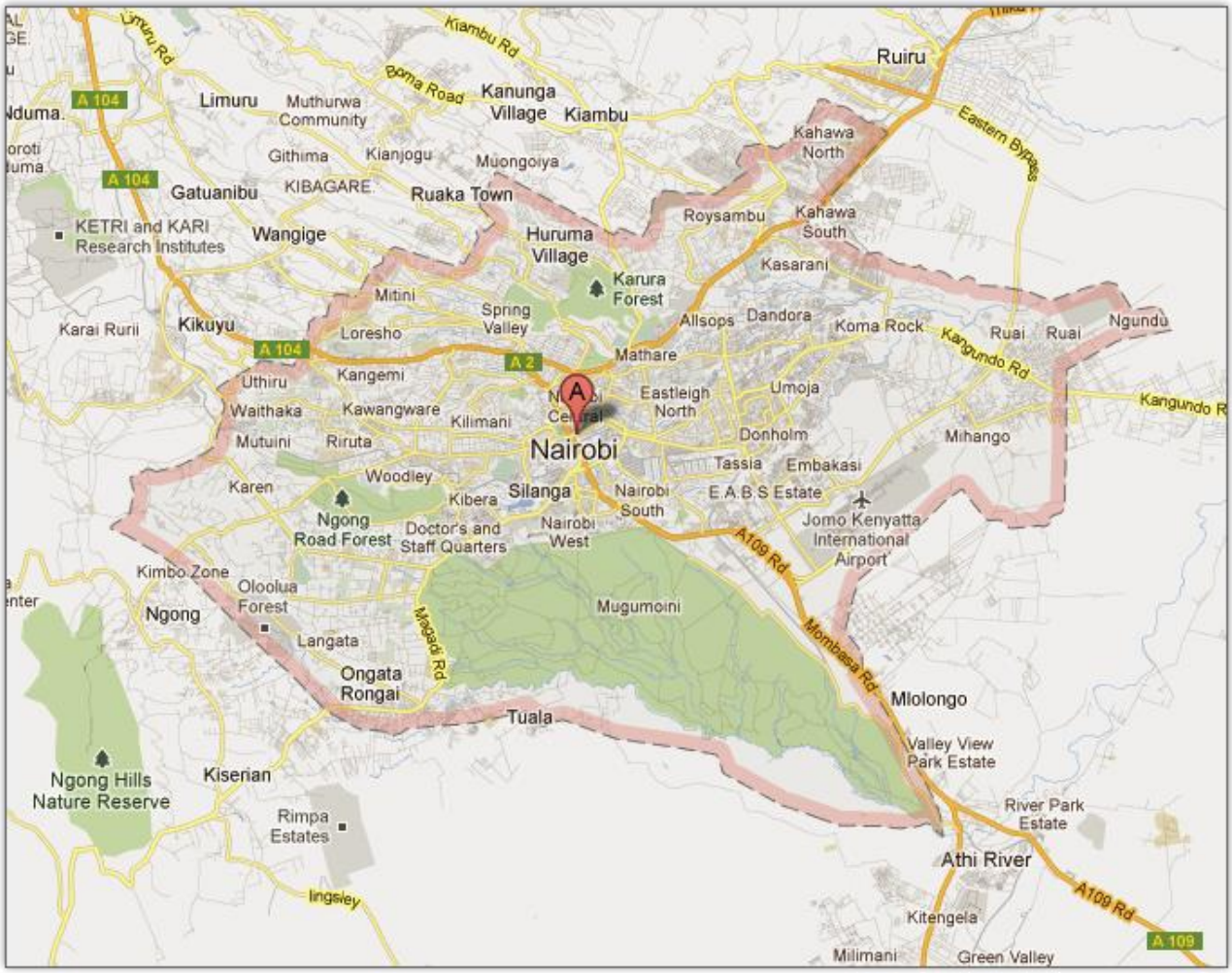
……

……

……

Thank you for your participation

APPENDIX D: NAIROBI COUNTY MAP



APPENDIX E: LIST OF PRIVATE SOLID WASTE MANAGEMENT COMPANIES

1	Boulevard Bins Ltd
2	Nairobi Garbage Collectors and Consultants
3	Zoa Taka Ltd
4	Simple Garbage Collectors Ltd
5	Garbage Dot Com Ltd
6	Allybins Garbage Management
7	December Waste Services
8	Leinad Enterprises
9	Tamia Limited
10	Safi Environment Company Ltd
11	Evabo Enterprises
12	Dawac Garbage Collectors
13	Daima Bin Services
14	Vijana Kwa Mazingira
15	Green Leaf Services Ltd
16	Smart City Cleaners Ltd
17	Dial-a-Home Limited
18	Sabiti Cleaning Services
19	Masters Management Services Ltd
20	Bins Nairobi Services
21	Heritage Garbage Collectors
22	Usafi Refuse Handlers
23	Three Bins Services
24	Colnet Limited
25	Boredo Suppliers
26	Flash Services
27	Prime Bins Limited
28	Black Bin Agency
29	Brown Bins Enterprises
30	Reliable Refuse Disposal
31	Hy-tech Bins
32	NgeiI Devt Youth Group
33	Jambo Bins
34	Smartlink Services Ltd

35	Multiple Waste Paper Collectors
36	Recycle and Reuse Ent. Ltd
37	Jewaka Garbage Collectors company
38	Helkon Kenya Ltd
39	Superbroom services ltd
40	Eco Trash Ltd
41	Hygiene Bins
42	City Bins
43	Ponya
44	Junky Bins
45	Metro Bins
46	Takataka solutions
47	Creative consolidated
48	Ideal bins
49	Mersa Cleaning
50	Aminah Mellea
51	Bunny Bins
52	Mammoth
53	Timothy
54	Lujusa

Source: Nairobi City County, 2012 and WEMAK (2014)

APPENDIX F: KNH-UON/ ERC RESEARCH APPROVAL LETTER

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
(254-020) 2726300 Ext 44355

KNH/UON-ERC
Email: uonknh_erc@uonbi.ac.ke
Website: www.uonbi.ac.ke

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/288 Link:www.uonbi.ac.ke/activities/KNHUoN

2nd September 2014

Priscilla Wanjiru Ngunju
School of Public Health
College of Health Sciences
University of Nairobi

Dear Priscilla

RESEARCH PROPOSAL: MUNICIPAL SOLID WASTE MANAGEMENT: CONTRIBUITON AND CHALLENGES OF PRIVATE SOLID WASTE MANAGEMENT COMPANIES IN NAIROBI COUNTY, KENYA (P288/05/2014)

This is to inform you that the KNH/UoN-Ethics & Research Committee (KNH/UoN-ERC) has reviewed and **approved** your above proposal. The approval periods are 2nd September 2014 to 1st September 2015.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH/UoN ERC before implementation.
c) Death and life threatening problems and severe adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH/UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
f) Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
g) Submission of an *executive summary* report within 90 days upon completion of the study
This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

For more details consult the KNH/UoN ERC website **www.uonbi.ac.ke/activities/KNHUoN.**

Protect to Discover