FACTORS AFFECTING REALIZATION OF INTEGRATED SOLID WASTE MANAGEMENT IN KENYA: A CASE OF NAIROBI COUNTY

BY

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A RESEARCH PROJECT REPORT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF ARTS IN PROJECT PLANNING AND MANAGEMENT OF THE UNIVERSITY OF NAIROBI

2012

DECLARATION

This research project is my original work and has not been presented to any other examination body. No part of this research project should be reproduced without my consent or that of The University of Nairobi.

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DEDICATION

This research study is dedicated to all people who care about clean and sustainable Environment

ACKNOWLEDGEMENT

I acknowledge the work and effort of many people who have contributed towards successful completion of this research project. I feel greatly indebted to my lecturers at The University of Nairobi especially Dr. Luketero for their professional guidance in carrying out my research project. I would like to express my gratitude to the authors of the various books I used to build on this project. I cannot forget to thank God for the blessings and divine providence throughout the research project period.

ABSTRACT

This research study investigated factors affecting realization of Integrated Solid Waste Management in Kenya. Solid waste management is increasingly becoming a problem in many cities of the world and Kenyan urban centres are no exception. Solid Waste management is limited by technology employed, inadequate equipment, personnel and financial resources. The objectives of this study were to assess how stakeholders cooperation has affected realization of integrated solid waste management, to establish how community awareness affect realization of integrated solid waste management, to find out how technology affect realization integrated solid waste management and also to establish how community awareness affect realization integrated solid waste management. The researcher targeted respondents from City Council of Nairobi who are tasked with solid waste management. Descriptive research design was employed whereby a population representative sample of two hundred and forty five (245) respondents was selected by stratified random sampling from a target population of five hundred and seventy two (572) staff of the City Council of Nairobi's department of environment. The researcher collected primary data by use of semi-structured questionnaires, interviews and direct observation. Secondary data was also collected from published books, journals reports and other academic articles. The collected data was analyzed by use of SPSS and the study findings presented by use of frequency distributions. The study found out that lack of information and financial resources sharing hinder stakeholders cooperation hence affecting realization of Integrated Solid waste Management (ISWM). It was also found out that use of old technology, inadequate solid waste prevention and minimization practices as well as lack of community awareness on solid waste management issues has affected realization of ISWM in Nairobi County. The study recommends stakeholders cooperation, use of contemporary technology on management of solid waste, implementation of solid waste prevention and minimization techniques and community sensitization on solid waste management as a recipe for realization of ISWM. The researcher has suggested for further research to be carried out on impact of private sector on solid waste management, economic and financial gains of solid waste prevention and minimization techniques as well as environmental impact of inefficient solid waste management

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ABBREVIATIONS AND ACRONYMS

CBO	Community Based Organization
CROP	Community Recycling Opportunities Program
CCN	City Council of Nairobi
DEFRA	Department for Environment, Food and Rural Affairs
EMCA	Environmental Management and Coordination Act
EPA	Environment Protection Agency
GDP	Gross Domestic Product
GHG	Green House Gases
GTZ	German Agency for Technical Development
HCL	Hydrogen Chloride
ISWM	Integrated Solid Waste Management
JICA	Japan International Co-operation Agency
KCC	Kampala City Council
MRF	Material Recovery Facility
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NCBD	Nairobi Central Business District
NEMA	National Environmental Management Authority
NOx	Nitrogen Oxide
NGO	Non Governmental Organization
OECD	Organization for Economic Co-operation and Development
PVC	Polyvinyl Chloride
MoU	Memorandum of Understanding
MSE	Small and Medium Enterprises
SO_2	Sulphur Dioxide
SW	Solid Waste
SWM	Solid Waste Management
UN	United Nations
UNEP	United Nations Environmental Programme
USEPA	United States Environmental Protection Association

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

The rapid increase in volume and diversification of solid wastes generated mainly as a result of economic growth, urbanization, industrialization, unsustainable production and consumption patterns has severe impacts on the global and local environment, natural resources, public health, local economy, and living conditions and therefore threatens the attainment of the Millennium Development Goals (Wilson, 2007). Globally, a number of factors influencing Integrated Solid Waste Management (ISWM) could be pointed out, such as the inefficient organizations, systems and institutions in national and local governments, the shortage of the human resources in the local governments, financial problems of solid waste management services and facilities, increase of the necessity of the management of hazardous and electronic solid waste, lack of capacity of introduction and operation of recycling scheme and system, ineffective technology of solid waste management, lack of the capacity and the social problems on the workers on solid waste management and absence of communication within key stakeholders in solid waste management. It is estimated that the total amount of solid waste generated worldwide reached 1.84 billion tons in 2004, a seven percent (7%) increase on the 2003 total. It is further estimated that, between 2004 and 2008, worldwide generation of solid waste rose by thirty one point one percent (31.1%), representing an annual rate of increase of some seven percent (7%). (Ikiara, 2006)

Solid waste is inextricably linked to urbanization and economic development. As countries urbanize, their economic wealth increases. As standards of living and disposable incomes increase, consumption of goods and services increases, which results in a corresponding increase in the amount of waste generated. As the world hurtles toward its urban future, the amount of municipal solid waste (MSW), one of the most important by-products of an urban lifestyle, is growing even faster than the rate of urbanization. According to Hoornweg et al. (2012), there were 2.9 billion urban residents who generated about 0.64 kg of MSW per person per day (0.68 billion tons per year) ten years ago. Today, these amounts have increased to about 3 billion residents generating 1.2 kg per person per day (1.3 billion tons per year). By 2025 this will likely increase to 4.3 billion urban residents generating about 1.42 kg/capita/day of municipal solid waste (2.2 billion tons per year) Municipal solid

waste management is the most important service a city provides: in low-income countries as well as many middle-income countries, MSW is the largest single budget item for cities and one of the largest employers. Solid waste is usually the one service that falls completely within the local government's purview. A city that cannot effectively manage its waste is rarely able to manage more complex services such as health, education, or transportation. Poorly managed waste has an enormous impact on health, local and global environment, and economy; improperly managed waste usually results in down-stream costs higher than what it would have cost to manage the solid waste properly in the first place. The global nature of MSW includes its contribution to Greenhouse Gases (GHG) emissions, for example the methane from the organic fraction of the solid waste stream, and the increasingly global linkages of products, urban practices, and the recycling industry. Developing and implementing ISWM requires comprehensive data on present and anticipated waste situations, supportive policy frameworks, knowledge and capacity to develop plans/systems, proper use of environmentally sound technologies, and appropriate financial instruments to support its implementation (Hoornweg et al., 2012).

In Nairobi city, increasing urbanization, rural-urban migration, rising standards of living, and rapid development associated with population growth have resulted in increased solid waste generation by industrial, domestic, and other activities (Karanja, 2005). This increase has not been accompanied by an equivalent growth in the capacity to address the problem. In 1992, from 800 to 1000 tonnes of solid waste were generated in Nairobi every day, of which less than ten percent (10%) was collected; by 2002, the amount had grown to over 1500 tonnes per day of which forty percent (40%) was either uncollected, or disposed of by burning or illegal dumping. In 2010, only half of approximately 3000 tonnes of solid waste generated daily in Nairobi City were collected. The proper management of solid waste has thus become one of the most pressing and challenging environmental problems in the city (Syagga, 1992; CCN, 2007; UNEP, 2010).

1.1.1. Profile of Nairobi City and the City Council of Nairobi.

At the moment Nairobi city has a population estimated to be about 3,138,295 million growing at a rate of four percent (4%) to five percent (5%) percent per annum (KNBS, 2009). With this kind of population growth, solid waste generation is also concurrently growing and stands at over 3,000 tonnes per day. Management of solid waste is a general problem in Kenya. In fact only 30-45 per cent of the estimated 3,000 tonnes of solid waste generated

daily in Nairobi is collected (Parrot et al., 2009). The growth and development of Nairobi is managed by the City Council of Nairobi (CCN) in accordance with the Local Government Act. Cap 265 Laws of Kenya and is normally under the guidance and supervision of the Ministry of Local Government. Management of solid waste in CCN is the responsibility of the Department of Environment (DoE) which among other primary mandates; cares for the provision and the regulation of solid waste in the City of Nairobi. City Council of Nairobi's objectives towards solid waste management are to: improve public health of the people; improve the environment; and maintain public cleanliness in order to keep public places aesthetically acceptable; by ensuring the proper storage, collection, transportation, safe treatment and disposal of solid waste. City Council of Nairobi's main responsibilities towards SWM are: to formulate and implement solid waste management policies; to provide services for collection, transportation, treatment and disposal of solid waste; to regulate and monitor the activities of all generators of solid waste and private companies engaged in solid waste activities; to formulate and enforce laws and regulations relating to solid waste management; and to coordinate with other departments within CCN, donor agencies, NGOs and other government organizations involved in solid waste management (Ngau et al., 2009).

1.2. Statement of the Problem

The city of Nairobi produces waste at a rate that outpaces its capacity to collect and dispose it of in a safe and environmentally sound manner. Its current approaches to waste management are neither effective nor sustainable. This necessitates a paradigm shift in thinking. Traditional end-of-pipe solutions to solid waste management problems only deal with symptoms of poor management and not the root causes. As a result, indiscriminate dumping and littering is socially acceptable in the City. Besides the littering problem which is apparent in most Kenyan urban centres, plastic waste, particularly carrier bags, are causing an increasing number of environmental and health problems. The collection of waste and transportation is largely informal. Further waste disposal is open dumping, with little recovery activities. Nairobi City Council does not operate any transfer station or composting plant where commercial waste recovery or recycling could be carried. The contribution of the informal sector is complicated by the fact that the recyclables are mixed with the other wastes, both at the household level and at the dumpsite.

Waste generation increases with population expansion and economic development. Improperly managed solid waste poses a risk to human health and the environment.

Uncontrolled dumping and improper waste handling causes a variety of problems, including contaminating water, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies. In addition, it may result in safety hazards from fires or explosions. Improper waste management also increases greenhouse gas (GHG) emissions, which contribute to climate change. Planning for and implementing a comprehensive program for waste collection, transport, and disposal—along with activities to prevent or recycle waste—can eliminate these problems. The City Council of Nairobi has no capacity to collect all the waste generated, it should look into employing a policy of separation of waste, waste recycling, reuse and waste reduction at source. Owing to its cross-sectoral nature, management of solid waste is fragmented into several pieces of legislation, such as the EMCA Act, the Public Health Act, the Local Government Act and the Forest Act, among others. The Government should consider a comprehensive law on waste management, including a strategy and guidelines for implementation. Institutional strengthening of relevant bodies and a national solid waste management policy will also be required. This study, therefore, seeks to establish the factors affecting Realization of Integrated Solid Waste Management in Nairobi City.

1.3. Purpose of the Study

The purpose of this study was to establish the factors affecting Realization of Integrated Solid Waste Management in Nairobi County.

1.4. Objectives of the Study

The objectives of the study will be as follows;

a) To assess how stakeholders cooperation affects realization of Integrated Solid Waste Management in Kenya.
b) To establish how solid waste prevention and minimization practices affect realization of Integrated Solid Waste Management in Kenya.
c) To find out how technology affect realization of Integrated Solid Waste Management in Kenya.
d) To establish how community awareness affect realization of Integrated Solid Waste Management in Kenya.

1.5. Research Questions

a) How does stakeholders' cooperation affect realization of Integrated Solid Waste Management in Kenya?
b) How does solid waste prevention and minimization practices affect realization of Integrated Solid Waste Management in Kenya?
c) How does technology affect realization of Integrated Solid Waste Management in Kenya?
d) How does community awareness affect realization of Integrated Solid Waste Management in Kenya?

1.6. Significance of the Study

Society

Integrated solid waste management leads to a healthy society because environmental pollution menace is addressed. Also reduced exploitation of scarce natural resources is achieved through recycling. It is hoped that the findings of this study will help raise awareness on issues pertaining to solid waste management from community level to the national level.

Policy Makers

Policy makers and urban authorities will also make use of the findings of this study in their planning and policy formulation strategies. This will help generate initiatives to reduce the solid waste management problem. It will also help provoke debate on solid waste management issues and thus yield development of better solid waste management options. It is, therefore, anticipated that the study's findings herein will offer insight on the role played by this neglected SWM sector in Kenya by formulating relevant solid waste and other key environmental management policies.

