

**CHALLENGES AND POSSIBLE INTERVENTIONS FOR EFFECTIVE SOLID
WASTE MANAGEMENT IN NGOMONGO VILLAGE OF KOROGOCHO
INFORMAL SETTLEMENT, NAIROBI COUNTY**

BY

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

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DEDICATION

To my wife Janet Oluoch and son Jonathan Ng'uono whose inspiration has been so instrumental in the completion of this work.

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TABLE OF CONTENTS	
DECLARATION.....	i
DEDICATION.....	ii
ACKNOWLEDGEMENT.....	iii
TABLE OF CONTENTS	iv
LIST OF ABBREVIATIONS AND ACRONYMS	xi
ABSTRACT.....	xiii
CHAPTER ONE: INTRODUCTION	1
1.1 Background of the study	1
1.2 Problem Statement.....	3
1.3 Purpose of the study.....	5
1.4 Research questions.....	5
1.5 Objectives of the study.....	5
1.6 Justification and significance of the study	6
1.7 Scope of the study.....	7
1.8 Assumption of the study	7
1.9 Definition of terms and variables.....	7
CHAPTER TWO: LITERATURE REVIEW	10
2.1 Overview.....	10
2.2 Solid Waste Management Systems	10
2.2.1 Solid Waste Management Systems Globally	10
2.2.2 Solid Waste Management Systems in Africa.....	16
2.2.3 Solid Waste Management Systems in Kenya.....	18
2.2.4 Solid Waste Management Systems in Nairobi.....	19
2.2.5 Solid Waste Management Systems in Ngomongo.....	19
2.3 Solid Waste Management Challenges.....	20
2.3.1 Solid Waste Management Challenges Globally.....	21
2.3.2 Solid Waste Management Challenges in Africa	23
2.3.3 Solid Waste Management Challenges in Kenya	24

2.3.4 Solid Waste Management Challenges in Nairobi	26
2.3.5 Solid Waste Management Challenges in Ngomongo.....	27
2.4 Planning Interventions for Effective Solid Waste Management.....	27
2.4.1 Planning Interventions for Effective Solid Waste Management Globally	29
2.4.2 Planning interventions for Effective Solid Waste Management in Africa.....	31
2.4.3 Planning interventions for Effective Solid Waste Management in Kenya.....	32
2.4.4 Planning interventions for effective solid waste management in Nairobi	33
2.4.5 Planning interventions for effective solid waste management in Ngomongo.....	33
2.5 Information Gap.....	34
2.6 Conceptual Framework.....	34
CHAPTER THREE: STUDY METHODOLOGY	36
3.1 Research Design.....	36
3.2 Target Population.....	37
3.3 Sampling Plan	37
3.4 Data Collection Methods	40
3.4.1 Literature Review Questionnaire	40
3.4.2 Questionnaire	41
3.4.3 Interviewing	41
3.4.3 Observation Literature Review	41
3.5 Data Collection Instruments.....	41
3.5.1 Literature Review.....	41
3.5.2 Interviewing	42
3.5.3 Observation	42
3.5.4 Use of GPS.....	42
3.6 Data Analysis	43
3.7 Ethics	43
3.7.1 Confidentiality and Privacy	44
3.7.2 Use of Vulnerable or/ and Special Populations.....	44

3.7.3 Anonymity	44
3.7.4 Physical and Psychological Harm.....	44
3.7.5 Voluntary and Informed Consent.....	45
3.7.6 Dissemination of Findings	45
3.8 Limitations	45
CHAPTER FOUR: STUDY AREA.....	47
4.1 Introduction.....	47
4.2 Historical Background of Ngomongo Village	47
4.2 Location	47
4.3 Climatic conditions	51
4.3.1 Temperature	52
4.3.2 Rainfall.....	52
4.3.3 Humidity	53
4.3.3 Sunshine	53
4.4 Topography	53
4.5 Population and Demographic Characteristics	54
4.6 Economic Factors and Land Use	54
4.7 Socio-Economic Indicators.....	56
4.8 Industries.....	56
CHAPTER FIVE: RESEARCH FINDINGS	57
5.1 INTRODUCTION	57
5.2 Demographic Information.....	57
5.2.1 Respondents' Distribution by Gender.....	57
5.2.2 Households' Education Qualification	58
5.2.2 Households' Occupation.....	59
5.3 SOLID WASTE MANAGEMENT SYSTEM IN NGOMONGO VILLAGE	59
5.3.1 Major Solid Waste Generated in Ngomongo	59
5.3.2 Solid Waste Storage System in Ngomongo	61

5.1.3 Solid Waste Separation in Ngomongo	63
5.1.4 Reuse and Selling of Solid Wastes in Ngomongo	66
5.1.5 Solid Waste Collection in Ngomongo	70
5.1.6 Solid Waste Disposal in Ngomongo	74
5.2 CHALLENGES AND POSSIBLE INTERVENTIONS ON SWM IN NGOMONGO	78
5.2.1 Challenges to SW Collection	78
5.2.2 Challenges of SW Disposal.....	80
5.2.3 Possible Interventions to Challenges of SWM.....	82
5.3 PLANNING INTERVENTIONS ON SWM IN NGOMONGO	84
5.3.1 Planning Issues that Affect SWM in Ngomongo	84
5.3.2 Planning Interventions to Ensure Effective SWM in Ngomongo	87
5.4 SYNTHESIS OF FINDINGS	89
5.4.1 Solid Waste Management System in Ngomongo.....	89
5.4.2 Challenges and Possible Interventions on SWM in Ngomongo	91
5.4.3 Planning Interventions for Effective SWM in Ngomongo.....	92
5.4.4 Environmental and Health Implication of Poor SWM in Ngomongo.....	92
CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS.....	94
6.1 INTRODUCTION	94
6.2 SOLID WASTE MANAGEMENT SYSTEMS IN NGOMONGO	94
6.3 CHALLENGES OF SOLID WASTE MAMNAGEMENT IN NGOMONGO AND POSSIBLE INTERVENTIONS	95
6.4 PLANNING INTERVENTIONS ON SOLID WASTE MANAGEMENT IN NGOMONGO.....	96
6.5 ENVIRONMENTAL AND HEALTH IMPLICATION OF POOR SWM IN NGOMONGO.....	96
6.6 STUDY RECOMMENDATIONS.....	97
6.6.1 Solid Waste Management Systems in Ngomongo	97
6.6.2 Challenges and Possible Interventions for Solid Waste Management in Ngomongo .	98
6.6.3 Planning Interventions On Solid Waste Management in Ngomongo	98

6.6.4 Environmental and Health Implication of Poor SWM in Ngomongo.....	99
6.6.5 Areas of Further Research.....	100
REFERENCES.....	101
APPENDICES.....	111
APPENDIX I: HOUSEHOLD QUESTIONNAIRE.....	111
APPENDIX II: BUSINESS ENTERPRISE QUESTIONNAIRE.....	116
APPENDIX III: INTERVIEW SCHEDULE DIRECTOR OF ENVIRONMENT-COUNTY GOVERNMENT OF NAIROBI.....	121
APPENDIX IV: SCHEDULED QUESTIONNAIRE FOR HEAD OF WASTE DEPARTMENT, NEMA.....	123
APPENDIX V: INTERVIEW SCHEDULE FOR VILLAGE ELDERS.....	125
APPENDIX VI: INTERVIEW SCHEDULE FOR ASSISTANT CHIEF, NGOMONGO SUB- LOCATION.....	127
APPENDIX VII: INTERVIEW SCHEDULE COMMUNITY HEALTH UNIT OFFICER	129
APPENDIX VII: RESEARCH PERMIT.....	131

LIST OF MAPS

Map 1: Nairobi in the National Context.....	48
Map 2: Ngomongo in the context of Nairobi.....	49
Map 3: Ngomongo in the local context.....	50

LIST OF TABLES

Table 1: Sample size proportion per stratum	38
Table 2: Sample size distribution.....	40
Table 3: Land Use Composition in Nairobi	55
Table 4: Respondents' Distribution by Gender	58
Table 5: Highest Education Qualification.....	58
Table 6: Households' Occupation	59

LIST OF CHARTS/GRAPHS

Chart 1:Categories of Wastes Generated by Households	60
Chart 2: Types of Wastes Generated by the businesses.....	61
Chart 3: Types of Wastes Generated by the businesses.....	62
Chart 4: Wastes Storage Methods by the Business Enterprises.....	63
Chart 5: Wastes Separation at Household Level.....	63
Chart 6: Wastes Separation by Business Enterprises.....	64
Chart 7: Methods of Wastes Separation at Household Level	65
Chart 8: Methods of Wastes Separation by Business Enterprises	65
Chart 9: Reuse of Items Generated from Wastes by Households	66
Chart 10: Reuse of Items from Generated Wastes by Business Enterprises.....	67
Chart 11: Reuse Methods for items from the generated Wastes by Households	67
Chart 12: Reuse Methods for items from the generated Wastes by Business Enterprises	68
Chart 13: Selling of Wastes Generated to Recyclers by the households	69
Chart 14: Selling of Wastes Generated to Recyclers by Business Enterprises	69
Chart 15: Solid Wastes Collection for Households in Ngomongo	71
Chart 16: Solid Wastes Collection for Business Enterprises in Ngomongo	72
Chart 17: Wastes Collection Point for the Households.....	73
Chart 18: Wastes Collection Points for Business Enterprises.....	74
Chart 19: Wastes Disposal Methods by Households	75
Chart 20: Waste Disposal Methods by Business Enterprises	75

Chart 21: Waste Disposal Sites by Households	76
Chart 22: Community Wastes Disposal Sites	77
Chart 23: Solid Waste Collection and Transportation Challenges for the Households ...	78
Chart 24: Solid Wastes Collection and Transportation Challenges for Business Enterprises.....	79
Chart 25: Solid Wastes Disposal Challenges for Households	80
Chart 26: Solid Wastes Disposal Challenges for Business Enterprises	81
Chart 27: Proposed Interventions to the Problem of SWM at household level	82
Chart 28: Proposed Interventions to the Problems of SWM by Business Enterprise	83
Chart 29: The link between Planning of Ngomongo village and SWM by households ..	84
Chart 30: The Link between Planning and SWM in Ngomongo Village by Business Enterprises.....	85
Chart 31: Planning Issues Affecting SWM as Proposed by Households.....	86
Chart 32: Planning Issues Affecting SWM as proposed by Business Enterprises.....	87
Chart 33: Proposed Planning Interventions for Effective SWM as Suggested by Households.....	88
Chart 34: Planning Interventions for Effective SWM as Proposed by Business Enterprises.....	89