Researchers

Academically, this research will generate fresh knowledge to researchers who wish to carry out further investigation on the issue with possible recommendations on any areas in

need of revisions. The study will also provide some baseline data that will guide future studies in Management of Solid waste in other Kenyan urban centres.

Development Partners

Partners in development such as Non-Governmental Organizations (NGOs), United Nations (UN) Agencies and entire Donor community could use this information to identify specific income generating activities, thus making waste contribute to the poverty eradication program in the country. Where the suggested income generating solutions are adopted, they will help generate some income for those engaged. This study therefore will make a contribution towards finding an economically and environmentally friendly Solid Waste Management Systems.

1.7. Delimitations of the Study

The study focused on factors affecting realization of Integrated Solid Waste Management in Kenya within geographical boundary of Nairobi City where a lot of diversified types of solid waste are generated. The study sought to find out how stake holders co-operation, solid waste prevention and minimization practices, technology and community awareness affect realization of Integrated Solid Waste Management. The target population in this study was the staff members of CCN, Department of Environment (DoE).

1.8. Limitations of the Study

The researcher encountered some challenges in accessing the records of CCN while collecting data for the study. The researcher, however, overcame this by informing the study respondents that the data will be used solely for academic purpose and that utmost confidentiality will be maintained. The official letter from University of Nairobi authorizing this research and introducing the researcher to the organization also played a major role in addressing this limitation. There was also some phobia and unavailability of the respondents during data collection exercise. The researcher addressed this by giving the respondents enough time to answer the questionnaires, carrying out follow up courtesy calls to respondents to collect filled questionnaire. The purpose of the study was also briefly explained to the respondents before administering the questionnaires to reduce cases of non response. The study did not investigate private companies which have been contracted by CCN to collect, transport and dispose of solid waste as well as how foreign goods dumping have affected solid waste management in Kenya.

1.9. Assumptions of the Study

The researcher has assumed that the findings of this study will generally represent the challenges facing realization of Integrated Solid Waste Management in other Kenyan urban centres. It is also assumed that the respondents from the CCN's department of environment are more knowledgeable on issues related to solid waste management.

1.10. Definition of Significant Terms

Integrated Solid Waste Management

Integrated solid waste management (ISWM) is defined by Tchobanoglous et al. (1993) as the selection and application of appropriate techniques, technologies, and management programs to achieve specific solid waste management objectives and goals. It refers to a strategic initiative for the sustained management of solid waste though the use of comprehensive integrated format generated through sustained preventive and consultative approach to the complementary use of a variety of practices to handle solid waste in a safe and effective manner.

Stakeholder

Individual or institution (public and private) interested and involved in related processes and activities associated with a modernisation process, plan, project goal, or desired change in Solid Waste Management.

Solid Waste

Materials that are discarded or rejected when their owner considers them to be spent, useless, worthless, or in excess. It includes municipal solid waste, Industrial solid waste, hazardous solid waste and hospital solid waste.

1.11. Organization of the Study

The research study has been organized in five parts; chapter one which has addressed the background of the study as well as the problem statement and research objectives, chapter two which contain the research literature review. Chapter three has tackled research design and methodology whereas chapter four focuses on data analysis, presentation and interpretation. Chapter five has dealt with summary, discussion, conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature on Factors influencing Realization of Integrated Solid Waste globally, regionally, as well as in Kenya. The researcher assessed the existing literature about past research work in this field with view of addressing the inherent gaps which this study sought to fill.

2.2 Global Perspective of Solid waste Management

Integrated Solid Waste Management has proven to be a challenge for countries around the world as noted by Tchobanoglous et al. (1993). As the world population grows and the amount of waste produced grows, the management of the solid waste produced continues to be a problem. Globally, solid waste volumes are increasing quickly –even faster than the rate of urbanization. In the general perception, solid waste management is not a difficult process; Trucks pick up waste and dump it in a place far away from human settlements. In reality the process is complex and requires precise interaction of the many actors involved (Rouse, 2006). In 1992, the Earth Summit in Rio de Janeiro highlighted the problems associated with increasing volumes of solid wastes generated at the global level. It was after this summit that the traditional methods of dumping and burning of municipal solid waste was rejected as the only way to deal with solid waste materials.

2.2.1 Solid Waste Management in Europe

In 1996 the European Union General Strategy on Waste produced a hierarchy of waste management options, which involved a number of treatment options with regard to waste management (European Commission, 1999; European Union, 2004). The first step in the hierarchy is the prevention of waste. If it is possible to reduce the amount of waste generated initially then it would be less of a problem to dispose of. Emphasis of this principle can include cleaner production within industry and manufacturing and also at the household level by influencing markets and consumers to demand 'greener products' which are not over packaged or products that have been previously recycled. The second tier is *Recovery, Re-use, and Recycling*. If waste cannot be prevented, then as much of it as possible should be re-used, recovered and recycled. It is stated in European Union Directives that Member states have to introduce legislation on waste collection, reuse, recycling and final disposal of these solid waste streams. Several European Union member countries are already managing to

recycle over 50% of packaging waste (European Union, 2004). Comparatively figures from Bogota in Colombia are that only 16% of the total waste amount generated is recycled at a formal level, however on an informal level figures are not available, but could be 10-15% higher than the recorded figure (Pacheco, 1992; Bartone, 1991; Ali et al, 1993; Baud and Schenk, 1994 as cited in Beall, 1999). Thus even accounting for under reporting of informal recycling, it appears there is a clear difference in recycling rates between economically developing countries and economically developed countries.

The final tier involves Optimum final disposal and improved monitoring. Adequate methods for final disposal need to be implemented. These could include incineration or sanitary landfill sites. Incineration is a contentious issue, but one that is being explored in the European Union and the United States alike as an alternative to waste disposal at landfill sites. It is viewed as a possible energy recovery initiative (Snow, 2003). Strict emission standards within the European Union would monitor possible incinerators with the aim of reducing emissions of dioxins and acid gases such as nitrogen oxides (NOx), sulphur dioxides (SO2), and hydrogen chlorides (HCL), which can be harmful to human health (UNEP, 2004; European Union, 2004). The management of sanitary landfills is more stringent than was the case years ago and requires mandatory engineered linings; and leachate and gas management procedures (Vesiland et al,., 2002). Environmental impacts from unmonitored landfill sites can include noxious gases, odour, ground and surface water contamination; and soil pollution as well as the negative visual impact of an unmonitored landfill site.

Waste prevention and management was identified at the European Union's sixth Environment Action Program as one of the top priorities (ISWA & UNEP, 2002). The Environment Action Program noted that Integrated Solid Waste Management initiatives should be incorporated into the management of natural resources (Furedy, 1992; International Solid Waste Association, 2002; Gopalan et al., 2003). Including solid waste management within the concept of resource management has led the way forward to a more integrated approach which considers the entire product lifecycle. Adopting this type of paradigm shift includes aspects of sustainable development, including environmental, economic and social aspects. The Environment Action Program noted that it is also important to separate waste generation from economic activity, so that economic growth will not necessarily lead to the increase in solid waste generation. Better waste prevention initiatives, improved use of resources and emphasis being placed on the encouragement of more sustainable consumption patterns are ways in which waste management will be addressed in the European Union. The

aim is to reduce the amount of waste going to final disposal by 20% from 2000-2010, and by 50% by 2050. There is also a strong emphasis on the cutting down of household hazardous solid wastes disposed of at landfill sites (European Union, 2004).

2.2.2 Solid Waste management in U.S.A and New Zealand

In the United States and New Zealand and adopt zero solid waste strategies, which focus on solid waste minimization and reduction as opposed to landfill or incineration. The collection and recovery of recyclable materials in Northern European countries is often done separately. Paper is collected through curbside recycling programs from residential houses and transported in compactor trucks; whilst glass is often collected in collection containers called 'igloos' at recycling drop off centers. The 'igloo' system has been in operation since the start of the 1970's. Igloos are also used to collect other recyclables like plastics, metal cans and paper (UNEP, 2004). The collection and recovery of materials from igloos is done by municipal governments or authorities, NGO's, private contractors or various charities. Recyclables are then sold to recyclers, who pay per ton for recyclables received depending on the market related value. Due to the fluctuating nature of the market and related prices given per ton, organizations are often compensated by the government in the form of recycling credits (Gray, 1993). Recycling credits refer to a system where economic incentives are used to ensure that certain materials within the solid waste stream are recycled and diverted from landfill.

Commingled type of curbside collection where recyclables are mixed together for collection is more common in the United Kingdom and the United States (UNEP, 2004). Materials recovery and recycling becomes more sporadic within Southern Europe (including France and the United Kingdom). Curbside recycling initiatives are not common and recyclable collection containers are generally seen in major city centers (UNEP, 2004). Private collectors and municipalities do collect and recover recyclables, but there are only a few formal household curbside recycling initiatives in place (OECD, 2002; Hogg, 1999; Department for Environment, Food and Rural Affairs (DEFRA), 2003).

The United States has been quite proactive with waste management options. An example can be seen in California where the Integrated Solid Waste Management Act was passed in 1989 by the State Legislature, which required Californian counties to divert 50% of what is sent to landfill by 2000 (San Francisco, 2004). The past two decades has seen the emphasis of municipal solid waste management shift to include the aspect of sustainable

waste management and resource recovery. Major contributing factors of this shift can be attributed to the continuous increase in waste generation and the realization that current waste management practices are not sustainable. As seen in the European Union, factors influencing the increase in the amount of waste generated include rapid population growth; the increase in personal affluence and associated lifestyles; less space available in many urban areas to safely and economically dispose of municipal solid waste; increasing awareness of environmental hazards associated with landfills and other disposal techniques (incineration); and the increasing costs associated with safe disposal of solid waste at landfills (i.e. engineering, operational and management costs associated with sanitary landfills).

The waste management system in the United States offers different recycling options for households (Vesiland et al, 2002). The most common is the commingled collection of recyclables where all recyclables are placed in the same container and collected together. These are then taken to a central Material Recovery Facility (MRF) where the goods are separated and sold to various recycling companies. An alternative which is also used is a split 340 litre wheelie bin where recyclables are split between the compartments and remaining waste in a separate bin. This method requires either two separate trucks to collect the various materials; or a single truck with dual compartments. One more alternative that is used is to put the recyclables into a different colour plastic bag which is set next to the residual waste on the day of collection. They are both collected together and the coloured bags removed once at the landfill site or first taken to a MRF (Vesiland et al, 2002).

2.2.3 Solid Waste Management in Asia Countries

Solid-waste management in Asian countries has given alarming signals because of their improper waste management. The urbanization, industrialization, and an increase in economic status and activities have increased the quantity of municipal solid waste and altered its contents. Lack of motivation on the part of the municipalities has also created a grave situation. Although the developing countries generate less solid waste per capita in comparison to developed countries, the collection, storage, transportation, processing, and disposal of solid waste is highly ineffective, and consequently damaging to the environment.

Cities and countries that are categorised as high and medium income, like Hong Kong tend to follow trends developed either in the European Union or those initiated within the United States to some degree or another. Hong Kong has limited available land and tends to follow waste management solutions from the European Union; whilst Australia which does

not have a limited land supply tends to follow those set up by the United States (ISWA & UNEP, 2002). The amount of waste generated within Hong Kong has increased from 0.95kg in 1990 to 1.11kg in 2002 per person per day (Tsoi and Choi, 2003). Strategies to minimise the production of solid waste have been launched in the form of the Solid Waste Reduction Framework Plan and recycling initiatives have been set up at schools, hospitals, housing complexes, hotels and public places. Curbside recycling initiatives are still in the pilot stages and have yet to be assessed, but already through the existing informal and voluntary recycling systems in place, Hong Kong is able to divert 36% of its recyclable waste stream from landfill (Ray, 2008). Australia has embarked on a 'Zero Waste' strategy to combat its solid waste problem. Furedy (1992) states that within Asian cities many recycling or solid waste minimization programmes are initiated by Community Based Organisations (CBO's) and NGO's and not by a national strategy initiated by the government. These strategies are initiated to encourage better resource recovery and the social elevation of informal waste salvagers as well as improved waste management.

2.2.4 Solid Waste Management in African Countries

Most African states, Kenya included, do not know how to manage solid waste, but instead, know how to dump it (GTZ, 2004). Waste management within Botswana is in general very similar to other African countries in that the services are irregular and the current waste system is not sustainable. However, it is also a country that is experiencing many changes within the solid waste management sector. The current solid waste management system is run by local councils and involves collection, transportion and disposal of the waste. The type of bins used for solid waste are not standardized and any receptacle can be used. Sold waste workers are poorly paid for the work they do and generally lack interest in their work. Solid waste workers are stigmatized by the community because solid waste work is considered not very valuable. The vehicles used to collect and transport the solid waste are often not appropriate (Matsoga, 2000).

Governments eager to adopt international solid waste removal schemes have bought mechanized vehicles which require regular servicing and specialized parts. The breakdown of trucks often leads to a halt in services or large delays while the part is imported from other countries. Once waste is collected it is usually taken to an open dump site where it is disposed of. Solid waste which is not collected by the council services is dumped in open areas, or alongside the road (Matsoga, 2000). Solid waste management services are in the process of

changing. In 1998 the Botswana strategy for solid waste management was passed as well as the Waste Management Act, 15 of 1998. Within this strategy and Act, recycling plays a big role and government has begun to actively research recycling possibilities within Botswana as well as alternative disposal treatment techniques, which include sanitary landfill sites. Current studies on Bamenda city in Cameroon indicate that one new and increasing element in waste composition is that of non-biodegradable waste.

2.3. Review of Theoretical Literature

The traditional solid waste management hierarchy with waste disposal as the preferred treatment method has been replaced with a revised waste management hierarchy which places waste prevention and minimization as the top priority as well as integrated solid waste management planning which views the entire product and waste cycle holistically. Recycling was also highlighted as a tool to reduce the amount of waste requiring treatment i.e. land filling or incineration. Effective waste management systems are necessary to ensure the protection and sustainability of social, financial and environmental dimensions of the urban community. Internationally effective waste management systems should adopt an integrated approach to waste and view waste management systems holistically and not as fragmented compartments of collection, treatment and disposal. Many cities in the world should recognize the waste management problem and realize the need for a paradigm shift in the philosophy of waste and the treatment of solid waste (Scheinberg et al., 2008)

Poor understanding of solid-waste management leads to different kinds of environmental problems within urban metropolis. The emission of greenhouse gases and air pollutants, the pollution of groundwater, occupational hazards, etc. are other areas of concern (UN-HABITAT, 2010). The new millennium has introduced the global focus on sustainable development, especially in the area of solid waste. Solid-waste management is the responsibility of the municipalities under the provision of their respective acts. Solid-waste management practices in developing countries like India are far from satisfactory, and the associated problems are due to a lack of technical expertise, financial constraints, and legal provisions. Generally, state and municipal governments consider solid waste a low priority, and consequently give less budgetary support to this field. Slow decision-making processes in the municipalities create an additional hindrance. In a broader sense, municipal solid-waste management is a very complex task, as the social, economic, and cultural cooperation among households, communities, enterprises, and municipal authorities is minimal and lack of awareness of the rules and regulations, as well as environmental concerns with poor

resources, have created a chaotic situation. Although India has formulated legislation relating to municipal solid waste, hazardous waste, and biomedical waste, the compliance and awareness of rules among communities and municipalities are lagging behind. Waste collectors and rag pickers take out the recyclable portion of solid waste and sell it to retailers, which are recycled in the informal sector to the extent of 10% of the waste generated, but no efforts have been made by the government to encourage a recycling industry (Pinnock, 1998).

The municipal corporations and municipalities generally collect solid waste through various modes of transportation like handcarts, animal-driven carts, rickshaws, etc. and street sweeping is carried out manually. Generally, municipal solid waste is dumped in low-lying areas by the smaller town municipalities without caring about the environment, whereas a regulatory framework is being partially followed by metro-cities. Cities with a million-plus population are complying with some of the regulations and green production practices in various activities of solid-waste management, namely the segregation of solid waste, composting at the community level, the transportation of solid waste in closed vehicles, and its disposal in controlled landfill sites having weighbridge facilities with a leachate-management facility. Solid-waste management, especially in India, can be practised efficiently and in an eco-friendly manner through green production measures, and by considering and incorporating various policy, legislative, financial, technology, and management issues (White et al., 1995).

Electronic waste or e-waste, and waste from white goods are increasing (UN-HABITAT, 2009). In regular household waste generation, plastics, paper and cartons, tin cans, glass, bottles and fibre are on the increase. Their rates of generation have a relationship with the different socio-economic parts of the city- a trend that suggests the increasing influence of globalization and changing consumption habits (OECD, 2001). Uganda's rate of urbanization is growing fast. It is estimated that Kampala City Council (KCC) spends United States Dollars (USD) 1.53 million per month to remove only thirty percent (30%) of the total waste generated. Also the communities are ignorant of the best ways to manage the waste, as there is little community initiative to undertake collective action. Given this situation there is need to promote complimentary alternatives such as community initiatives to remove garbage while earning some income for the poor. This aspect to earn an income would motivate them to support the programme (Rotich et al., 2005)

It is absolutely true that the residents of the city of Nairobi have become a throw away society and one that does not value the importance of a clean and safe environment. The city of Nairobi is inhabited with two generations of people. A minority of those who lived in it when it was referred to as the "green city in the sun" and a great majority who were born into a city where indiscriminate dumping and littering of the environment is socially acceptable (CCN, 2008). A report by NEMA (2003) reveals that Nairobi generates 2500 tonnes of solid waste daily, of this sixty eight percent (68%) is municipal solid waste generated from households. As amounts of solid waste increase, the cost of its removal increases too. In Nairobi, Polythene bags and plastics, including Polyvinyl Chloride (PVC) items, make up approximately 225 tonnes out of the 2500 tonnes of solid waste generated daily. This represents about eleven percent (11%) of total waste generated daily, while seventy five percent (75%) comprises biodegradable waste that can be composted. The remaining percentage is made up of other recyclable materials such as textiles, metal and glass. Open burning of municipal solid waste is widely used by the residents of Nairobi, as a means of disposing of solid waste. Ikiara et al. (2004) has summarized the extent and nature of Solid Waste Management in Nairobi. First, the collection ratio, that is, the proportion of solid waste generated that is collected, is low. Second, marked inequality in the geographical service distribution characterizes the service with the western suburbs well serviced by private firms and the City Council of Nairobi while the eastern part is hardly serviced. Third, there is widespread indiscriminate dumping in illegal dumpsites and waste pickers litter the city with unusable waste materials without control. Fourth, there is only one official dumpsite (CCN-owned and operated) and this is full and a nuisance to the adjacent residential areas. Fifth, the city has no transfer facilities. This situation holds true for almost all of the urban areas in Kenya (UNEP/NEMA, 2005).

2.4. Factors Affecting Realization of Integrated Solid Waste Management

In this section the study presents factors affecting realization of solid waste management as outlined by the study objectives.

2.4.1. Stakeholders Cooperation

Solid waste collection schemes of cities in the developing countries generally serve only a limited part of the urban population. The majority of the people especially in slum areas remaining without waste collection services. These are usually the low-income earners living in poor conditions in peri-urban areas. One of the main causes of inadequate collection

services is the lack of stakeholders cooperation to cope with the increasing amount of solid waste produced. Operational inefficiencies are due to inefficient institutional structures, inefficient organizational procedures, or deficient management capacity of the institutions involved (OECD, 2004). Legislative tools in place for solid waste management for Kenya include; Local Government Act Cap 265 and the Public Health Act Cap 242 which make it a duty for Local Authorities to maintain their areas of jurisdiction at all times in a clean sanitary condition, the Environmental Management and Coordination Act (EMCA, 1999) that calls for development of standards and regulations to manage waste, and the Physical Planning Act Cap 386 that provides for waste disposal at designated sites only. At the local level are the policies and by-laws of the Councils that include: the General Nuisance by-law, solid waste management bylaw, and in Nairobi, the Private Sector Involvement Policy on Solid Waste Recycling and Composting Policy. Waste management is vested on the local authorities through the Local Government Act Cap 265 and the Public Health Act Cap 242. Resulting from these, local authorities have enacted by-laws to help manage waste. For industries and businesses, the Environmental Management and Coordination Act (EMCA) of 1999 rests on them the responsibility for management of the wastes they have generated. This scenario has resulted to confusion and effort duplication in solid waste management. Key stakeholders like the consumers, civil society and the informal solid waste handlers have not been adequately involved in solid waste management efforts. (NEMA, 2009)

2.4.2 Solid Waste Prevention and Minimization Practices

Solid waste source reduction initiatives (including prevention, minimization, and reuse) seek to reduce the quantity of waste at generation points by redesigning products or changing patterns of production and consumption. For example the developed countries have developed, a "throw away culture", since consumer goods are cheap hence an increase in packaging (more items are individually packaged), resulting in significant increases in MSW as production becomes cheaper. An emphasis on mass production and the development of cheap consumer goods has caused quality and longevity of goods to be sacrificed in the name of lowest market price, causing people to be more likely to simply throw away and replace items instead of repairing or maintaining them (Vliet et al., 2005). It would seem that the easiest and most effective way to manage solid waste is to reduce the amount of waste to be disposed.

A reduction in waste generation has a two-fold benefit in terms of greenhouse gas emission reductions. First, the emissions associated with material and product manufacture

are avoided. The second benefit is eliminating the emissions associated with the avoided waste management activities. The key advantages of recycling and recovery are reduced quantities of disposed waste and the return of materials to the economy. In many developing countries, informal waste pickers at collection points and disposal sites recover a significant portion of discards. In China, for example, about 20% of discards are recovered for recycling, largely attributable to informal waste picking (Hoornweg et al 2005). Related GHG emissions come from the carbon dioxide associated with electricity consumption for the operation of material recovery facilities. Informal recycling by waste pickers will have little GHG emissions, except for processing the materials for sale or reuse, which can be relatively high if improperly burned, e.g. metal recovery from e-waste. Sound environmental management is achieved when the 3Rs (Reduce, Reuse and Recycle) approaches are implemented according to the order, first source reduction, second recycling and composting and third disposal to the landfill or waste combustors. These approaches emphasize waste reduction (creation of less waste and increased material recovery) and appropriate disposal options as part of an integrated evaluation of needs and conditions. UNEP (1996) laid out a series of questions to be asked when evaluating technologies and policies in the context of an integrated MSW system.

2.4.3. Technology

Specific environmental conditions dictate the appropriateness of various technologies, and the level of industrialization and technical knowledge present in various countries and how cities will constrain solutions. A somewhat more low-technology approach to Solid Waste Management is composting. The waste of many developing nations would theoretically be ideal for reduction through composting, having a much higher composition of organic material than industrialized countries. For example, generally in developing countries, the average city's MSW stream is over sixty four percent (64%) organic material (Hoornweg et al., 2012). According to studies by Cointreau-Levine (1996) in Bandung, Indonesia and Colombo, Sri Lanka have revealed that residential waste composed of seventy eight percent (78%) and eighty one percent (81%) compostable material, and market waste 89% and 90% compostable, respectively. However, composting has not been overwhelmingly successful and widespread in practice throughout the developing world. Although well documented in China and other areas of eastern Asia, composting projects have had a spotty record throughout Africa, Latin America and elsewhere, and have had the largest number of failed facilities worldwide (UNEP, 1996).

There are many advantages to composting. First and foremost, it would reduce, in some cases significantly, the amount of waste requiring ultimate disposal, extending the life of landfills. When done correctly, the end result becomes a useful product, capable of being used at the household or farm level to augment soil nutrient levels and increase organic matter in the soil, increasing soil stability. If the product is of high quality and markets exist, the product can be sold. Environmentally, the process by which composting decomposes organic waste is preferable to landfill processes. In a landfill, bacteria break down organics an anaerobically in the absence of oxygen, resulting in the releases of methane gas. When properly composted, however, the organic matter is decomposed using an aerobic process, which produces no methane by-product. The dumping of solid waste in landfills is probably the oldest and definitely the most prevalent form of ultimate garbage disposal. Many "landfills" are nothing more than open, sometimes controlled dumps. The difference between landfills and dumps is the level of engineering, planning, and administration involved. Open dumps are characterized by the lack of engineering measures, no leach management, no consideration of landfill gas management, and few, if any, operational measures such as registration of users, control of the number of "tipping fronts" or compaction of waste. In an examination of landfills throughout the developing world in 1997-1998, Johannessen (1999) found varying amounts of planning and engineering in MSW dumping; among the various regions visited, African nations (with the exception of South Africa) had the fewest engineered landfills, with most nations practicing open dumping for waste disposal. In Nairobi, dumping (at Dandora dumpsite) is a major method employed in Solid Waste (SW) disposal.