LIST OF PLATES

Plate 1: The various storage techniques	62
Plate 2: Plastic materials Collected for Recycling	70
Plate 3: Common Disposal Places within Ngomongo Village.....	77
Plate 4: Waste Disposal at the River	82

LIST OF FIGURES

Figure 1: Conceptual Model.....	35
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LIST OF ABBREVIATIONS AND ACRONYMS

CBO-Community Based Organisation

CCR- Centralized Chutes for Recyclables

EfW-Energy from Waste

EPA-Environment Protection Agency

GCI-Global City Institutes

GCIF-Global Cities Indicators Facility

GHG-Green House Gas

GPS-Global Positioning System

GWMO-Global Waste Management Outlook

HDB-Housing Development Board

ISUDP-Integrated Strategic Urban Development Plan

ISWA-International Solid Waste Association

ISWM-Integrated Solid Waste Management

JICA-Japan International Cooperation Agency

KNBS-Kenya National Bureau of Statistics

MSWM-Municipal Solid Waste Management

NCC-Nairobi City County

NEA-National Environment Agency

NEMA-National Environment Management Authority

NIUPLAN- Nairobi Integrated Urban Development Master Plan Nairobi

NRP- National Recycling Programme

UN-United Nations

UNDESA- United Nations, Department of Economic and Social Affairs

UNIDO-United Nations Industrial Development Organisation

UNDP-United Nations Development Programme

UNITAR-United Nations Institute for Training and Research

UNEP-United Nations Environment Programme

UN HABITAT-United Nations Human Settlement Programme

USA- United States of America

SPSS-Statistical Package for Social Scientists

SWM-Solid Waste Management

WTE- Waste to Energy

WWW-World Wide Web

ABSTRACT

Increased solid waste generation and management problem is largely as a result of rapid urban population growth. The purpose of this study was to examine the challenges and propose possible interventions to ensure effective solid waste management in Ngomongo village of Korogocho informal settlement. The study objectives were to: determine the solid waste management system in the village, identify the main challenges and propose planning interventions for effective SWM in the village. The target population was households and business enterprises within Ngomongo village. A sample size of 140 households and 40 business enterprises were interviewed. The study employed both primary and secondary sources of data. Primary data was collected through administration of questionnaires and interviews of key informants. Observation as well as use of GPS were also employed for the primary data collection. Secondary data collection was in form of literature review. The study found that solid waste management in Ngomongo village is done mainly by youth groups. It is characterised by low levels of waste separation and reuse, erratic collection and poor disposal systems. The study also found that SWM in Ngomongo experiences challenges ranging from lack of proper designated disposal sites leading to poor disposal system, erratic collection system and expensive charges levied by private waste collectors. The planning issues affecting SWM in Ngomongo were lack of designated disposal sites as well as solid waste receptacles, congestion and accessibility problem among others. Overall, SWM in Ngomongo is inadequate. This has the potential for negative environmental and health implications including pollution and spread of diseases. The study therefore recommends that activities of youth groups should be supported in order to increase their capacity as far as collection and disposal of solid waste is concerned. Residents should be sensitized on effective solid waste management especially on separation and recovery of useful material. Solid waste receptacles should be provided in order to act as transfer

stations from where wastes from Ngomongo can be collected and transported to the final disposal point. Planning will help in siting of the facilities.

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

Today, worldwide urbanisation is thought of as an unstoppable characteristic of global societal change (United Nations, 2014). World Urbanisation prospects place world's urban population as of 2014 at 54 per cent (UNDESA, 2014). The report further states that sub-Saharan Africa for instance is in the midst of a dramatic urban transition that will persist well into the 21st century. Between 2010 and 2035, the sub-Saharan urban population will more than double from approximately 298 million to 697 million and by mid-century it is estimated that over 1 billion people will be living in urban areas (UNDESA, 2014). In Kenya the figure for urban population is placed at 32.3 per cent with the rate of urbanization being 4.2 per cent (UN HABITAT, 2013a). Viji (2012) concludes that urbanization is now becoming a global phenomenon, but its ramification is more pronounced in developing countries.

Rapid urban population growth has resulted in a number of land-use and infrastructural challenges, including municipal solid-waste management (Hoornweg & Bhada-Tata, 2012). Bandyopadhyay (2013) argues that cities only occupy two per cent of the world's land surface yet they are responsible for consuming over 75% of the planet's resources and produce 75% of the world's waste. The study further acknowledges that over the past few years, handling this solid waste has become a major organizational, financial and environmental challenge. As cities rapidly grow, so does the amount of waste that they generate. Changing human consumption patterns and the changing structure of economic activity generates various types of waste that must be appropriately managed to ensure sustainable development and a decent standard of living for all urban residents (UN HABITAT, 2014). NEMA (2011) also concurs that

urbanisation, economic growth and industrialization have led to unsustainable patterns of production and consumption which have eventually resulted in considerable increase in both the quantity and variety of waste.

Globally, waste volumes are increasing quickly –even faster than the rate of urbanization (Hoornweg & Bhada-Tata, 2012). Currently, world cities generate about 1.3 billion tonnes of solid waste per year. This volume is expected to increase to 2.2 billion tonnes by 2025 and waste generation rates will more than double over the next twenty years in lower income countries (Hoornweg & Bhada-Tata, 2012). UNEP (2012) points out that the health and environmental implications associated with garbage disposal are mounting in urgency, particularly in developing countries. This, according to UN HABITAT (2010) is especially the case in low income settlements of developing countries where services are often grossly deficient. Low income areas suffer from increasing per capita generation of solid waste and lack of land conveniently situated for solid waste disposal (UN HABITAT, 2010).

Waste, often dubbed as the “third pollution,” requires attention similar to air or water pollution (Ichinose, et al., 2013). Hoornweg & Bhada-Tata (2012) argue that solid waste management is the single largest budget item for many cities. However according to Tacoli (2012), national and municipal governments often have insufficient capacity or funding to meet the growing demand for solid waste management services. Hoornweg & Freire (2013) underscore that municipal solid waste generation is unlikely to peak before the year 2100, and this will exacerbate shortfalls in municipal budgets to collect and properly dispose of waste. UN HABITAT (2014) adds that in low-income countries rapid urban growth is putting extraordinary pressure on limited urban resources to deal with the ever increasing volume and variety of solid wastes. The situation is not made any better by the fact that even though solid waste services have a cost just like any

other services provided, in general the expenditures are never recovered (Guerrero et al., 2013).

In Nairobi, 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 (JICA, 2014). According to the Draft Master plan developed by JICA (2014), the increase in solid waste generation has not been accompanied by equivalent growth in capacity to address it. Njoroge et al., (2014) for instance, observe that Nairobi generates 4,016 tonnes but only about 33 per cent is collected while recycling rate is about 3.7% per cent leaving about 63% uncollected. Proper management of waste has thus become one of the most pressing and challenging environmental problems in the city (JICA, 2014). The problem of solid waste management according to Njoroge et al., (2014) is especially tough to the urban poor who cannot afford the services and hence left to deal with waste disposal on their own.

1.2 Problem Statement

Waste management is a basic human need and can also be regarded as a ‘basic human right’ (UNEP, 2015). However, Muhammad & Manu, (2013) indicate that it still constitutes a serious problem in many Third World cities. Inadequate municipal solid waste management is certainly one of the contributing factors to the degradation of environmental quality (Badgie, et al., (2012). For instance, Muhammad & Manu, (2013) observe that most Third World cities do not collect the totality of wastes generated, and of the wastes collected, only a fraction receives proper disposal. Cheserek et al., (2012) sums it up that the main solid waste management strategy has been one of ‘collect and dump’.

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 waste properly in the first place (Hoornweg & Freire, 2013). On a local scale, improper waste management, especially open dumping and open burning, pollutes water bodies, contaminates air and land, and attracts disease vectors and people who live near or work with solid waste have increased disease burdens. On a global scale, solid waste currently contributes to climate change (emitting 5 percent of total greenhouse gases) (Hoornweg, & Freire, 2013).

Nairobi's solid waste situation is largely characterized by low coverage of solid waste collection, pollution from uncontrolled dumping of waste, inefficient public services, unregulated and uncoordinated private sector and lack of key solid waste management infrastructure. It is estimated that Nairobi generates 4,016 tonnes and only about 33 per cent gets collected while recycling rate is about 37 per cent leaving about 63 per cent uncollected (Njoroge et al., 2014).

Njoroge et al., (2014) point that apart from Kayole temporary dumpsite located 13 kilometres from the City centre, started in 2009 and has a capacity of 930,000m³, Nairobi's Dandora dumpsite is the only site which is operational. It is an open site where all the waste collected from the city is dumped off. There are over 70 illegal dumpsites scattered throughout the city where most private waste collectors dump collected waste. This coupled with the unmanaged Dandora dumpsite and uncollected waste make solid waste management in the city a challenge (Njoroge et al., 2014).

The challenge of solid waste management is much pronounced in informal settlements. For instance, Mwangi (2011) in a study done in Makina village of Kibera informal settlement reveal that 80% of households use shallow rubbish pits to store their wastes which with time turn into large dumpsites due to the irregular waste collection services in the area.

This study therefore seeks to examine the challenges, possible solutions and propose intervention measures to ensure effective solid waste management in Ngomongo village, Korogocho informal settlement, Nairobi County.

1.3 Purpose of the study

The purpose of this study is to examine the challenges, possible solutions and propose intervention measures to ensure effective solid waste management in Ngomongo Village in Korogocho informal settlement.

1.4 Research questions

In view of the problem statement, the study seeks to address the following research questions with regard to municipal solid waste management in the study area.

- i. What solid waste management systems are in place in Ngomongo village?
- ii. What are the main challenges and possible solutions to effective solid waste management in Ngomongo?
- iii. What planning interventions can be implemented to ensure effective solid waste management in Ngomongo?

1.5 Objectives of the study

The objectives of the study are:

- i. To determine solid waste management systems in Ngomongo village of Korogocho informal settlement
- ii. To identify the main challenges and possible interventions to effective solid waste management in Ngomongo village of Korogocho informal settlement
- iii. To identify and propose planning interventions that can be implemented to ensure effective solid waste management in Ngomongo village of Korogocho informal settlement.

1.6 Justification and significance of the study

This study is justified in terms of area of study, because Ngomongo is one of the informal settlements in Nairobi City County. UN HABITAT (2014a), points out that urban waste management services are often woefully inadequate in informal settlements. These settlements are deprived economically and are not able to pay for collection and transportation of wastes generated within their localities thus resulting in illegal dumping in streams, rivers, highways and other undesignated areas (NEMA, 2014). UNEP & UNITAR (2013) observe that it is the urban poor who often live and work near waste disposal sites and are most at risk sometimes suffering acute health and environmental impacts associated with poor solid waste management.

From a planning context, this study is justified by an observation made by UNEP & UNITAR (2013) that land use planning policies set the context for planning of waste management in cities and towns. The authors reiterate that land use planning attributes such as street width and layout, which influence collection choices, temporary waste storage options, as well as siting of landfills, waste transfer stations and other waste management facilities are all important to solid waste management. Aurah (2013) in a study done in Nairobi, concludes that Nairobi's inability to effectively deal with the issue of solid waste management is partly caused by the high population of Nairobi residents and the ever emerging unplanned settlement areas in the city. The relationship between planning and solid waste management can therefore not be overemphasised. This further indicates the significance of this study to the urban and regional planning field.

The study is also justified from a revenue point of view. In fact, Hoornweg & Bhada-Tata (2013) emphasise that municipal solid waste management is the largest single

budget item for cities and one of the largest employers in low-income countries as well as many middle-income countries. However, World Bank (2014) observes that SWM service is often inefficient and underperforming in developing countries. This study is therefore justified as it will help to come up with recommendations for Ngomongo village that are cost effective.

1.7 Scope of the study

The scope of the study is restricted both to the subject of study and area where the research was conducted. In terms of subject, the study was confined to challenges and possible solutions for effective solid waste management in Ngomongo village. The study area was restricted to Ngomongo village of Korogocho informal settlement, Ruaraka Sub County, Nairobi County.

1.8 Assumption of the study

The study assumes that:

There will be no major policy pronouncement that affects the existence of informal settlements in the near future.

1.9 Definition of terms and variables

- In the purpose of this study there are a number of terminologies and variables that will be used repeatedly throughout the entire work and therefore for purposes of clarity the study will give them contextual meanings.
- **Solid Waste Collection:** Collection of solid waste from point of production (residential, industrial, commercial, institutional) to the point of treatment or disposal.

- **Solid Waste Sorting:** Sorting is a kind of activity which is separating different types of wastes in their respective nature (Regassa et al., 2011).
- **Municipal Waste:** Wastes generated by households, and wastes of similar nature generated by commercial and industrial premises, institutions such as schools, hospitals, care homes and prisons and from public spaces such as streets, markets, slaughter houses, public toilets and bus stops, parks and gardens (UN HABITAT, 2010). Such wastes usually contain a high proportion of putrescible (organic) components, such as food, kitchen, and garden waste (UNEP, 2013).
- **Hazardous wastes:** Materials which exhibit ignitable, reactive or corrosive characteristics (UNEP, 2010).
- **Municipal solid waste management (MSWM):** Refers to the collection, transfer, treatment, recycling, resources recovery and disposal of solid waste in urban areas (Sahoo et al., 2013).
- **Composting:** Composting is the biological decomposition of the biodegradable organic fraction of municipal solid waste under controlled conditions to a state sufficiently stable for nuisance-free storage, handling, and safe use in land application (Badgie, et al., 2012).
- **Recycling:** Processing of discarded materials into new useful products (Badgie, et al., 2012).
- **Reuse:** Re-use involves using discarded goods without reprocessing or re-manufacture (UNEP-GEAS, 2013).
- **Incineration:** Controlled burning of wastes at a high temperature.
- **Informal Settlement:** Are residential areas where: inhabitants have no security of tenure vis-à-vis the land or dwellings they inhabit, with modalities ranging from squatting to informal rental housing; the neighbourhoods usually lack, or are cut off from, basic services and city infrastructure and; the housing may not

comply with current planning and building regulations, and is often situated in geographically and environmentally hazardous areas (UN HABITAT, 2015).

- **Stakeholders:** individuals or groups that have an interest or roles in solid waste management (Hoornweg & Bhada-Tata 2012).

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview

Waste management is one of the essential utility services underpinning society in the 21st century, particularly in urban areas (UNEP, 2015). However, World Bank (2014) posits that cities face numerous challenges at every stage of the MSW value chain. According to UN HABITAT (2010) it is one of the costly urban services, typically absorbing up to 1 per cent of Gross National Product and 20-40 per cent of municipal revenues in developing countries. Whether that percentage of revenue is ever deployed to actual solid waste management is debatable considering that services are often grossly deficient especially within low income settlements which often comprise sizable proportion of the city's area (UN HABITAT, 2010).

Ineffective solid waste management practices make a poor impression on foreign investors and tourists, and may result in loss of reputation and investment (UN Habitat, 2013c).

2.2 Solid Waste Management Systems

Solid waste management may vary from country to country and city to city (UNEP-IETC, 2009). Suresh et al., (2013) observes that devising a proper solid waste management system requires a greater knowledge about composition of municipal solid waste. Waste is generally managed as identifiable waste streams generated from a number of identifiable sources (UNEP & UNITAR, 2013).

2.2.1 Solid Waste Management Systems Globally

Globally, waste volumes are increasing quickly –even faster than the rate of urbanization (Hoornweg & Bhada-Tata, 2012). Nevertheless, proper waste management has a major contribution to make in shifting the planet towards a sustainable future (UNEP &

UNITAR, 2013). According to Hoornweg & Bhada-Tata (2012), municipal solid waste management is the most important service a city provides both in low-income countries as well as many middle-income countries.

Wilson (2007) observes that while developed countries exhibit a high degree of sound environmental considerations in their waste management utilizing sanitary landfills, waste treatment and processing, energy and material recovery options, in developing countries waste disposal is uncontrolled and waste treatment, processing, energy and material recovery are rare.

Many developed countries have made great strides in addressing waste management, particularly since the environment came onto the international agenda in the 1960's (UNEP, 2015). Global Waste Management Outlook (GWMO) of 2015 reports that the initial focus was on waste after it had been discarded, whereas at present attention has moved upstream, addressing the problem at its source through, for example, designing out waste, preventing its generation, reducing both the quantities and the uses of hazardous substances, minimizing and reusing, and, where residuals do occur, keeping them concentrated and separate to preserve their intrinsic value for recycling and recovery and prevent them from contaminating other waste that still has economic value for recovery (UNEP, 2015).

For instance, in Adelaide City, Australia, waste collection system is highly modernized, and 100 per cent of households in the Adelaide metropolitan area receive a high-quality kerbside waste collection service, usually on a weekly basis (UN HABITAT, 2010). The high standards of collection and street and public place cleaning services and customer care are consistent regardless of the socio-economic status of the area. Here solid waste collection system is by both private sector companies and public company. According to UN HABITAT (2010), approximately 70 per cent of the population receive kerbside

collection services that are operated by the private sector under contract to local councils, while 30 per cent by a public company set up by a group of councils. The majority of collection services operate as three-bin systems for separate collection of recyclables, green organics and residual waste (UN HABITAT, 2010).

In Adelaide recycling and disposal, according to UN HABITAT (2010), is at 54% and 46% of the total waste collected respectively. Disposal is purely by landfilling carried out to a high standard of environmental protection (UN HABITAT, 2010). The situation is even better in Sweden where according to Research Office of the Legislative Council Secretariat (2014), only 1% of municipal solid waste ("MSW") end up at landfills while treatment is characterised by an almost equal share of recycling/composting (48%) and incineration (51%) as of 2011. Incineration has developed to such a level that Sweden has been short of feedstock to fuel its incineration plants and started to import waste from its neighbouring countries (Research Office, 2014).

In the Czech Republic, Danco (2013), reports that around 70% of MSW generated is landfilled while the MSW recycling rate stands at 16% and municipalities are responsible for MSW management in their administrative territories. The Czech Republic has also implemented a landfill tax where citizens pay a fee for municipal waste services per capita (Danco, 2013).

Developing countries on the other hand have solid waste management problems different from those found in fully industrialized countries (Abdelhamid, 2014). A typical solid waste management system in a developing country displays an array of problems, including low collection coverage and irregular collection services, crude open dumping and burning without air and water pollution control, the breeding of flies and vermin, and the handling and control of informal waste picking or scavenging activities (Ogawa, 1996). This is consistent with UNEP (2015) assertion that low- and

middle-income countries still face major challenges in ensuring universal access to waste collection services, eliminating uncontrolled disposal and burning and moving towards environmentally sound management for all waste. Achieving this challenge is made even more difficult by forecasts that major cities in the lowest income countries are likely to double in population over the next 20 or so years (UNEP, 2015).

Abdelhamid (2014), observe that most developing countries lack the technical and financial resources to manage solid wastes safely. As a result, solid waste management service is often inefficient and underperforming in developing countries (World Bank, 2014). Muhammad & Manu (2013) conclude that most Third World cities do not collect the totality of wastes generated, and of the wastes collected, only a fraction receives proper disposal.

In tropical Asia for instance, McRae (2012) observe that waste management technologies and policies have not kept pace with the increase in waste production. The deficiency in technology, policies and financial resources according to (Abdelhamid, 2014), means that in those countries, storage at the point of waste generation is often inadequate and collection services are not only inefficient but also insufficient. Disposal is usually a matter of transporting the collected wastes to the nearest available open space and then discharging them, (Abdelhamid, 2014).

In Bangladesh, according to Ahsan, et al., (2014), major portions of wastes remain unmanaged and are thrown in adjacent spaces, roadsides and drains. Similarly, there is no system of waste separation at source and often, wastes, irrespective of types, are generally deposited in community bins and secondary disposal sites provided either by dwellers themselves or by NGOs, CBOs, city authority, or private sectors from where they are collected by city authorities and transferred to ultimate disposal sites (Ahsan, et al., 2014).

In India all waste whether biodegradable, recyclable, construction, hazardous or soiled are mixed together (Vij, 2012). Vij, (2012) point out that no system of waste segregation at the source exists here and generally solid waste is disposed of in low-lying areas, outskirts of cities, alongside roads or any vacant place wherever waste collectors find that they will not be seen or objected by anybody. Where there are landfills, they are not scientifically designed and so create air, water and soil pollution (Vij, 2012). The situation in India is made worse by the fact that in a maximum of municipalities, there is no separate department for waste management. Often, SWM is the responsibility of a health officer who is assisted by the engineering department in the transportation work (Vij, 2012). This coupled with lack of coordination among various departments of civic bodies lead to poor management of solid waste.