Another option for Solid Waste Management is incineration. Incineration should not be considered a 'disposal' option, since following incineration there is still some quantity of ash to be disposed of (probably in a landfill), as well as the dispersal of some ash and constituent chemicals into the atmosphere. It should instead be considered more in terms of its waste-reduction potential, which can be eighty percent (80%) to ninety five percent (95%) in terms of waste volume (Rand et al., 2000). This appears to be an extremely attractive option, however, with occasional exceptions; incineration is an inappropriate technology for most low-income countries like Uganda. Above all, the high financial start-up and operational capital required to implement incineration facilities is a major barrier to successful adoption in developing countries. SW reduction by incineration, along with sanitary disposal of the residue, would therefore be a useful alternative to traditional disposal

methods, and have proven useful in island nations such as Bermuda and the British Virgin Islands. Negative environmental consequences of incineration mostly revolve around airborne emissions. Certainly, incinerators should not be located where prevailing wind patterns would carry emissions over densely settled areas. The use of emissions reduction technology, although expensive, should be mandatory in any new construction. Incineration volatilizes many compounds potentially harmful to human health: metals (especially lead and mercury), organics (dioxins), acid gases (sulfur dioxide and hydrogen chloride), nitrogen oxides, as well as carbon monoxide and dust. (Rand et al., 2000; UNEP, 1996).

2.4.4 Community Awareness.

An integrated approach to solid waste management will have to take into account community and regional-specific issues and needs and formulate an integrated and appropriate set of solutions unique to each context. As with any issue in developing nations, solutions which work for some countries or areas will be inappropriate for others. In his study in Kenya, Kim (1998) observed that in order for community-based waste management to be a success, it must address more than the need for improved environmental management; in that it also must provide opportunities for income generation and the development of strong community bonds. Together with the support provided by NGOS, community-based waste management promotes internal solidarity around shared concerns, which in turn creates a momentum for demanding greater accountability of government and increased room for participatory decision-making. The community sector needs to be included in waste management efforts as both private and public sector actors are unable to provide waste services to low income areas of the city. Syagga (1992) supports the involvement of the community sector as an effective way of increasing access of the poor to urban services, including Solid Waste Management.

Indeed Kim (1998) led credence to this, when he observed that in Nairobi, organizations in the community sector, such as charitable organizations, ethnic associations, professional "support" NGOs, welfare societies, village committees, self-help groups, and security committees are already providing many of these services. Zerbock (2003) further argues that any potential change to the waste disposal framework must take into account the urban poor, many of whom dependent on waste scavenging for their entire subsistence. Micro-enterprises, or community based organizations can be effective in addressing the garbage problem. They often use simple equipment and labour intensive methods, and therefore can collect waste in places where the conventional trucks of large companies cannot

enter. The Medium and Small Enterprises (MSEs) may be started as a business, to create income and employment, or they may be initiated by community members who wish to improve the immediate environment of their homes (Scheinberg et al., 2007)

2.5. Gaps to be filled by the Study

Solid waste management is conventionally thought as being the sole responsibility of municipalities to ensure that collection and disposal services are available across all communities, while ensuring the sustainability of these services as demonstrated by various researchers such as Ikiara (2004). The complexity and daunting nature of solid waste management challenges require a deeper collaboration among different stakeholders – governments, civil society, private sector, informal sector, local communities, and the UN system, adoption of contemporary technology in solid waste management. In practice, such collaboration or partnerships could create win-win solutions for both the public utilities and private sector if duly supported by appropriate policy frameworks. For example, such partnerships could lead to savings in municipal budgets, of which a large portion is often used for waste management. The private sector, on the other hand, may use this opportunity to convert solid waste into valuable resources and environmentally friendly products that would not only contribute towards achieving resource efficiency, but could also provide income-generating opportunities. Integrating private, formal, and informal systems of solid waste management can significantly increase the efficiency and effectiveness of municipalities in delivering required services, and enable municipalities to save valuable resources while also providing health and environment benefits, including co-benefits. The urban councils are directly responsible for the total waste management process or contract parts of it out to the private sector.

Other authors cite additional problems, such as rapid urbanisation and population growth, the complex nature of the society, low standards of living and education, the attitude of the waste workers and the stagnating economy (Yhdego, 1995; Agunwamba, 1998). According to Contreau-Levine (1996), City Council of Nairobi has neither official policy towards the privatisation of solid waste collection nor do they provide assistance to private companies to enable them operate in informal settlement. Government is facing enormous resource challenges in providing quality public services and should look towards collaboration with the private sector to help deliver their public service mandate. This study will delve into other challenges facing realization of integrated solid waste management through waste minimization techniques, technology employed in the solid waste

management, stakeholders cooperation and community awareness. This study is one of those that will make a contribution towards filling that gap by focusing on Integrated Solid Waste Management unlike in the previous research studies where challenges facing solid waste management have targeted distinct phases of solid waste management life-cycle.

2.6. Conceptual Framework

Integrated Solid waste management (ISWM) involves a comprehensive waste prevention, recycling, composting and disposal program. An effective ISWM system considers how to prevent and minimize solid waste generation in ways that effectively protect human health and the environment. ISWM involves evaluating local needs and conditions and then selecting and combining the most appropriate waste management activities for those conditions. ISWM indicators include percentage of households that receive waste collection services, the amount of solid waste reaching sanitary landfills, the number of recycling centres and the amount of solid waste recycled, per capita and per Gross Domestic Product (GDP) waste generation, the uptake of cleaner production methods, solid waste collection rate, solid waste sector as a percentage of GDP, public availability of reliable information on solid waste, number of transfer stations in an urban centre, percentage of solid waste separated at source, level of treatment of hazardous waste, level of public awareness on management of solid waste issues, number of players in solid waste management and their level of cooperation, level of technology employed during solid waste collection, transportation, treatment and disposal. The aforementioned indicators are moderated by government policies and legislation on solid waste management and are affected by financial and economic factors.

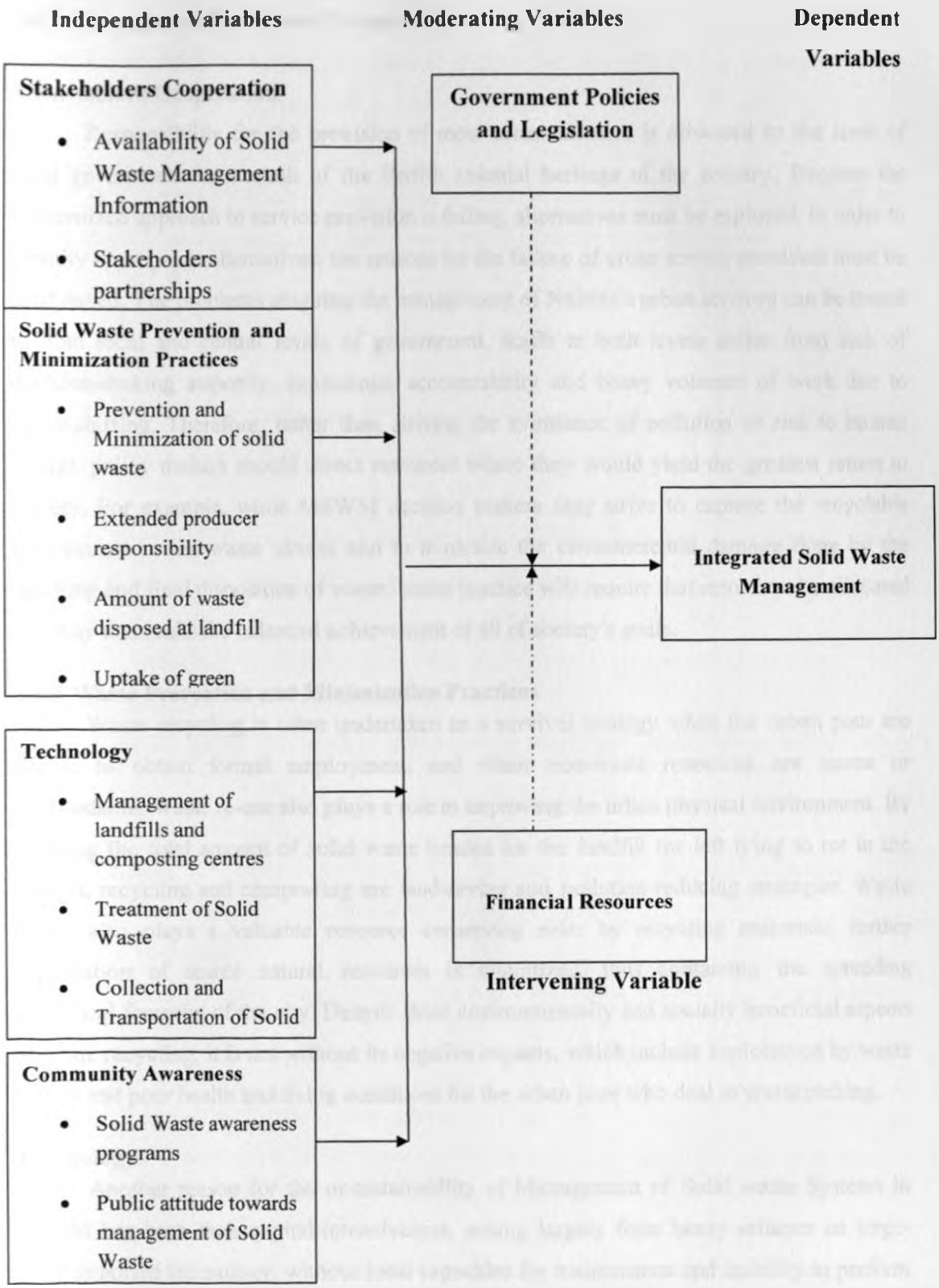


Fig.1 Theoretical Framework

2.6.1 Discussion of Conceptual Framework

Stakeholders Cooperation

Responsibility for the provision of most urban services is allocated to the level of local government as a result of the British colonial heritage of the country. Because the westernized approach to service provision is failing, alternatives must be explored. In order to identify appropriate alternatives, the reasons for the failure of urban service provision must be established. The problems plaguing the management of Nairobi's urban services can be traced to both local and central levels of government. Staffs at both levels suffer from lack of decision-making authority, experience, accountability and heavy volumes of work due to under-staffing. Therefore, rather than striving for avoidance of pollution or risk to human beings, policy makers should direct resources where they would yield the greatest return to society. For example, while MSWM decision makers may strive to capture the recyclable components in the waste stream and to minimize the environmental damage done by the handling and final disposition of waste, sound practice will require that resources be allocated in a way that seeks the balanced achievement of all of society's goals.

Solid Waste Prevention and Minimization Practices

Waste recycling is often undertaken as a survival strategy when the urban poor are unable to obtain formal employment, and when non-waste resources are scarce or unaffordable. Waste re-use also plays a role in improving the urban physical environment. By reducing the total amount of solid waste headed for the landfill (or left lying to rot in the streets), recycling and composting are land-saving and pollution-reducing strategies. Waste re-use also plays a valuable resource conserving role: by recycling materials, further exploitation of scarce natural resources is minimized, thus containing the spreading ecological footprint of the city. Despite these environmentally and socially beneficial aspects of waste recycling, it is not without its negative impacts, which include exploitation by waste buyers and poor health and living conditions for the urban poor who deal in waste picking.

Technology

Another reason for the unsustainability of Management of Solid waste Systems in Nairobi has been their capital-intensiveness, arising largely from heavy reliance on large-scale imported technology, without local capacities for maintenance and inability to perform when it comes to collection from overwhelmingly inaccessible communities and recycling. This creates the dire need for local construction of practical, effective, and sustainably

affordable equipment through the application of appropriate technology, ranging from manual to modestly 'Jua Kali' mechanized bins, carts, custom-built vans, shaker–sorters, dryers, badgers, drum digesters, and gasification chambers.