In Port-au-Prince, Haiti, the existing solid waste management system is affected by unfavourable economic, institutional, legislative, technical and operational constraints. The use of open dumps is common for the disposal of wastes, resulting in soil and water resource contamination by leachate, in addition to odours and fires. Lack of data on generation rates and solid waste composition combined with lack of public awareness constitute a major challenge for SW management in Port-au-Prince (Bras, et al., 2009).

Despite the sorry state of affairs in SWM for Asian and Caribbean cities, there are success stories where some countries have recorded improvement in their SWM systems. Singapore for instance, as pointed out by UNEP (2015) in the Global Environmental Outlook, has transformed her waste management strategy from a situation of dumping of wastes in swamps in the 1960's to developing a SWM system with the central idea that waste is a resource. Singapore has devised cost effective systems to collect and treat waste. UNEP (2015) expounds that the system involves households paying a flat monthly fee which is less than 0.5% of the average monthly

household income. The fees according to UNEP (2015), is collected via monthly utility bill that also includes the fees for electricity, water and gas. As part of the strategy, all combustible waste that is not recycled is treated in energy-from-waste (EfW) plants, whereby the waste volume is reduced by 90% and energy is recovered to produce electricity that meets up to 3% of Singapore's total electricity demand (UNEP 2015). The report concludes that only non-combustible waste, comprising 2% of Singapore's waste, and residues from the EfW plants are sent to the Singapore's only landfill, the offshore Semakau Landfill, which was commissioned in 1999.

Another major focus of Singapore's waste management strategy according to GWMO of 2015 is recycling. UNEP (2015) reports that Singapore's National Environment Agency (NEA) launched a National Recycling Programme (NRP) in 2001 to provide recycling collection services to the residents. The programme, according to UNEP (2015) started with provision of recycling bags with fortnightly door-to-door collection. In response to feedback from residents living in high-rise public flats built by the Housing and Development Board (HDB), where over 80% of Singapore's population lives, regarding space constraints for storage of recyclables, coupled with a demand for more recycling infrastructure, the number of recycling bins and the collection frequency have gradually increased. In November 2008, UNEP (2015) reports that through consultation with stakeholders, NEA was mandated by law to compel estates to have Centralized Chutes for Recyclables (CCR).

Whereas WTE strategy seems to have worked for Singapore, in some countries such as Indonesia as submitted by McRae (2012), success in SWM has been achieved largely based on projects that combine recycling and composting in various mixes.

In conclusion, generally, there seems to be a marked difference between solid waste management system in developed and developing countries. For instance, while in developed countries collection systems achieve an almost 100 per cent in most cases, the

same cannot be said of developing countries whether in Asia or in the Caribbean. Jacobi & Besen (2011) observe that richer countries generate larger amounts of waste and garbage but have greater management capacity due to a host of factors, including economic resources, environmental concern of the population, and technological development. On the other hand, cities in developing countries with very rapid urbanization lack financial and administrative capacity to provide infrastructure and essential services, garbage collection and disposal included (Jacobi & Besen, 2011).

2.2.2 Solid Waste Management Systems in Africa

Municipal solid waste management constitutes one of the most crucial health and environmental problems facing governments of African cities (Achanken, 2003). However, in many African cities, according to UN HABITAT (2014b), waste management systems appear to be absent, with solid waste disposed of directly adjacent to informal settlements in mounds, trenches and near watercourses. Many cities are marred by inefficient collection, management, disposal and reuse of municipal solid waste ((Simelane & Mohee, 2012). On a positive note however, UN HABITAT (2014b) notes that African urban wastes provide many recycling and reuse opportunities and are a key area for development.

In Addis Ababa, Ethiopia for example, Desta, et al., (2014) contend that current condition of SWM lacks integrated waste management approach and the systems are not all effective that wastes are often improperly disposed in undesignated sites. This is attributed to rapid population growth in addition to unplanned urban expansion and financial scarcity to proper waste management (Desta, et al., 2014).

The situation in Egypt is not any better where according to the World Bank (2015), MSW collection systems capture between 30-85% of the waste generated in urban areas. In Cairo, although the situation is a bit better because as World Bank (2015) reports, a

collection rate of roughly 65% is achieved. However, the remaining material accumulates in and around residential and commercial areas and is often dumped into rivers and abandoned canals (World Bank, 2015). Municipal Solid Waste (MSW) disposal facilities are substandard, with just 2% of the country's waste managed in state-of-the-art sanitary landfills. The balance is primarily managed at controlled and uncontrolled dumpsites, where environmental controls are minimal, and open burning of the waste is commonplace.

One notable factor with solid waste management in Egypt is that the informal sector plays a significant role in Egypt's collection and recycling sector. The informal systems are most common in places where municipal collection services are poorly managed or the logistics of transporting household waste down the stairs or block to a designated disposal point is too onerous or inconvenient (World Bank, 2015).

In Douala, Cameroun, solid waste management practices include: collection, recycling, solid waste disposal on land, biological and other treatments as well as incineration and open burning of waste. However, the recycling of materials (paper, plastics, metals, and glass) in the Douala municipality as practiced by several small and medium size enterprises, has only risen to about 28% over the past decade (Mbue, et al., 2015).

In East Africa, Okot-Okumu, (2012) reports that the system is characterised by predominantly conventional waste management methods that have failed because they do not effectively address local conditions such as culture, financing system, institutional framework, technical and human capacities, socio-political situation and waste characteristics. Waste management is a decentralised function of urban councils but its funding is predominantly external (Okot-Okumu, 2012).

2.2.3 Solid Waste Management Systems in Kenya

In Kenya, according to NEMA (2014), waste management has been traditionally by legislation bestowed to the local authorities. Waste management systems tend to follow one main stream: open dumping which is very limiting considering the complex nature of solid wastes (NEMA, 2014). The system also contravenes the internationally recognized principle of Integrated Solid Waste Management (ISWM): waste minimization, reuse, recycling, composting and landfilling.

NEMA (2014) contends that the ability and the capacity of councils to manage waste was over-stripped due to urbanization and rapid population growth. Furthermore, the Councils relegated the waste management agenda to the bottom in priority of allocated meagre resources, both financial budget and physical for its management. The technical and institutional capacities are equally and seriously inadequate. (NEMA, 2014).

Many of the collection systems in the country are poorly coordinated and operated due to a number of reasons. These are: limited availability of appropriate equipment for collection; limited proper guidelines and supervision; limited technical personnel capacity; low level of awareness and education on the importance of proper solid waste management. This scenario has resulted in sporadic and non-formal waste collection systems that require a lot of resources for their regulation (NEMA, 2014).

In Kisumu presently, solid waste management system has incorporated private enterprises into the city's solid waste management system (Kisumu Draft ISUDP, 2014). According to the draft plan the system is one where companies in the private waste collection business do not require consent from the county to enter into contractual agreement with their customers. The private collectors and county refuse collection crew have access to key waste production points in the city whereas informal waste-pickers operate in the less accessible areas of the city (Kisumu Draft ISUDP, 2014).

2.2.4 Solid Waste Management Systems in Nairobi

There exists in the solid waste domain in the city, both public and non-public actors engaged in the collection, transportation and disposal of solid waste as well as the recovery, re-use and recycling with the latter existing and operating extra-legally. The actors and their activities are organised differently according to type of activity and are governed in their operations by both formal and informal rules and regulations (Karanja & Okoth, 2003).

UNEP (2010) specifically notes that on waste collection, CBOs and private collectors have been growing whilst publicly operated collection system has been falling further and further behind. The growth rate of collection by CBOs and private waste collectors has been at similar rates as the overall growth in waste (UNEP, 2010).

Despite being run by both formal and informal actors, Nairobi's solid waste situation is largely characterized by low coverage of solid waste collection, pollution from uncontrolled dumping of waste, inefficient public services, unregulated and uncoordinated private sector and lack of key solid waste management infrastructure. It is estimated that Nairobi generates 4,016 tonnes and only about 33 per cent gets collected while recycling rate is about 37 per cent leaving about 63 per cent un-collected (Njoroge et al., 2014).

One key observation about solid waste management in Nairobi by Hiltunen, (2010), is that the overall process of waste management is highly differentiated between informal settlements and upmarket areas.

2.2.5 Solid Waste Management Systems in Ngomongo

Ngomongo as an informal settlement has no documented studies as far as solid waste management is concerned. However, being an informal settlement, it is highly likely that

the conditions of solid waste management systems in Ngomongo do not vary much with those of other informal settlements in Nairobi. This study therefore will either validate or invalidate this assumption.

Hiltunen, (2010) notes that the overall process of waste management in Nairobi is to a lesser extent, connected to informal settlements experiencing poor solid waste management systems. For example, the author identifies area of Kariobangi South as lacking not only primary and secondary collection, but also a central collection system. Neither is there a central collection point available.

Closer to Ngomongo is Korogocho informal settlement where according to Gathuthi et al., (2010), in an economic survey report, waste management service is provided majorly by individuals (49%) followed by CBO's (9%) while 34% of the population had no one providing solid waste management service.

2.2 Solid Waste Management Challenges

As cities rapidly grow, so does the amount of waste that they generate. Changing human consumption patterns and the changing structure of economic activity generate various types of waste that must be appropriately managed to ensure sustainable development and a decent standard of living for all urban residents (UN Habitat, 2014a).

2.3 Solid Waste Management Challenges

Hoornweg & Bhada-Tata (2012) observe that solid waste management is the single largest budget item for many cities. However according to Tacoli (2012) most national and municipal governments often have insufficient capacity or funding to meet the growing demand for solid waste management services.

2.3.1 Solid Waste Management Challenges Globally

Challenges in solid waste management are more acute in developing countries than in developed countries (Hoornweg & Freire, 2013). Perhaps one major challenge in developed countries as pointed out by Hoornweg & Freire (2013), is the complexity of wastes generated by their populations. Wealthier cities tend to produce more complex waste, with higher proportions of electronics and plastics, which are harder to manage (Hoornweg & Freire 2013).

Land space for siting landfills is also a challenge in solid waste management in developed countries. For instance, the United Kingdom will run out of landfill space by 2018 with their current generation rates (UN Habitat (2013c).

The problem of solid waste management is especially acute in developing countries because as Muhammad & Manu (2013) observe, most third world cities do not collect the totality of wastes generated, and of the wastes collected, only a fraction receives proper disposal. This is supported by UNEP's (2015) assertion that low- and middle-income countries still face major challenges in ensuring universal access to waste collection services, eliminating uncontrolled disposal and burning and moving towards environmentally sound management for all waste.

Badgie, et al., (2012) hold that inadequate municipal solid waste management is certainly one of the contributing factors to the degradation of the environmental quality. Surmounting this challenge is made even more difficult by forecasts that major cities in the lowest income countries are likely to double in population over the next 20 or so years (UNEP, 2015). Ahsan et al (2014) for instance opine that SWM in Bangladesh for instance, like in most developing countries, has so far been ignored and least studied environmental issue.

In India, according to Vij (2012), the challenge of solid waste management range from rapid population growth, lack of planning, insufficient resource allocation due to lack of prioritization of solid waste management to societal apathy towards solid waste management. As a result, waste scatters on vacant plots and alongside roads (Vij,2012). Even newly developed cities are finding it difficult to get the landfill place to dump the waste of the city (Vij, 2012). Senguta & Barnwal (2012) add that in Delhi, more than 5000 tons of municipal solid waste is generated every day, which is disposed of in landfills and that too much land is being consumed for disposal creating danger of ground water contamination.

Ogawa (1996) identifies technical constraint as another challenge facing most developing countries in SWM. The author underscores that in most developing countries, there typically is a lack of human resources at both the national and local levels with technical expertise necessary for solid waste management planning and operation. Many officers in charge of solid waste management, particularly at the local level, have little or no technical background or training in engineering or management (Ogawa, 1996).

Guerrero et al., (2013) concludes that solid waste management is a challenge for the cities' authorities in developing countries mainly due to the increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated with its management, the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system functioning (Guerrero et al., 2013).

2.3.2 Solid Waste Management Challenges in Africa

UN HABITAT (2014a) notes that due to poor policies, 62% of urban populations in Sub-Saharan Africa live in slum areas dominated by uncontrolled informal spatial developments, most often located in environmentally fragile areas, and without access to basic services including waste management systems.

According to Simalane & Mohee (2012), in urban centres throughout Africa, less than half of the solid waste generated is collected and 95 per cent of that is neither contained nor recycled. The authors further state that the waste is indiscriminately thrown away at dumping sites on the periphery of urban centres, or at temporary sites; a situation that is confirmed by a number of studies conducted in African towns and cities. In Abeokuta, South West Nigeria, for instance, 41.86% residents do not have their wastes collected by anybody (Achi et al., 2012), while in Dar es salaam collection rates stand at less than 40% (Breeze, 2012).

Mixing of wastes is another problem facing solid waste management in Africa as observed by Remigios (2010) where dumping is unrestricted and industrial, agricultural, domestic, and medical wastes end up in one site which in most cases is not fenced off.

Another challenge in solid waste management in Africa is lack of data. Simalane & Mohee (2012) observe that the quality and availability of data on solid-waste generation and management in Africa is scanty, a factor that impedes development of programmes that promote efficient use of solid waste.

Okot-Okumu, (2012) in a survey of East African cities, identifies lack of prioritisation of waste management in the annual plans of urban councils. UN HABITAT, (2013b) underscores that SWM services in East Africa are chronically underfunded, with too few vehicles, poor equipment and inadequate maintenance. This is further demonstrated by Kasala, (2014) in a study done in Keko Machungwa informal settlement, Dar es Salaam,

where financial constraints resulting from unwillingness of the service users to pay lead to constraints in solid waste management.

Public apathy towards solid waste management is also a challenge to solid waste management. In this regard, Ali et al., (2010) identify public misconceptions, attitudes and behaviours as some of the issues greatly contributing to the problems of illegal dumping and uncollected household waste being witnessed in the major cities of the East African region including Dar es Salaam, Kampala and Nairobi. In Dar es Salaam, Kasala (2014) point out low public participation and cooperation as some of the challenges of solid waste management.

In conclusion, Waste management problems in Africa vary in nature and complexity ranging from infrastructural, political, technical, socio-economic to organizational/management-related challenges. Moreover, regulatory and legal issues and challenges need to be addressed (UNIDO, 2009).

2.3.3 Solid Waste Management Challenges in Kenya

In Kenya, the problem of solid waste management is real (Gakungu, 2011). Mwanzia et al., (2013) note that Kenya is urbanising fast, and as it does so, the problems of solid waste management are escalating. Okalebo et al., (2014) postulate that rapid urbanization and consequent collapse of solid waste management of cities is a global phenomenon and Kenya is no exception. Urbanisation therefore is an accelerating factor in the problem of solid waste management.

One of the notable challenges facing solid management in Kenya is inadequacy of the available systems. Cheserek, et al., (2013) in a study done in Eldoret found out that the main solid waste management strategy has been one of ‘collect and dump’. The systems according to NEMA (2014) tend to follow one main stream of open dumping which is limiting considering the complex nature of solid wastes. Furthermore, it contravenes

internationally recognized principle of Integrated Solid Waste Management (ISWM) of waste minimization, reuse, recycling, composting and landfilling (NEMA, 2014).

Other challenges of solid waste management in Kenya, as demonstrated by a study done in Nakuru by Mwanzia et al., (2013) are lack of access roads and unwillingness to pay for collection services especially in low income residential areas. In addition, licensed enterprises cite high and multiplicity of fees including trade permit, conservancy fees, inspection fees and NEMA license fees (Mwanzia, et al., 2013). Similarly, Cheserek et al., (2013) identify lack of capacity by local authorities (now county governments) to implement legislation covering solid waste management.

Low collection rates and improper disposal systems also plague solid waste management in Kenya. For instance, in Nairobi solid waste collection rate is about 33% of the waste generated (Njoroge et al., 2014) while in Kisumu collection rate is estimated at 20% (Kisumu draft ISUDP). As a result, the draft ISUDP observe that many households, particularly in the peri-urban and extended city areas do not have the privilege of any mode of collection, and have resorted to burning of waste or digging pits to bury the waste on-site resulting in air pollution especially in the densely populated areas.

The challenges of solid waste management in Kenya are summarised by NEMA (2014) as follows: Many of the collection systems in the country are poorly coordinated and operated due to a number of reasons ranging from limited availability of appropriate equipment for collection; limited proper guidelines and supervision; limited technical personnel capacity; to low levels of awareness and education on the importance of proper solid waste management.

2.3.4 Solid Waste Management Challenges in Nairobi

Rapid population growth rate, increased urbanization rate and current changing lifestyles of the Nairobi residents result to the evolving estimates of waste generation rates as well as characterization of the wastes generated (Njoroge et al., 2014). Mutisya & Yarime (2011) opine that while poor management of solid waste is a general problem in Kenya, it is probably worst in Nairobi.

According to Oyake-Ombis (2014) challenges of solid waste management in Nairobi include lack of prioritization of solid waste management in budgeting process, lack of efficient waste collection and disposal mechanisms as well as public apathy towards solid waste management.

A combination of all of the factors including lack of resources - financial and personnel, institutional weakness, improper selection of technology, transportation systems and disposal options, public apathy towards environmental cleanliness and protection have made this goal unattainable in many of these cities (Aurah, 2013). Until all stakeholders become full participants in SWM, a fully sustainable SWM system is not possible (Aurah, 2013).

Rotich et al., (2006) observe that laws governing MSW disposal, revenue collection and project implementation and management are often not enforced. This is confirmed by Magutu et al., (2010) who add that inability to formulate and implement sound solid waste management policies; poor enforcement of available solid waste management regulations; limited utilization of recycling activities; the inability to regulate and monitor the activities of all generators of solid waste, and poor transportation services provision are some of the challenges facing the solid waste management system in Nairobi. The problem is worsened by financial mismanagement which results in a

persistent lack of funds to expand and improve municipal solid waste handling capacities as well as capacity-building (Rotich, et al., 2006).

2.3.5 Solid Waste Management Challenges in Ngomongo

Solid waste management challenges in Ngomongo could be likened to those being faced by Korogocho informal settlement due to their proximity to each other. This is because (as already noted), there are no documented studies on Ngomongo as far as solid waste management is concerned. This study will however validate or invalidate whether solid waste management situation in Korogocho compare with those of Ngomongo.

According to Gathuthi et al., (2010), the challenge of solid waste management is marred with very poor to non-existent solid waste management service. As a result, cleanliness is wanting in all the villages of Korogocho (Gathuthi et al., 2010).

2.4 Planning Interventions for Effective Solid Waste Management

According to World Urbanisation Prospect (2014), rapid and unplanned urban growth threatens sustainable development when necessary infrastructure is not developed or when policies are not implemented to ensure that benefits of city life are equitably shared. Rapid urban population growth according to Hoornweg & Bhada-Tata, (2012) has resulted in a number of land-use and infrastructural challenges, including municipal solid-waste management.

Waste generation is increasing in quantity and complexity with urban growth (Hoornweg & Freire, 2013). Thus, cities should implement plans that ensure supply of affordable, serviced land which is probably the most important input for sustainable urbanization.

World Bank (2013) defines planning as charting a course for cities by setting the terms of urbanization, especially policies for using urban land and expanding basic

infrastructure and public services. It is the first step in designing or improving a waste management system (EPA, 2002).

Waste management planners should, for example, take into consideration institutional, social, financial, economic, technical, and environmental factors. Planners equally need to recognize that these factors vary from place to place (EPA, 2002).

World Bank (2013), notes that planning is fundamental to the provision of most basic infrastructure services—water, energy, sanitation, and solid waste management to all residents (urban and peri-urban alike). This is done through allocation of land use in a way that allows for infrastructure improvements.

Planning makes the most of municipal budgets by informing infrastructure and services investments, and balancing demands for growth with the need to protect the environment. It also distributes economic development within a given area to reach social objectives, and creates a framework for collaboration between local governments, the private sector and the public at large (UN, Habitat, 2013c). In this regard, GCIF (2015) suggests that urban planning process should include a diverse set of stakeholders including low income and marginalised groups, national minorities and indigenous people because this allows such plans to leverage on the expertise of the said stakeholders.