Community Awareness

The community needs to be included in waste management efforts as both private and public sector actors are unable to effectively provide waste services the city.

2.7. Operational Definition of Terms

Commercial waste

Waste that comes from shops, services, and other generators that are neither residential nor industrial. Sometimes includes institutional or public sector waste

Clients

Refers to people from whom waste pickers collect waste. They may be residents, hotels, restaurants, businesses, schools or church groups, amongst others.

Communal collection

A system wherein individuals bring their waste directly to a central point for collection.

Communication

A task of getting specific information or ideas across the people not as learners but as a target audience.

Commingled materials

Specific mixing of recoverable materials for purposes of efficient collection. The combination is designed for post-collection separating or sorting.

Communal container

A vessel to contain waste, usually larger than one cubic metre and used for more than one household.

Composition

Quantitative description of the materials that are found within a particular waste stream, in the form of in a list of materials and their absolute quantities per day or per year, or as percent of total materials.

Cooperative

Refers to an organization comprising various waste picking networks which come together with a common purpose. Savings and credit cooperative societies are the only existing

cooperatives for waste pickers in Kenya. An example of a cooperative is the Plastic Recyclers Savings and Credit Cooperative Society Limited in Nairobi.

Criminal gang

Is a group of people that engages in activities such as extortion. For example, waste pickers are forced to pay a fee in order to dump waste in a public dumping site, particularly at the Dandora dumping site.

Garbage

Wastes generated from household preparation, cooking and serving of food; market refuses, handling, storage and sales of produce and meals.

Globalization

Access of foreign solid waste into Kenyan market.

Landfill

The engineered deposit of waste onto and into land.

Municipal Solid Waste

Refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste and street sweepings.

Network

Refers to an organization consisting of various waste picker individuals and organizations.

Recovery rate

A percent relationship between the amount of recoverable materials that reach recycling, composting or energy recovery and the total amount generated.

Resource recovery

Process of extraction of economically usable materials or energy from wastes.

Sanitary landfill

An engineered method of disposing of solid wastes on land in a manner that protects human health and the environment. The waste is compacted and covered every day. The landfill is sealed from below and leachate and gas are collected, and there is gate control and a weigh-bridge

Tipping fee

The amount that is charged for disposing of waste at a facility, usually per ton, per cubic metre, or per vehicle

Transfer

The movement of wastes from their first point of discharge to final disposal; it usually includes some very basic processing: compaction, pre-sorting or size reduction

Treatment

Labour based or mechanical methods to reduce the risk of exposure or reduce the impacts to the environment of toxic or hazardous materials associated with the waste stream and in some cases, can concurrently capture and increase the economic value of specific waste stream components value added

Valorisation

The entire process of extracting, storing, collecting, or processing materials from the waste stream in order to extract and divert value and direct the material to a value added stream.

Transfer station

A place where waste from collection vehicles is aggregated and organised, before being transported to disposal sites or treatment facilities

Waste prevention

Often called source reduction—means reducing waste by not producing it. Examples of waste prevention would include purchasing durable, long-lasting goods and seeking products and packaging that are as free of toxic substances as possible. It can be as simple as switching from disposable to reusable products, or as complex as redesigning a product to use fewer raw materials or to last longer. Because waste prevention actually avoids waste generation, it is the preferred waste management activity. Overall, waste prevention conserves resources, protects the environment, and prevents the formation of greenhouse gases.

2.8. Summary of Literature Reviewed

There are many factors that vary from place to place and that must be considered in the design of a solid waste management system. These include stakeholder partnerships, solid waste minimization techniques, technology employed in solid waste management, awareness and attitudes of residents. Public awareness and attitudes to waste can affect the whole SWM system hence an efficient and effective Solid Waste Management system depend on public awareness and participation. Institution issues include the current and intended legislation and the extent to which it is enforced. Standards and restrictions may limit the technology options that can be considered. The policy of governments regarding the role of the private sector (formal and informal) is more structured in the developed countries as compared to the developing world. The strength and concerns of trade unions can also have an important influence on what can be done to effectively manage SW in Nairobi. In conclusion, there are various approaches to addressing the SWM problem and the most effective ones adopt state of the art technology. The new world order is to focus more on ways of preventing and minimizing generation of solid waste as we adopt environmentally friendly technology on solid waste management.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1. Introduction

This chapter address details on how the study was designed and the methodology adopted. It is divided into seven sections: Research design, target population of the study, sample design, data collection instrument, data collection procedure and data analysis.

3.2. Research Design.

Kothari (2004) defines a research design as an arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose. Mark (2003) also describes a research design as the overall plan for conducting a study in order to answer a research question. This study employed a descriptive research design to describe the challenges facing realization of Integrated Solid waste Management in Kenya. According to Neuman (2000), this type of research design determines and reports the way things are.

3.3. Target Population.

Population is said to be the aggregate of all cases that conform to some designated set of specifications. The study targeted the 572 staff of CCN Department of Environment as respondents as shown on Table 3.1.

Table 3.1.Target Population

Population Target	Frequency (N_i)	Percentage ($N_i/N*100$)
Top Management Staff	15	3
Middle Level Management Staff	43	8
Technical Staff	35	6
Subordinate Staff	479	84
Total	**N= 572**	**100**

Where: Ni = Number of staff in management level i

N = Total population size

3.4. Sample Size Selection and Sampling Procedure

The study employed stratified random sampling technique to select a representative study sample from the four levels of management in the Department of Environment (DoE) which were treated as strata for the study. Stratified random sampling proportional to size of each stratum was adopted because of heterogeneity of the sampling units to ensure a population representative sample was chosen for the study. This is a probabilistic sampling approach which according to Zikmund, (2003) every element in the population has an equal chance of selection and the bias inherent in non-probability sampling procedures is eliminated. Determining sample size is a very important issue because samples that are too large may waste time, resources and money, while samples that are too small may lead to inaccurate results. In many cases, we can easily determine the minimum sample size needed to estimate a process parameter, such as the population mean μ. When sample data is collected and the sample mean $\bar{x}$ is calculated, that sample mean is typically different from the population mean μ. This difference between the sample and population means can be thought of as an error. The margin of error E is the maximum difference between the observed sample mean $\bar{x}$ and the true value of the population mean μ:

$$E = z_{\alpha/2} \frac{\sigma}{\sqrt{n}}$$

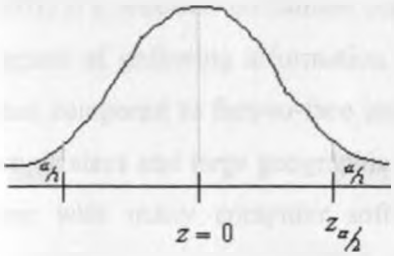
where: $z_{\alpha/2}$ is known as the critical value, the positive z value that is at the vertical boundary for the area of $\alpha/2$ in the right tail of the standard normal distribution. σ is the population standard deviation and n is the sample size.

$$n = \left[\frac{z_{\alpha/2}\sigma}{E} \right]^2$$

This formula has been used to determine the study sample size with a confidence of $1-\alpha$, the mean value μ within $\pm E$ error margin.

The study was based on 95% degree of confidence which corresponds to $\alpha = 0.05$. Each of the shaded tails in the following figure has an area of $\alpha/2 = 0.025$. The region to the left of $z_{\alpha/2}$ and to the right of $z = 0$ is 0.5 – 0.025, or 0.475. In the Table of the Standard Normal (z

) Distribution, an area of 0.475 corresponds to a z value of 1.96. The critical value is therefore $z_{\alpha/2} = 1.96$.



$\sigma^2 = \sqrt{(\sum X - \bar{x})^2 / N}$

$=16$

$n = (1.96 \times 4)^2 / E$; But E=0.5

$= \underline{245}$

Based on this rationale, a sample size of 245 respondents is more than 10% of the target population and therefore an adequate representative sample for this study according to Mugenda and Mugenda (2003). The sample was selected as shown on Table 3.2

Table 3.2 Sample Size

Population Target	**Frequency(N_i)**	**(N_i/N)**	**Percentage (N_i/N*100)**
Top Management Staff	15	0.026	6
Middle Level Management Staff	43	0.075	18
Technical Staff	35	0.06	15
Subordinate Staff	479	0.84	205
Total	**N= 572**		**245**

Where N_i/N = Proportional Allocation

3.5. Data Collection Methods and Procedures

Both primary and secondary data were collected for the study. Primary data was collected using semi-structured qu estionnaires. A questionnaire according to Meriwether (2001) is a research instrument consisting of a series of questions and other prompts for the purpose of gathering information from respondents. Questionnaires are very cost effective when compared to face-to-face interviews. This is especially true for studies involving large sample sizes and large geographic areas. Data entry and tabulation for research can be easily done with many computer software packages. Questionnaires reduce bias because a researcher's own opinions will not influence the respondent to answer questions in a certain manner since there are no verbal or visual clues to influence the respondent.

Questionnaires are less intrusive than telephone or face-to-face surveys. When a respondent receives a questionnaire in the mail, s/he is free to complete the questionnaire on his own time-table. The questionnaires comprised of both open and closed ended questions in order to collect a detailed all round data which provided a rich base for the descriptions of the variables under consideration. Standardized questions were constructed as a way of operationalizing the conceptual framework and in accordance with the need to make it possible to measure reactions of many respondents to a limited set of questions, thus facilitating comparison and statistical aggregation of the data. This helped to focus on breadth and depth. The investigator also gathered secondary data from document reviews as well as through direct observation.

3.3.1 Pilot Testing

A pilot testing according to Meriwether (2001) involves simulating the actual data collection process on a small scale to get feedback on whether or not the instruments are likely to work as expected in a "real world" situation. A typical pilot test involves administering instruments to a small group of individuals that has similar characteristics to the target population, and in a manner that simulates how data will be collected when the instruments are administered to the target population. Pilot testing gives a researcher an opportunity to make revisions to data collection instruments and procedures to ensure that appropriate questions are being asked, the right data will be collected, and the data collection methods will work. It provides an opportunity to detect and remedy a wide range of potential problems with an instrument. These problems may include; questions that respondents don't understand, ambiguous questions, questions that combine two or more issues in a single

question (double-barreled questions) and questions that make respondents uncomfortable. Pilot testing can also help researchers identify ways to improve how an instrument is administered. For example, if respondents show fatigue while completing the instrument, then the researcher should look for ways to shorten the instrument. The data collection instruments were pre-tested within Nairobi City residents to confirm their validity and reliability in gathering correct information sufficient for the research study.

3.5.2 Validity of the Research Instruments

According to Mugenda and Mugenda (2003), validity is the accuracy and meaningfulness of inferences which are based on the research results. The process of drawing the correct conclusions based on the data obtained from an assessment is what validity is all about. Validity of the study data was achieved through a pilot test of the questionnaire whereby twenty (20) Nairobi city residents were selected to answer the questionnaire. The research edited the data collection instruments to avoid complex and ambiguous words as well as offending offensive questions.

3.5.3 Reliability of the Research Instruments

According to Cooper and Schindler (1998), reliability refers to ability to secure consistent results with repeated measures of the same phenomenon using the same instruments. Questionnaires provide sufficient, complete and accurate information without bias to maximize reliability of the data. It is also easier to analyze such data and hence more economical. The researcher adopted triangulation method by use of questionnaires, document reviews and direct observation to ensure that the data gathered is reliable and meaningful to the research.

3.6. Data Analysis Methods and Justification

Data was analysed quantitatively using Statistical Package for Social Sciences (SPSS). In order to make the data analysis results more user-friendly and attractive to the readers, different graphic interactive models such as table have been used. SPSS was adopted for the data analysis because it offers effective data management which makes data analysis quicker because the program knows the location of the cases and variables. SPSS has wide range of options which include more techniques of screening or cleaning the information in preparation for further analysis. Design of SPSS supports better output organization which makes it certain that the output is kept separate from data itself.

3.7. Ethical Considerations

The investigator took necessary steps towards ensuring that the research study does not infringe on the ethics of the respondents by avoiding sensitive questions which may offend respondents.