EPA (2002), points out that since integrated solid waste management involves both short- and long-term choices, it is critical to set achievable goals. EPA (2002) further submits that while developing an ISWM plan, one should identify goals or objectives (e.g., protect human health, protect water supplies, eliminate open dumping, increase recycling or composting). The ISWM plan helps to guide through the implementation process (EPA, 2002).

2.4.1 Planning Interventions for Effective Solid Waste Management Globally

Globally, UNDESA (2014) submits that 54 per cent of the world's population currently reside in urban areas. However, we are living in an increasingly urbanised world, where many cities' infrastructure systems are already strained or unable to service existing populations (GCIF, 2015).

UN HABITAT, (2009), posits that urban planning has an important role in assisting governments to meet the urban challenges of the 21st century of which solid waste management is one of them. Cities need policies for the provision of public goods and basic infrastructure services including water, sanitation, and solid waste management (World Bank, 2013).

UNDESA, (2014) submits that a holistic approach to urban planning and management is needed to improve living standards of urban and rural dwellers alike. World Bank, (2013) further adds that cities need policies for the provision of public goods and basic infrastructure services including water, sanitation, and solid waste management. According to UN Habitat, (2013c) cities can achieve this by integrating waste management and spatial planning. For instance, measures such as providing spaces for sorting and recycling close to areas where waste is produced can help to reduce the size of a disposal site.

Updating cadastral information is another way through which spatial planning can help in solving solid waste management problems. An updated cadastre according to UN Habitat, (2013) has the ability to improve recovery of collection fees for solid waste. In Colombia for example, some cities have a single utility bill that covers many services such as water, sewerage, telephone, electricity and solid waste while in Ecuador cities

attach a surcharge of 10-12 per cent to electricity bills to cover waste management costs (UN Habitat (2013c).

Sustainable urbanization requires that cities generate better income and employment opportunities, expand the necessary infrastructure for water and sanitation, energy, transportation, information and communications; ensure equal access to services; reduce the number of people living in slums; and preserve the natural assets within the city and surrounding areas (UNDESA, 2014).

Urban planning can help to solve the problem of solid waste management through resource allocation and budgeting exercises. This is achieved by incorporating political visions and values into the physical reality of cities (UN HABITAT, 2010b). Ai (2010) observes that there is great potential for planners to identify material flows through urban systems, given that land use and zoning determines the destination of material inputs and source of waste generation. In India, Vij, (2012) opines that there is need for including treatment and disposal facilities for urban solid waste management as part of a city's master plan. Similarly, planners have access and can make the influence on infrastructure planning, which could include not only landfill and waste to energy (WTE) facilities, but also recycling centres, drop-off sites, and even remanufacturing facilities within urban centres (Ai, 2010).

Urban planning also helps to promote inclusivity especially for the informal sector (UN HABITAT, 2010b). This entails finding ways to pro-actively guide and build on the contribution of the informal processes, actors and resources to city development, instead of refusing such contribution and attempting to control it through regulation at all costs (UN HABITAT, 2010b). In Columbia for instance, according to the Global Waste Management Outlook (2015), the Ministry of Housing and Urban Planning issued a decree in 2013 on public services and a resolution in 2014 on solid waste management

planning, requiring municipal authorities across Colombia to shift their waste management plans to inclusive models that incorporate informal recyclers. EPA (2002) concludes that one should never neglect to ask for community's input in developing a solid waste management plan, so as to ensure an informed public and to increase public acceptance.

In spite of the importance of planning in solid waste management, Dewi et al., (2010) observe that many planners and decision makers in the area of municipal solid waste, lack thorough understanding of the whole chain of waste management system and its impact on environmental quality and public health. City planners' involvement in waste management has been largely limited to siting waste management facilities (Dewi et al., 2010).

2.4.2 Planning interventions for Effective Solid Waste Management in Africa

Urbanisation is on the rise in Africa and this trend is expected to continue in the future. Of concern is that the infrastructure and land use planning including for waste management is not coping with the growth of urban areas. This is particularly urgent in the slum areas which constitute a big part of many of the cities and towns in Africa (UNIDO, 2009).

The importance of urban planning in solid waste management in Africa is perhaps demonstrated by lack of it. For instance, Onu et al., (2014), in a study carried out in the Niger Delta region of Nigeria established the understanding of the problem of MSWM and its relationship with inadequate implementation of urban planning procedures during the building and development of cities.

It is important that policies and comprehensive waste and hazardous waste management strategies, (integrated waste management) including basic elements like waste collection, waste treatment, waste recycling, disposal sites, etc. should be in place. These

would address recycling of items such as papers, plastics, batteries, lubricating oils and electronic wastes. Integrated waste management plans have to support pro-poor involvement in waste management as a source of employment and hence income generation (UNIDO, 2009).

Proper urban planning is the key to bridging the urban divide and is an essential tool in making cities inclusive, environmentally friendly, economically vibrant, culturally meaningful and safe for all (UN HABITAT, 2010b). This observation concurs with the findings of a study by Kasala (2014) that identifies the problem of inaccessibility in some parts of informal settlement as one of the challenges of solid waste management in Dar es Salaam.

2.4.3 Planning interventions for Effective Solid Waste Management in Kenya

In Kenya, just like other African countries, the problem of solid waste management is partly caused and exacerbated by lack of planning or implementation of plans. NEMA (2014) for instance cite the case where some county governments' existing disposal sites fall in areas which do not meet the zoning requirements of the specific areas in which they are located. Human settlements such as residential estates and commercial developments have mushroomed near the disposal sites causing serious environmental and health risks to the inhabitants (NEMA, 2014). This further indicates lack of development control as a planning tool.

Examples of manifestations of poor planning are evident across the major towns of Kenya. For instance, in Kisumu, the existing dumpsite - Moi Stadium dumpsite, is situated in an improper location (Draft Kisumu ISUDP). Homabay also suffers the same fate where existing disposal site is located within a residential area, adjacent to a school and a cemetery which is not only a health hazard but also creates conflicts with the residents (UN HABITAT, 2010b).

The place of planning in the provision of solid waste management is highlighted by Chesereck et al., (2012) who identify base maps and comprehensive development master plans to ensure coordinated development; initialize programmes for urban renewal and slum upgrading as ways through which planning can help to solve the problem of solid waste management.

In addition, Mukui (2013) singles out involvement of residents in planning for solid waste management options as another strategy through which the problems of incorrect solid waste management can be solved by planning.

2.4.4 Planning interventions for effective solid waste management in Nairobi

JICA (2014), submits that a planning strategy for solid waste management needs to be formulated along collection and transportation plan; reduce, reuse recycle and intermediate treatment plan; as well as final disposal.

On collection and transportation, according to JICA (2014), it is necessary to consider an effective collection and transportation system for maximum service provision with utilization of current resources such as equipment and human capacity. The report also suggests that it is prudent to introduce a 3R system and intermediate treatment system to divert waste to be disposed in landfill sites. Lastly the current disposal system of open dumping as noted by JICA (2014), causes environmental deterioration of the surrounding areas. Hence, to improve the situation, the development of sanitary landfill and operation procedure should be put in place considering financial and technical capability while at the same time close the Dandora dumping site.

2.4.5 Planning interventions for effective solid waste management in Ngomongo

Solid waste management challenges in informal settlements as noted, by Mwanzia et al., (2013) is also caused by lack of access roads which leads to low collection rates.

Inappropriate siting of disposal sites has also been identified in Homabay (UN Habitat, 2010b) and Kisumu (Kisumu Draft ISUDP, 2014).

Both lack of access and inappropriate location of disposal sites have planning implications and the two could arguably be used to explain the solid waste management challenge in Ngomongo. As such therefore it could be argued that providing access roads and proper siting of disposal sites could be used as planning tools to partly solve the problem of solid waste management in Ngomongo.

2.5 Information Gap

A serious search uncovered that no documented studies have been carried out in Ngomongo as regards solid waste management. Most studies conducted about solid waste management in Nairobi have either concentrated in Kibera or considered Nairobi as a whole. As such therefore, there exists an information gap in solid waste management in Ngomongo village.

The findings of this study will therefore be a major step in filling the existing gap. The study specifically seeks to highlight the existing solid waste management systems, challenges of SWM and eventually recommend planning interventions that can be implemented to effectively manage SW in Ngomongo. The recommendations of this study could also be applied to other informal settlements especially those that exhibit the same attributes as Ngomongo village.

2.6 Conceptual Framework

From the literature, achieving an effective SWM in informal settlements, there has to be an adequate and a properly functioning SWM system, challenges have to be identified and addressed. Gaps in prevailing systems and challenges to SWM have planning dimension. Ensuring an effective SWM therefore must also identify and address the planning issues that impact on SWM. This is encapsulated in figure 1 below.