3.8 Operational Definition of Variables

The Table below outlines the operational definition of variables of the research study

Table 3.3 Operational Definition of Variables

Objective	Operational Definition of Variables				Data Analysis Techniques
	Indicator	Variable	Variable Type	Scale	
Stakeholders Cooperation	Available Sources of SWM information	Level of sharing of SWM information amongst stakeholders	Dependent	Interval	Frequencies distributions,
	Stakeholders partnerships	Number of MoUs signed between the stakeholders	Independent	Nominal	Frequencies distribution
Solid Waste Prevention Minimization Practices	SW prevention and Minimization	Rate of re-use and recycling of solid waste	Independent	Interval	Frequencies Distributions
	EPR	Level of participation of manufacturers in SWM	Independent	Interval	
	Solid Waste disposed at landfill	Amount of solid waste reaching disposal site	Dependent	Ratio	
	Green production	Level of manufacturers products packaging	Independent	Interval	
Technology	Management of landfill and composting centres	Number of well managed landfills and composting centres	Dependent	Interval	Frequency Distributions
	Treatment of SW	Type of treatment carried out	Independent	Nominal	Frequencies Distributions
	Collection and Transportation of SW	- Mode of SW collection at generation source - Efficiency level of transportation system	Independent	Interval	Frequencies Distributions
Community Awareness	Community SWM awareness sensitization campaigns	- Media of channelling the campaigns - Intensity of campaigns	Independent	Nominal	Frequency Distributions
	Public attitude towards MSW	Perception of the community about SWM	Dependent	Nominal	Frequency Distributions

3.9. Summary

The chapter has tackled the research design of the study, target population and sampling design. Data collection methods and procedures as well as data analysis methods have been discussed. The researcher has also highlighted operational definition of variables.

CHAPTER FOUR

DATA ANALYSIS, PRESENTATION AND INTERPRETATION

4.1. Introduction

This chapter presents and illustrates data analysis, presentation and interpretation of the research findings. The data from the respondents was analyzed using the Statistical Package for Social Scientists (SPSS) and presented using frequency tables. Other related data is provided descriptively in this chapter. The respondents in this study were the City Council of Nairobi staff, Department of Environment. They were targeted because solid waste management docket falls under Department of Environment.

4.2 Questionnaire Return Rate

This section outlines the number of questionnaires which were answered and returned to the investigator. Out of two the hundred and forty five (245) copies of questionnaires issued, two hundred and thirty one (231) were filled and returned to the researcher. The response rate is tabulated in Table 4.1 below.

Table 4.1 Response Rate

Questionnaires	Frequency	Percentage
Response	231	96
Non-Response	14	6
Total	**245**	**100**

Ninety four percent (94%) of respondents filled and returned their questionnaires. There was only a non response rate of six percent (6%). According to Mugenda and Mugenda (2003), ten percent (10%) of the total accessible population is regarded as an adequate sample for a study which uses descriptive research design. Ninety four percent (94%) response rate represent two hundred and thirty (230) respondents which translate into ninety three percent (93%) of the target population. The findings of the study based on the response rate of 94% are therefore valid for generalization to the entire target population of the study.

4.3 Demographic Profile of the Respondents.

This section outlines the demographic profile of the respondents who participated in this study in order to find out their gender, highest education level attained and working experience. These profiles are important in establishing skills and expertise of the respondents required to aid in realization of integrated solid waste management.

4.3.1 Distribution of the Respondents by Gender

The gender of the respondents was analysed and presented as shown in Table 4.2. The research was interested to know the distribution of the respondents by gender.

Table 4.2 Distribution of the Respondents by Gender

Gender	Frequency	Percentage
Male	96	42
Female	135	88
Total	**231**	**100**

Males comprised forty two percent (42%) of the total number of respondents with women making up fifty eight percent (58%). This indicate that majority of the staff at the department of environment are women.

4.3.2 Highest Level of Education.

The highest level of education of the respondents was important for the study because an Integrated Solid waste Management System require well trained and skillful human resource. The use of contemporary technology in solid waste management also require educated workforce.

Table 4.3 Highest Level of Education

Level of Education	Frequency	Percentage
KCSE	113	49
Certificate	51	22
Diploma	17	7
Degree	29	13
Post-Graduate Diploma	11	5
Masters	7	3
PHD	3	1
Total	**231**	**100**

From Table 4.3, different levels of education are well represented in the department with forty nine percent (49%) of the respondents having achieved 'O' level of education. Twenty two percent (22%) have gone a notch higher to obtain certificates in various fields of study. There is a sizeable number of respondents, seven percent (7%) with diplomas and only thirteen percent (13%) have attained degree level of education. All the staff with post graduate education combined represent only nine percent (9%) of the respondents. These findings deviate from those of Ngau & Kahiu (2009) who urgued that more than eighty percent (80%) of City council of Nairobi staff have no formal education.

4.2.4 Years of Working Experience at CCN

This question sought to establish the experience of the staff working at the department of environment at City Council of Nairobi as well as access staff retention rate at the City council of Nairobi. This factor is very important to the study it can establish the staff satisfaction and motivation towards executing their duties ans assignments.

Table 4.4 Staff Working Experience at CCN

Years worked	Frequency	Percentage
0-5	31	13
6-10	81	35
11-15	73	32
>15	46	20
Total	**231**	**100**

Table 4.4 indicate that thirteen percent (13%) of the DoE have less than five years of working experience. Thirty five percent (35%) of the respondents have between six (6) and ten (10) years of working experience at City Council of Nairobi. Thirty two percent (32%) have between eleven (11) and fifteen (15) years of working experience. Only twenty percent (20%) of the staff have more than fifteen years of working experience at CCN. This demonstrates that City Council of Nairobi is a good employer with high staff retention rate.

4.4 How Stakeholders Cooperation affect Realization of Integrated Solid Waste Management in Kenya.

This study sought to find out how stakeholders co-operation affect realization of integrated solid waste management. To achieve this objective, the researcher asked the respondents whether there is any form of information and financial resources sharing with stakeholders in solid waste management such as the NEMA which falls under the ministry of environment, manufacturers, NGOs, CBOs, Informal sector and the corporate world. Table 4.5 provides a summary of opinion by respondents on whether stakeholders cooperation affect realization of integrated solid waste management.

Table 4.5 Respondents Opinion on Stakeholders Cooperation.

Does Stakeholder Cooperation affect ISWM?	Frequency	Percentage
Yes	53	96
No	2	4
Total	**231**	**100**

From Table 4.5, ninety six percent (96%) of the respondents believe that stakeholders co-operation directly affect realization of integrated solid waste management in Kenya. There were, however, a small percentage of respondents, four percent (4%) who believe that stakeholders co-operation does not affect management of solid waste. This confirms findings by NEMA (2009) that civil society was not involved in solid waste management issues.

4.4.1 Problems that hinter Stakeholders Cooperation

The study sought to find out whether there is information sharing among stakeholders on solid waste management, financial resources sharing, policies encouraging stakeholders' co-operation as well as involvement of all stakeholders in the management of solid waste. These were treated as key indicators which determine the level of stakeholder co-operation

Table 4.6 Lack of Sharing Information on Solid Waste Management

Problem	Frequency	Percentage
Very serious	31	86
Serious	30	13
Not so serious	3	1
No problem	0	0
Total	**231**	**100**

Table 4.6 show that eighty six percent (66%) of the respondents believe that lack of information sharing by stakeholders is a very serious problem facing realization of solid waste. This was followed by thirteen percent (13%) of respondents who said lack of information sharing is a serious problem facing MSW in Nairobi city. Only one percent of the respondents said that informatiom sharing by stakeholders is not a serious problem. No respondent who acknowledged that lack of information sharing by stakeholders is not a problem facing realization of Integrated Solid Waste Management. A research carried out by UNEP in 2005 found out that there is inadequate documentation of information concerning solid waste management. The findings of this study agree with findings of UNEP research. This means that key stakeholders keep their own information for their own use without sharing with other interested parties.

Table 4.7 Lack of Sharing Financial Resources by Stakeholders

Problem	Frequency	Percentage
Very serious	121	52
Serious	89	39
Not so serious	14	6
No problem	7	3
Total	**231**	**100**

Table 4.7 above indicate that fifty two percent (52%) of the respondents believe that lack of sharing financial resources by stakeholders is a very serious problem facing realization of integrated solid waste management in Nairobi county. Another thirty nine percent (39%) believe this is a serious problem. Only six percent (6%) of the respondents believe that lack of sharing of funds is not a serious problem with the remaining three percent (3%) claiming that lack of sharing of financial resources by the stakeholders is not a problem. Wilson (2007) in his research study entitled "Development drivers for waste management" found out that there is no sharing of resources among key stakeholders in solid waste management. This tends to propagate duplication of solid waste management efforts which lead to ineffective solid waste management.

Table 4.8 Inadequate Legislation

Problem	Frequency	Percentage
Very serious	103	45
Serious	58	25
Not so serious	41	18
No problem	29	13
Total	**231**	**100**

From Table 4.8, forty five percent (45%) of the respondents said that there is inadequate legislation on Management of Solid Waste in Kenya and thus the current state of solid waste management in the city can be associated with lack of adequate legislation. This was also supported by another twenty five percent (25%) of the respondents who said that lack of adequate legislation is a serious problen affecting realization of integrated solid waste management. Eighteen percent (18%) of the respondents said that lack of adequate government legisation is not a serious problem with the remaining thirteen percent (13%) claiming thst lack of adequate goverrnment legislation is not a problem facing realization of integrated silid waste management in Kenya. Ikiara et al. (2006) found out that Kenya lacks structures and effecient legislation to adequately govern management of solid waste.

Table 4.9 Lack of Stakeholders Involvement in Management of Solid Waste

Problem	Frequency	Percentage
Very serious	163	71
Serious	51	22
Not so serious	14	6
No problem	3	1
Total	**231**	**100**

From Table 4.9. Seventy one percent (71%) of the respondents claimed that lack of involvement of all stakeholders in solid waste management activities has affected realization of integrated solid waste management in Nairobi city. Another twenty two (22%) percent also said that lack of involvement of key stakehoders in management of solid waste in Nairobi is a serious problem. There was six percent (6%) of the respondents who said that this not a serious problem affecting realization of integrated solid waste management. Only one percent of the respondents said that lack of all stakeholders involvement in solid waste management issues is not a problem affecting realization of integrated solid waste management. Zerbock (2003) found out in his study that CCN does not take in account the urban poor in the management of solid waste. These stakeholders scavenge on solid waste in a an attempt to recover recyclable solid waste for sale to get some money.

4.5 How Solid Waste Prevention and Minimization Practices affect Realization of Integrated Solid Waste Management.

This section presents data analysis on how solid waste prevention and minimization practices affect realization of integrated solid waste management. Solid waste prevention practices include less packaging of consumer goods or green production and Extended Producer Responsibility (EPR). This is a practice which if implemented properly reduce the volume of solid waste enterring solid waste cycle. On the other hand solid minimization pactices include re-use ,sorting at source, recycling and use of transfer stations to facilitate further sorting of recyclables. The following is a presentation of how respondents answered the questions about this objective.

Table 4.10 Sorting of Solid Waste at Source

Practice	Frequency	Percentage
Sorting	0	0
No sorting	231	100
Total	**231**	**100**

Table 4.10 show that one hundred percent (100%) of the respondents admitted that there is no sorting of solid waste at the source. This confirms an earlier study by Wilson (2007), who in

his earlier study found out that sorting of solid waste at source is not practised in Kenya. These findings confirm that the current solid waste management system does not support solid waste recovery and effective management.

Table 4.11 Transfer station

Practice	Frequency	Percentage
Transfer station	0	0
No transfer station	231	100
Total	**231**	**100**

There is no single transfer station in Nairobi city as confimed by the data in Table 4.10. As noted by Ikiara (2004), transfer stations ensure efficient management of solid waste by supporting activities such as recycling, recovery and composting.

Table 4.12 Recycling of Solid Waste

Practice	Frequency	Percentage
Recycling	14	6
No recycling	217	94
Total	**231**	**100**

From Table 4.12, ninety four percent (94%) of the respondents agreed that there is no recycling activities carried out by CCN. The only form of recycling, six percent (6%), is pracised by the informal sector and it is poorly developed to make any impact on realization of Integrated solid waste management. Vliet et al. (2005) found out that the easiest and most effective way to manage solid waste is to reduce the amount of solid waste gererated.