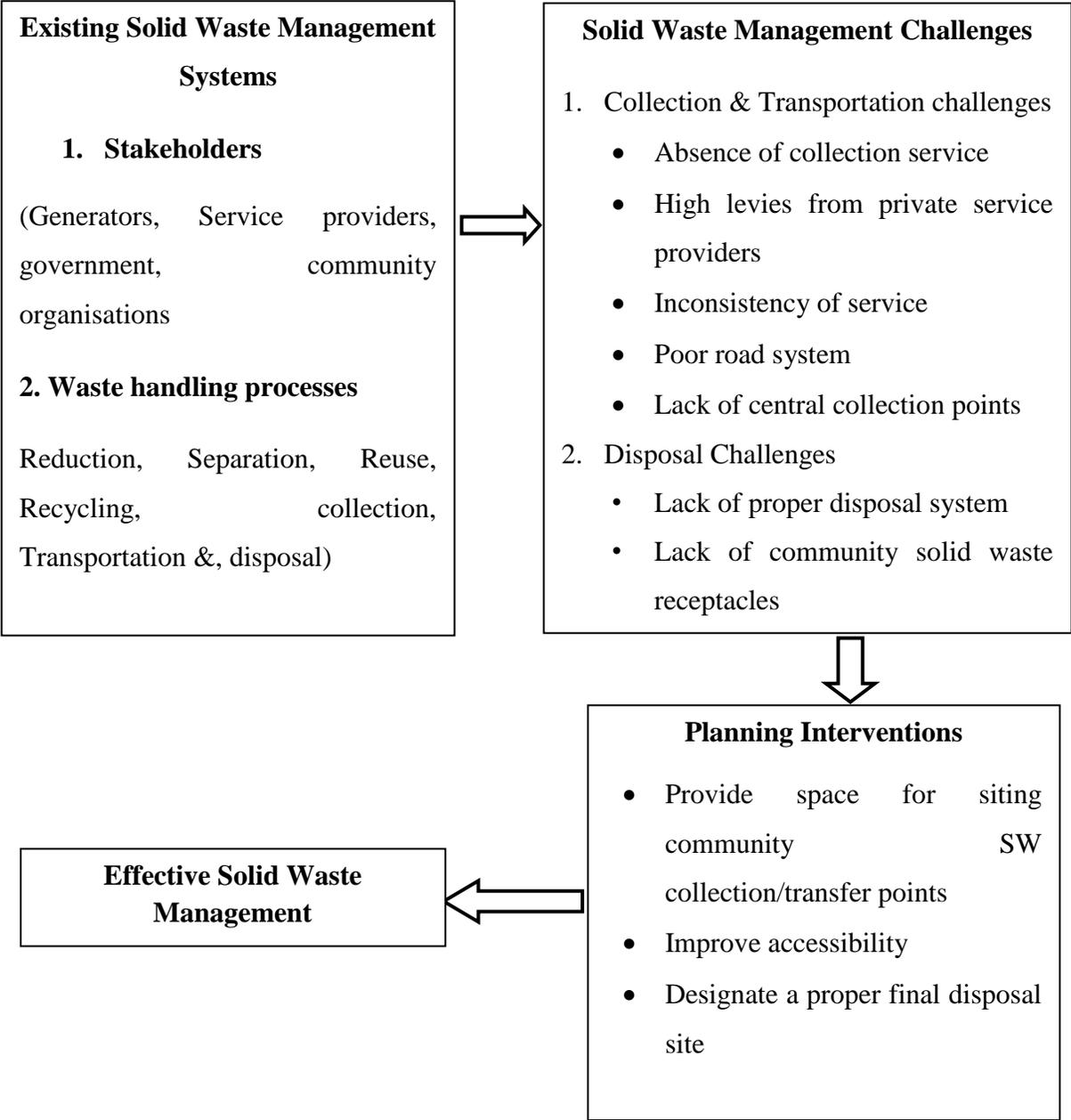


Figure 1: Conceptual Model

Source: Author (2016)

CHAPTER THREE: STUDY METHODOLOGY

3.1 Research Design

A survey design was used to enable assessment of SWM challenges and possible solutions and eventually recommend planning interventions to effectively manage solid waste within Ngomongo village of Korogocho informal settlement, Nairobi County.

The study sought to identify and describe the current SWM systems, challenges experienced and possible intervention measures for effective SWM system, and put forward recommendations for effective SWM in Ngomongo Village by collecting, numerical data from the sample and subjecting these data to statistical tests.

In order to achieve the objectives of this study, both primary and secondary sources of data were used. The primary data collection comprised household and enterprise interviews, perceptions and opinions of Ngomongo residents in relation to the SWM. The study also targeted the various government officials including the solid waste department of Nairobi City County, NEMA, Community Health Worker, Area Assistant Chief and Area Community Elder.

The state of the available disposal sites as well as the disposal methods in Ngomongo were also examined through observation by the researcher and additional data were captured by a camera. Mapping of the important sites and boundaries of the study area was done by use of GPS.

In order to obtain Secondary data about the study area, both published and unpublished books, reports and journals were relied on. The literature covered government printings, reports of non-governmental organizations, local policies and legislations as well as a number of UN agencies' reports.

This chapter therefore comprises analysis of the target population, sample and sampling procedure, instruments used in data collection, administration of instruments and data analysis techniques and reporting of findings.

3.2 Target Population

The unit of analysis for the study was households and businesses. Waste is generated by households and enterprises and therefore, the target population was all the households and enterprises in Ngomongo village.

The study also targeted key informants. These were drawn from Nairobi City County- Environment and Community Health Departments, NEMA, Area Chief as well as Community Leader.

3.3 Sampling Plan

The primary data collection involved administering structured questionnaires to the target population i.e. households and businesses in Ngomongo village. According to community health unit data, the village has an approximate population of 11, 120 persons and a total of 3750 households. The unit of analysis was the household and business enterprise. The number of businesses in the village was however not available.

With a population of approximately 11, 120 (more than 10,000) persons, the following formula was used to get the required sample size, the total sample size was:

$$n = \left(\frac{Z^2 pq}{d^2} \right)$$

n = Desired sample size.

Z = Confidence level, 95% with 1.96 standard score.

P = Proportion of target population that is estimated to characteristics being measured. For Ngomongo village which is largely homogenous, an estimated 90% of the residents are faced with the problem of solid waste management which is being measured.

$$q = 1-p$$

d = Level of statistical significance set (margin of error). With a household size of 3,750 and 90% of the population faced with the problem, a 5% accuracy level was required.

The sample size was therefore:

$$n = \left\{ \frac{1.96^2 (0.9) (1-0.9)}{(0.05)^2} \right\}$$

$$n = 138$$

Two different sampling methods were used in order to reach the target population. Both pure/simple random sampling and stratified sampling methods were used. The village is divided into two parts depending on ownership and size of lands: Gitathuru and Ngunyumu. The village was therefore divided into two strata/ groups as shown below:

Table 1: Sample size proportion per stratum

Group/Strata	Land Size (acres)	Proportion
Ngunyumu	27	32%
Gitathuru	57	68%
Total	84	100%

Source: Author, (2016)

With a sample of 138, each stratum had the following proportion of sample:

a) Ngunyumu

$$= \left\{ \frac{32}{100} \times 138 \right\}$$
$$= 44$$

b) Gitathuru

The remaining sample size was in Gitathuru.

$$\{138 - 44\}$$
$$= 94$$

The simple random sampling method was then used in each stratum to target the households until the required sample size was achieved.

There being no specific number of businesses in Ngomongo Village, 40 business enterprises (a number above a minimum of 30 required for a scientific research) were interviewed in the whole of the village. As with the case of household, business establishments were selected using both stratified sampling and simple random sampling. Businesses were however limited to those housed in structures. Ngunyumu and Gitathuru land parcels within Ngomongo formed the two strata and distribution of samples was done proportionately to the land size as shown below.

Table 2: Sample size distribution

Group/Strata	Land Size (acres)	Percentage Sample	Number of Sample
Ngunyumu	27	32%	13
Gitathuru	57	68%	27
Total	84	100%	40

Source: Author, (2016)

Simple random sampling was used to select the samples from each stratum.

3.4 Data Collection Methods

To achieve the objectives of the study, both primary and secondary data was collected. Primary data was collected through interviewing, questionnaire administration as well as observation. Secondary data on the other hand was obtained through review of relevant literature relating to the research topic.

3.4.1 Literature Review Questionnaire

This is ideally the first stage of data collection. According to Mugenda (2013), literature review should be an objective critique of existing studies, documents, books etc., that contain information related to the proposed study. In this study review of existing literature was done to understand the current state of solid waste management, beginning from a global perspective before narrowing down to Africa and Kenya and finally to Nairobi and Ngomongo village. This, as Mugenda (2013), reports, is to highlight the main findings of previous studies on SWM, and establish the gaps that had not been addressed.

3.4.2 Questionnaire

Questionnaires were used to collect both quantitative and qualitative data to enable assessment of the SWM systems and challenges in Ngomongo Village. Questionnaires were used to collect data from households and businesses enterprises within Ngomongo. Descriptive analysis was used to summarize the data collected.

3.4.3 Interviewing

Interviewing was used to obtain information from key informants. In addition, the method was used alongside questionnaire to obtain information from households and business owners.

3.4.3 Observation Literature Review

Observation was employed to obtain empirical data that could not be obtained through interviews and questionnaire administration. Such data include aspects such as place of solid waste disposal among other observable features of solid waste management.

3.5 Data Collection Instruments

This section highlights the key methods that were applied in this study. They include literature review, interviews and observation.

3.5.1 Literature Review

As already noted, literature was used to understand the current state of SWM and identify the gaps that could be addressed by this study. Literature included articles, journals, reports, theses among other relevant secondary data.

3.5.2 Interviewing

Interviewing was used in administering questionnaire to households and business enterprises. Similarly, interviewing was used in getting information from key informants. Similarly, interviews were used for collecting data from key informants whereby the study developed a list of questions and secured appointments with such persons drawn from Nairobi City County, NEMA, and the local Administration.

3.5.3 Observation

Observation was used to either verify data obtained by use of questionnaire and interviews or to record data that was not possible to capture by use of either of the two methods. For instance, observation was used to record SWM situation in Ngomongo especially in regards to issues like where the SW was being disposed in Ngomongo village.

In order to ensure that the required information is captured, the study developed an observation check list before going to the field to collect data. The list was basically used to guide the researcher on what to look for while in the field which for the purpose of this study included disposal sites, solid waste storage among others. A hand held camera was used to capture and record such information.

3.5.4 Use of GPS

A hand held GPS device was used in picking boundaries of Ngomongo as shown by the local administration.

3.6 Data Analysis

In order to interpret the raw data collected from the field, first it was cleaned, coded, keyed in the computer and analysed. All the administered questionnaires were collected and systematically organized for analysis. For the purpose of empirical or quantitative analysis, the responses were assigned numerical values especially for the closed questions. For the open ended questions, all responses were organized and numbers assigned to them.

For the purpose of quantitative analysis, all the data were converted into numerical codes that represented all attributes or measurements of variables. The codes were all obtained from a prepared codebook. The codes were then keyed into the computer for further analysis.

Qualitative analysis was also used in trying to establish trends, patterns and relationships from the information gathered. This was to inform the conclusion and recommendations. The above analysis was supported by data analysis tools such as excel spreadsheets and statistical packages for social scientists (SPSS).

Finally, the data was presented in the form of frequency tables, pi-chart, graphs etc. This was only applicable for the quantitative data.

3.7 Ethics

The survey and general research exercise adhered to the ethical guidelines that govern research activity. This ensured that the research work met the threshold for integrity test and also to prevent the researchers from being faced with humiliating situations for not behaving ethically. The research therefore adhered to the following ethical standards:

3.7.1 Confidentiality and Privacy

The respondents were assured that the information they provided would be kept confidential. Their consent would be sought before any information about them was to be revealed to a third party.

3.7.2 Use of Vulnerable or/ and Special Populations

Consent and permission from any disadvantaged or special population was sought from them or their guardians before any information was collected from them. The special population included children, disabled, street children or even the sick. Collection of information from this category of people was therefore based on the principle of informed consent.