Table 4.13 Extended Producer Responsibility (EPR)

Practice	Frequency	Percentage
Extended Producer Responsibility (EPR)	8	3
No EPR	223	97
Total	**231**	**100**

Extended producer responsibility is not yet developed and the study findings confirmed that ninety seven percent (97%) of the manufactures do not practice EPR as shown on Table 4.13. Lack of adopting EPR has contributed to increase in volume of solid waste due to over packaging of consumer goods by manufactures due to rising living standards as argued out by Vesiland et al.(2002).

4.6 How Technology affect Realization of ISWM

This section illustatrates an alysis results on how technology affect re alization of integrated solid waste management. Technology is synonymous to effective solid waste management for a sustainable environment. The following are the findings of the study on issues of technology used in solid waste management. Table 4.14 shows results of respondents view on the effects of current technology employed by CCN on management of solid waste.

Table 4.14 Does Current Technology Employed by CCN affect Realization of ISWM?

Practice	Frequency	Percentage
Yes	227	98
No	4	2
Total	**231**	**100**

From Table 4.14, ninety eight percent (98%) of the respondents said that technology employed by CCN on management of solid waste has contributed to the solid waste manace currently being experienced in Nairobi City.This shows that for CCN to effectively manage solid waste, the technology employed must be improved or new technology employed altogether. Johannessen (1999) noted that in most African developing countries, solid waste is disposed of by dumpimg with no leach management, no consideration of landfill gas management and no registration of dumpsite users.

Table 4.15 Problems of Current Technology Employed in MSW

Problem	Frequency	Percentage
Poor SW collection, Transportation & Disposal	82	35
Lack of treatment of SW	69	30
Ineffective SW Composting	47	20
High volumes of SW	23	10
Diseases	10	4
Total	**231**	**100**

Table 4.15 tabulates the problems emanating from current technology employed by CCN in management of solid waste. Poor collection, transportation and disposal of solid waste contributes to thirty five percent (35%) followed by lack of treatment at thirty percent (30%). Ineffective composting contributes to twenty percent (20%) with problems of high solid waste volumes contributing to ten percent (10%). Four percent (4%) of the respondents said that current technology employed by CCN contribute to public health diseases. These findings confirm those of Kim (1998) in his study entitled "Community based waste management for environmental management and income generation in low income areas where he found out that Kenya adopt traditional technology in solid waste management such as open dumping and burning of solid waste.

4.7 How Community Awareness Affect Realization of ISWM

This section provide respondents views on how community awareness affect realization of integrated solid waste management. This study sought to find out public perception on issues related to solid waste management, to find out whether the City Council of Nairobi conducts any community sensitization campaigns on solid waste management issues as well as the community roles which can play a pivotal role in the management of solid waste. The following are the findings, presentation and interpretation of the study objective. Table 4.16 presents results of the respondents views on the community perception on responsibility of Solid Waste Management.

Table 4.16 Community Perception Towards MSW

Perception	Frequency	Percentage
CCN responsibility	227	98
Everyone's responsibility	4	2
Total	**231**	**100**

From Table 4.16, ninety eight percent (98%) of the respondents believe that community perception affect has affected realization of Integrated Solid Waste Management in Nairobi city. Only two percent (2%) of the respondents said that the responsibility of solid waste management is for every community member. According to Ikiara (2004), the management of solid waste is the sole responsibility of local authorities. This perception has led to indiscriminate generation and disposal of solid waste by the public.

Table 4.17 Community Sensitization Campaigns on Solid Waste management

Perception	Frequency	Percentage
CCN conducts community Sensitization campaigns	27	9
No Campaigns conducted	210	91
Total	**231**	**100**

From Table 4.17, ninety one percent (91%) of the respondents indicated that CCN does not conduct community awareness campaigns to sensitize the public on effective management of solid waste. This almost confirms the true picture of the findings of Rotich et al.(2005) in his study entitled "Municipal solid waste challenges in developing countries- Kenyan case study.

Table 4.18 Community Roles which can affect Realization of ISWM

Problem	Frequency	Percentage
Recycling	74	32
Reduction	62	27
Re-Use	52	23
Composting	43	19
Total	**231**	**100**

Table 4.18 show that thirty two percent (32%) of the respondents believe that community can actively participate in management of solid waste by recycling, twenty seven percent (27%) by reducing amount of solid waste they generate, twenty three percent (23%) believe that the public can re-use some of the re-usable solid waste whereas nineteen percent (19%) believe that community can participate in composting of inorganic solid waste. These findings indicate that community can actually play a major role in management of solid waste if

actively involved. This contradicts findings of Ikiara (2004) which recommended improved budgetary allocation for solid waste management.

4.8 Summary of Data Analysis

The findings of the study show that there is lack stakeholders cooperation which has strongly affected effective management of solid waste in Kenya. Ninety six percent (96%) of the respondents said that there is no stakeholder co-operation in the management of solid waste in Nairobi. On stakeholders sharing of financial resources on management of solid waste, ninety one percent (91%) of the respondents said that this was lacking. Ninety nine (99%) percent of the respondents admitted that key stakeholders in the management of solid waste do not share information. seventy percent (70%) of the study respondents said that there is lack of inadequate policies to support stakeholder co-operation in this noble cause. Another ninety three percent (93%) of the respondents claimed that all stakeholders are not involved in solid waste management planning activities.

On solid waste prevention and minimization practices, one hundred percent (100%) of the respondents confirmed that there is no sorting of solid waste at the respective points of generation or source. There was also another one hundred percent (100%) confirmation that the City Council of Nairobi does not operate any transfer station and thus out of all the recyclable solid waste generated in the Nairobi city, only ninety four percent (94%) is recycled. Although Extended Producer Responsibility is a new phenomenon in Nairobi City, only three percent (3%) of the respondents admitted that the same is practised

The study covered the objective of technology by analysing life cycle of solid waste management which include generation, collection, transportation and disposal. The current technology employed by CCN in management of solid waste is inefficient because there are neither transfer stations nor separation of solid waste at points of generation. The disposal techniques are also environmentally unfriendly and are also threat to public health. The study established that ninety eight percent of the respondents (98%) believe the current solid waste management is as a result of old technology employed by the City Council of Nairobi. The study found out that poor solid waste collection, transportation and disposal account for thirty five percent (35%) of all the problems emanating from inefficient technology. Lack of treatment of solid waste account for thirty percent (30%) whereas inefficient solid waste disposal and composting account for twenty percent (20%).

There is need to build capacity on community awareness on solid waste management issues in order to reduce volume of solid waste generated and reaching disposal sites as well as ensure adequate disposal of solid waste at designated collection points. Ninety eight percent (98%) of the study findings indicate that the public believe that issues to do with solid waste management is a sole responsibility of City Council of Nairobi. Another Ninety one percent (91%) of the respondents said that City Council of Nairobi does not conduct any community sensitization campaigns on issues related to management of solid waste.

CHAPTER FIVE

SUMMARY OF FINDINGS, DISCUSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of findings, discussion, conclusions, recommendations as well as suggestions for further study.

5.2 Summary of Findings

The study results show that the stakeholder cooperation directly affect realization of integrated solid waste management as illustrated by ninety six percent (96%) of the study respondents management of solid waste. This is especially due to lack of sharing information on solid waste management, financial resources for managing solid waste as well as technological knowhow on management of solid waste. Key stakeholders are not involved in solid waste management issues as confirmed by seventy one percent (71%) of the respondents.

On solid waste prevention and minimization techniques, the study found out that although most solid waste generated in Nairobi are recyclable, there has been no effective mechanism to exploit recycling at an economic level. There are no other solid waste minimization practices such as sorting of solid waste at the point of generation or source and re-use of solid waste. The City Council of Nairobi has not put in place measures to implement Extended producer Responsibility and the few corporate who are engaged in the activity do it as a social corporate responsibility (CSR)

The study found out that CCN does not operate any solid waste transfer station, does not engage on recycling and the solid waste is disposed off in a dumpsite. The technology employed by City Council of Nairobi in management of Solid Waste is inefficient and thus contributing to poor management of solid waste. The solid waste disposal technology has contributed to high volumes of solid waste reaching the dumpsites and littering the roads due to poor transportation systems. This has contributed to public health diseases, pollution of water bodies by the leacheate and emission of greenhouse gases due to ineffective composting in addition to loss of revenues.

The research findings show that community awareness is important to effectively manage solid waste. The negative public perception towards management of solid waste needs to be addressed in order to effectively manage solid waste in Nairobi City. The study also established that community can play a major role in management of solid waste.

5.3 Discussion of the Study Findings

It is evident from the study findings that despite various research studies by various researchers, the problem of effective solid waste management system if far from being achieved. This study has found out that stakeholder co-operation has really affected realization of integrated solid waste management due to lack of information and financial resources sharing, adequate policies to support stakeholders co-operation as well as lack of involvement of all stakeholders on solid waste management issues. Ikiara et al.(2004) did find out that solid waste management in Kenya is very much unstructured and there is no clear organizational hierarchy on matters to do with solid waste management. Zerbock (2003) argued that the urban poor depend on solid waste scavenging for their entire subsistence and any meaningful solid waste management framework should take in to account their concerns.

Solid waste minimization and prevention practices has been hindered by lack of sorting of solid waste at the points of generation, lack of transfer stations, ineffective recycling efforts and lack of Extended producer Responsibility. This has led to an increase in volume of solid waste generated in Nairobi city as well as the volume and amount of solid waste reaching the disposal sites. These factors have affected realization of integrated solid waste management. Vliet et al.(2005) argued that developed countries have adopted a "throw away" culture to solid waste management since consumer goods are cheap and easy to replace than maintain. As Kenya gears up to achieve vision 2030, we expect the standards of living to increase proportionally with amount of solid waste generation.

Technology used by the City Council of Nairobi is outdated yet the volume of solid waste generation increases by each day. For integrated solid waste management to be achieved, technology will play a major role in the management of solid waste from generation to disposal stage. With the current climatic and environmental conservation efforts, use of contemporary technology will be instrumental in addressing collection, transportation and disposal of solid waste. According to Hoornweg et al. (2012), MSW stream for the developing countries is composed of sixty four percent (64%) organic. In view

of these findings Kenya can make use of the right technology to convert this solid waste into compost thereby reduce the amount of solid waste reaching dumpsites.

Community awareness campaigns have not yet been exploited hence CCN's inability to achieve integrated solid waste management. The public still believe solid waste management is the sole responsibility of the City Council of Nairobi hence their indiscriminate generation and disposal of solid waste. Community can play a very major role in the management of solid waste.

5.4 Conclusion

If integrated solid waste management status is to be achieved, there should be put in place measures to support cooperation of all stakeholders and government agencies with dockets touching on solid waste management. City council of Nairobi and other key stakeholders like NEMA have not worked on a policy to enforce extended producer responsibility to address the ever rising level of solid waste generation.

Solid waste prevention and minimization practices such as re-use, composting and recycling should be encouraged in an attempt to achieve an integrated solid waste management system. Use of transfer stations and separation of solid waste at source is an area which has really affected realization of integrated solid waste management in Nairobi city. Manufactures of consumer goods have also affected realization of integrated solid waste management due to over packaging of consumer goods by not embracing green production.

The technology currently in use is very outdated and latest technology should be embraced not only to reduce on the volume of solid waste reaching disposal sites but also to improve on public health status and conserve environment. There is poor collection, transportation and disposal of solid waste in Nairobi city which culminate into littering of the city streets and lack of treatment. Public health diseases have emanated by use of this archaic technology in the management of solid waste.

Community awareness is an area which has not been exploited by the City Council of Nairobi CCN does not conduct community awareness campaigns. Integrated solid waste management has not been achieved because key stakeholders in solid waste management do not share information and resources, the technology employed by CCN in the management of solid waste is archaic, solid waste minimization practices are negligible and lastly, there is no community awareness campaigns on solid waste management issues.

5.5 Recommendations

The researcher recommends the following measures to be undertaken in order to realize integrated solid waste management;

1. All stakeholders including the urban poor should be involved in management of solid waste should co-operate on solid waste management issues such as sharing information and resources as well as form partnerships.
2. The City Council of Nairobi should embrace solid waste minimization and prevention practices such sorting of solid waste at household level/point of generation, re-use, recycling and composting.
3. City Council of Nairobi should adopt latest technology of solid waste collection, transportation and disposal. This will help curb spread of diseases emanating from landfills and generation of greenhouse gases such as methane which are harmful to the environment.
4. The community needs to be sensitized on solid waste management matters such assorting, recycling, composting and disposal as well as on benefits of effective solid waste management. Community should also be sensitized to re-use solid waste such as plastic containers for domestic purposes and other solid waste reduction strategies.
5. The government should introduce a solid waste recycling compensation scheme to boost on solid waste re-use and recycling.

5.6 Suggestions for further study

The researcher suggests a research to be carried out about the following topics;

1. The impact of private sector in the management of solid waste.
2. Economic and financial gains of solid waste prevention and minimization practices.
3. Impact of dumping on solid waste management.
4. Environmental impact of inefficient solid waste management.

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APPENDIX I: TRANSMITTAL LETTER

The Director,
City Council of Nairobi,
Department of Environment,
P.O Box 30075,
Nairobi.

6th July, 2012.

Dear Sir,

Re: Academic Research

I am a Master of Arts in Project Planning and Management student at The University of Nairobi. I would like to carry out my academic Research Project on the topic entitled "Factors Affecting Realization of Integrated Solid Waste Management in Kenya: A Case of Nairobi County" for a period of two months ending 31st August, 2012.

I would like to declare that the purpose of this study is purely academic and the data collected from the records of City Council of Nairobi as well as from the staff of City council of Nairobi will be treated with utmost confidentiality and used sorely for the purpose stated herein. I therefore seek your permission to access records of City Council of Nairobi records on solid waste management as well as administer questionnaires to the staff of the Department of Environment.

Yours faithfully,

Patrick W. Musembi

APPENDIX II : QUESTIONNAIRE

INSTRUCTION:

This questionnaire is designed to facilitate the assessment of the current situation of challenges facing realization of Integrated Solid Waste Management in Nairobi city. The information collected will be used for academic purpose only and will be treated with utmost confidence. To enable an accurate assessment, it is important that all information requested in the questionnaire should be provided as completely and accurately as possible. (*Please answer all the questions honestly and exhaustively by ticking (√) in the appropriate box that closely matches your view or alternatively writing in the spaces provided where necessary).*

PART A: RESPONDENTS INFORMATION

1. Job Title.....
2. Sex: Male ☐ Female ☐
3. Highest Level of Education attained

KCSE	☐	Certificate	☐
Diploma	☐	Degree	☐
Masters	☐		
PHD	☐		
Other	☐		

4. How long have you worked for this organization?

0 – 5years	☐	6 – 9years	☐
10 – 14years	☐	15 years and more	☐

PART B: HOW STAKEHOLDER COOPERATION AFFECT REALIZATION OF INTEGRATED SOLID WASTE MANAGEMENT.

1. Are the key stakeholders in solid waste management co-operating in their solid waste management activities?

   Yes ☐ No ☐

2. If you have answered YES in question one above, please indicate how they are co-operating.....

3. If you have answered NO in question one above, please indicate why you believe there is no co-operation among the stakeholders.....
   .....

4. The following Table indicate some major problems which hinder stakeholders' co-operation in solid waste management. Please rate the severity of each problem affecting stakeholders' cooperation in management of solid waste in Nairobi County by ticking in the appropriate spaces provided below.

Problem	Very serious (4)	Serious (3)	Not so Serious (2)	No problem (1)
No sharing information on solid waste management				
No sharing financial resources and solid waste management technological knowhow by stakeholders.				
Ineffective enforcement of existing legislation on management of solid Waste.				
Stakeholders not being involved in solid waste management activities and decision making				

PART C: HOW WASTE PREVENTION AND MINIMIZATION PRACTICES AFFECT REALIZATION OF INTEGRATED SOLID WASTE MANAGEMENT

1. Has City Council of Nairobi put in place measures to prevent or minimize generation of solid waste?

   Yes ☐ No ☐

2. If YES in question one (1) above, kindly indicate the measures.....
   .....

3. Do we have sorting of solid waste at household level in Nairobi city.

   Yes ☐ No ☐

4. If you have answered YES in question three (3) above, please explain where this sorting is practised and the infrastructure put in place by the City Council of Nairobi to support this.....
   .....
   Does City Council of Nairobi or any other stakeholder in solid waste management operate any transfer station in Nairobi City?

   Yes ☐ No ☐

5. If YES in question three (3) above, please name the stakeholder and the location of the transfer station.....

6. Does City Council of Nairobi operate any solid waste recycling centre?

   Yes ☐ No ☐

7. If YES in question seven (7) above please name the recycling centre and its exact location.....

8. If NO in question seven (7) above, please indicate any private recycling centre known to you and the location.....

9. Does City Council of Nairobi ensure manufactures adhere to green production or enforce extended producer responsibility?

   Yes ☐ No ☐

PART D: EFFECTS OF TECHNOLOGY ON MANAGEMENT OF SOLID WASTE PRODUCTS

1. Do you think the current technology employed by NCC has an effect on Management of Solid Waste in Nairobi City?

   Yes ☐ No ☐

2. Please explain your answer in question 1 above.....

3. How does NCC manage solid waste life cycle chain?

   .....

   .....

4. Do you believe that the current mode of solid waste collection, transportation and disposal is environmentally sustainable?

   Yes ☐ No ☐

5. Give the reason for your answer in question 4 above.

   .....

   .....

6. Do we have any form of solid waste treatment in Nairobi city?

   Yes ☐ No ☐

7. If YES in question six (6) above, please name the form of treatment.....

   .....

8. Composting of organic solid waste generates greenhouse gases. Does CCN carry out technical supervision of the dumpsites or solid waste composting centres to ensure emission of these gases is controlled?

   Yes ☐ No ☐

9. In your opinion, why has NCC continued to dispose of solid waste in a dumpsite (Dandora) instead of using a sanitary landfill?

   .....

   .....

PART E: COMMUNITY AWARENESS

1. Do you conduct community sensitization campaigns on effective Management of Solid Waste?

   Yes ☐ No ☐

2. If yes in question one (1) above, how do you then conduct the campaigns?

   .....

3. Does public attitude towards solid waste affect management of solid waste in Nairobi city?

   Yes ☐ No ☐

   If yes, please explain.....

   .....

4. What roles in your own opinion can community play in enhancing effective Management of Solid Waste?

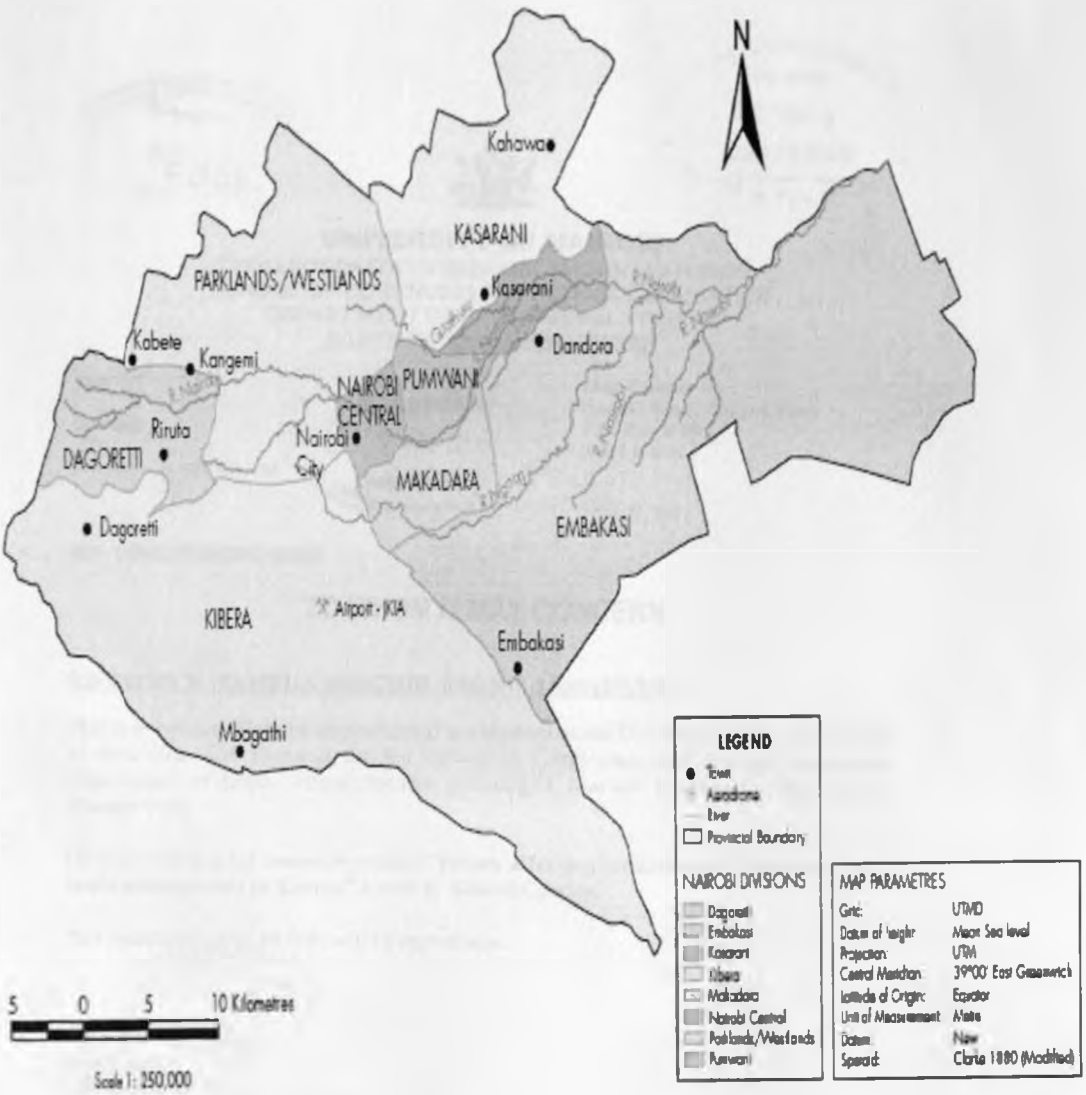
   .....

   .....

   .....

Thank you very much for your participation

APPENDIX III: MAP OF NAIROBI CITY



Source: UNEP *et al.*, 2007

APPENDIX IV: INTRODUCTION LETTER

UNIVERSITY OF NAIROBI
COLLEGE OF EDUCATION AND EXTERNAL STUDIES
SCHOOL OF CONTINUING AND DISTANCE EDUCATION
DEPARTMENT OF EXTRA-MURAL STUDIES
NAIROBI EXTRA-MURAL CENTRE

Your Ref:
Our Ref:
Telephone 318262 Ext. 120

Main Campus
Gandhi Wing, Ground Floor
P.O. Box 30197
NAIROBI

RECEIVED
9 JUL 2012

2nd July, 2012

REF: UON/CEES/NEMC/12/338

TO WHOM IT MAY CONCERN

RE: PATRICK WAMBUA MUSEMBI -REG.NO. L50/64375/2010

This is to confirm that the above named is a student at the University of Nairobi College of Education and External Studies, School of Continuing and Distance Education, Department of Extra- Mural Studies pursuing a Masters in Project Planning and Management.

He is proceeding for research entitled **"factors affecting realization of integrated solid waste management in Kenya"** A case of Nairobi County.

Any assistance given to him will be appreciated.

CAREN AWILLY
CENTRE ORGANIZER
NAIROBI EXTRA MURAL CENTRE

APPENDIX V: DATA COLLECTION LICENCE

PAGE 2

THIS IS TO CERTIFY THAT:
Prof./Dr./Mr./Mrs./Miss/Institution
Patrick Wambua Musembi
(Address) University of Nairobi
P.O.Box 30197 00100, Nairobi.
has been permitted to conduct research in

	Location
	District
Nairobi	Province

on the topic: Factors affecting realization of integrated solid waste management in Kenya: A case of Nairobi County

for a period ending: 31st August, 2012

PAGE 3

Research Permit No. NCST/RCD/14/012/107
Date of issue 30th July, 2012
Fee received KSH 1,000

Applicant's Signature

Secretary
National Council for Science & Technology