3.7.3 Anonymity

The research also ensured that the identity of the respondent was not disclosed especially where very sensitive information about a specific respondent was about to be revealed. This was achieved by assigning the respondents pseudo names, third party names, numbers or even codes.

3.7.4 Physical and Psychological Harm

Adequate preliminary pilot tests of instruments and background information was collected in order to avoid imparting any harm to the respondents especially the psychological harm which was more likely than physical. Actions and statements that were likely to lower self-esteem and self-worth of a respondent were therefore avoided.

3.7.5 Voluntary and Informed Consent

The respondents were informed of the purpose of the research before any information was sought from them. The respondents were therefore told the truth and provided with all the facts in order to make an informed decision on whether to participate or not. The questions remained within the scope of the stated purpose of the research. Some of the information that was made available to the respondent includes:

- a. Purpose of the research study
- b. A guarantee of confidentiality and anonymity if applicable
- c. Identification of the researcher
- d. Any foreseen risk
- e. Benefits and compensation or lack of them

3.7.6 Dissemination of Findings

The findings from the research will be made public and there would be no concealing of findings under any circumstances.

3.8 Limitations

Like many other surveys, the study had some limitations based on the data collection methods adopted and willingness of the respondents to give precise and accurate responses. The following were some of the methodological limitations faced in the course of collecting data:

- a) The Enumerator bias - During interviews or in the process of administering questionnaires, the opinions of the enumerators and their supervisors may skew the results by trying to influence the type of response to get from a respondent.

- b) The Respondent bias – The respondent may deliberately decide to give a misleading or incorrect response or in order to achieve some unknown objective.
- c) Privacy bias – A respondent may give a misleading information owing to the privacy of the answer required.
- d) The no response bias – this was only due to nature of the question or the ambiguity of a question, a respondent may not be in a position to give an appropriate response or may simply fail to provide a response at all.

In order to address and reduce the risk of bias, the survey team leaders ensured that:

- i. They dedicated enough time to select very experienced enumerators who were familiar with the study area.
- ii. The surveyors also had to explain to the respondents the objectives well and the confidentiality of the information provided. The respondents therefore did not withhold information they had.
- iii. In order to address ambiguity of some questions that might lead to wrong data being collected, the surveyors did a pre-test and all the ambiguous questions were addressed.
- iv. All the completed questionnaires were verified each day and feedback provided to the enumerators before conducting fieldwork in the following day.

CHAPTER FOUR: STUDY AREA

4.1 Introduction

This chapter is a brief description of the study area. It gives the situational analysis of the area in the context of Nairobi County setting. Factors addressed in the chapter include location and size; historical background; physical and environmental characteristics; economic factors and land use; human settlements and; infrastructure and service facilities. A brief description of issues specific to Ngomongo informal settlement relevant to the study topic is also highlighted.

4.2 Historical Background of Ngomongo Village

Ngomongo village was established in the 1980's when the original land owner sold the piece of land to two housing cooperative societies, Ngunyumu and Gitathuru. Ngunyumu bought 27 acres while Gitathuru bought 57 acres therefore making the present day Ngomongo village to be approximately 84 Acres (about 0.34 km²) piece of land.

The two housing cooperative societies later subdivided the parcels into smaller plots and sold to individuals who later developed them into residential housing. Ngomongo village therefore sits on private land.

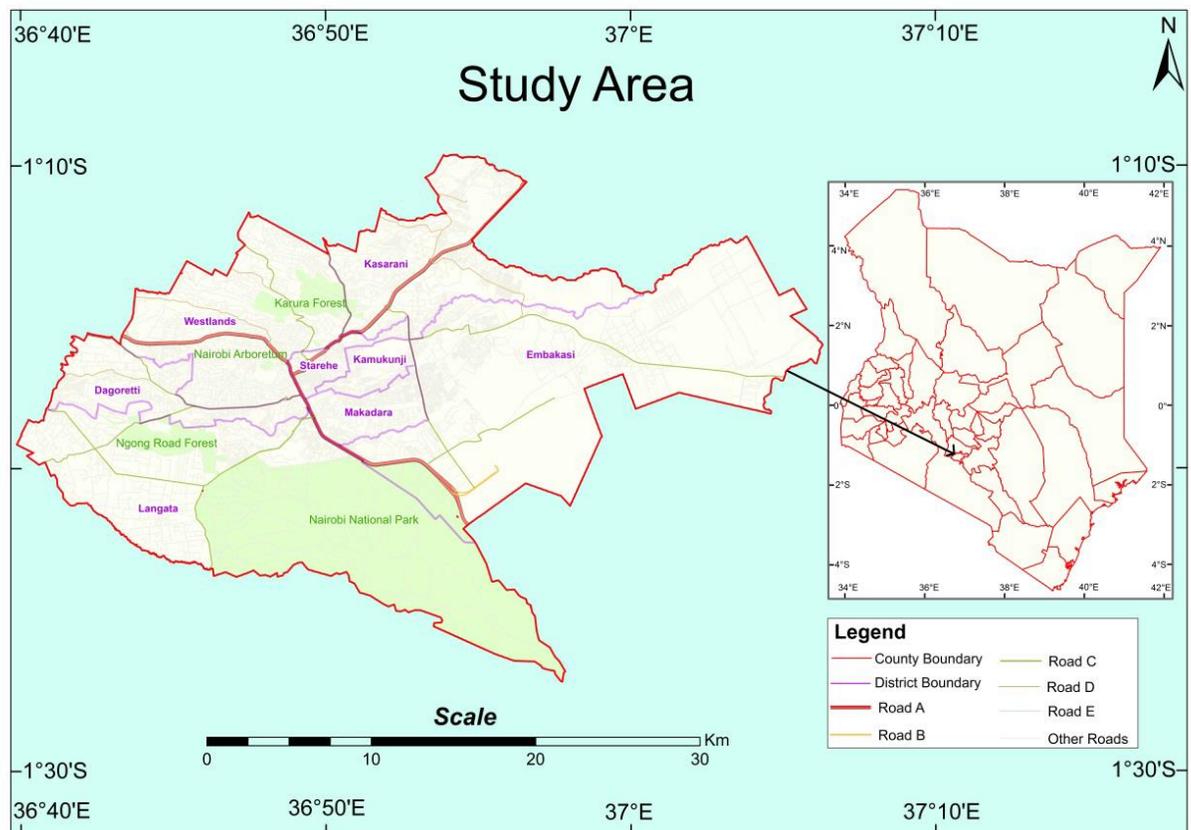
4.2 Location

Nairobi County is one of the 47 counties in the Republic of Kenya. It borders Kiambu County to the North and West, Kajiado to the South and Machakos to the East. Among the three neighbouring counties, Kiambu County shares the longest boundary with Nairobi County. The County has a total area of 696.1 Km² and is located between

longitudes 36° 45' East and latitudes 1° 18' South. It lies at an altitude of 1,798 metres above sea level (Nairobi City County, 2014).

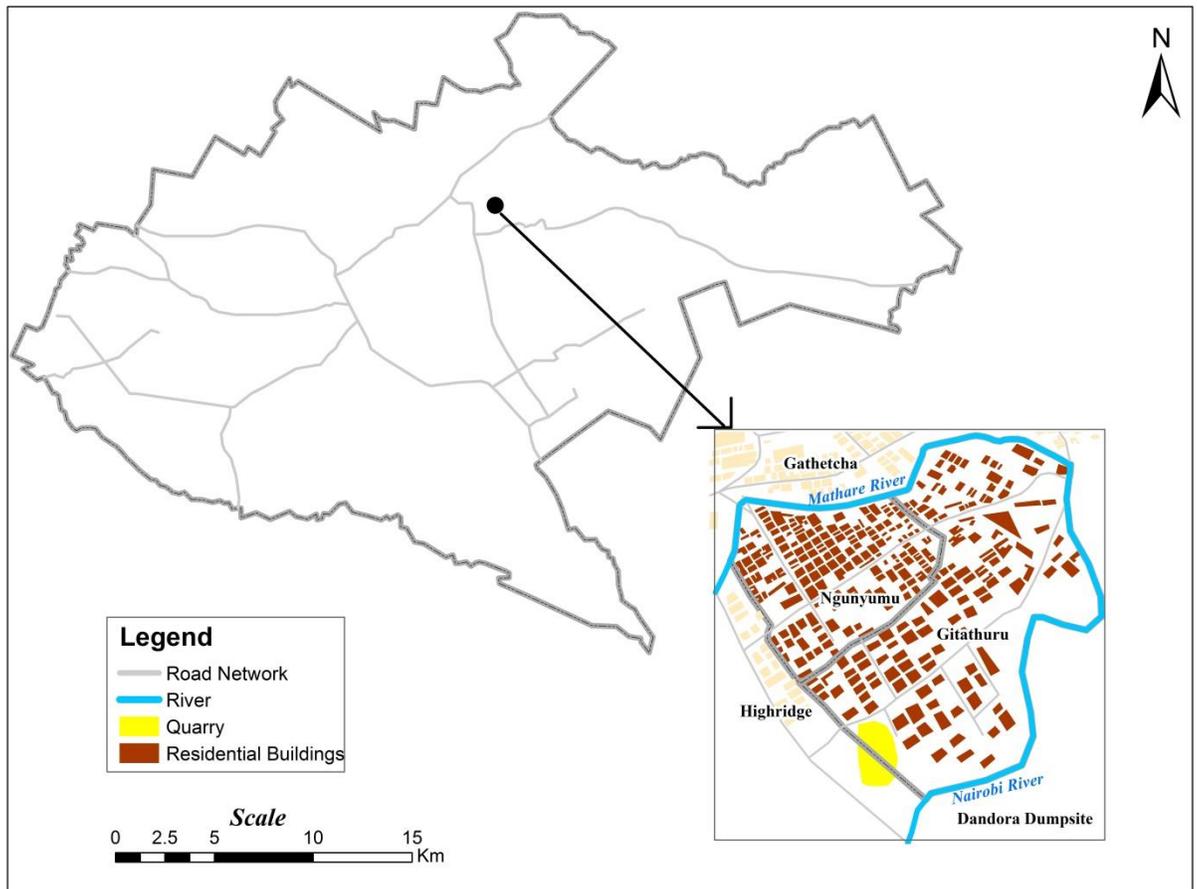
Ngomongo village, alongside other villages, is situated within the larger Korogocho informal settlement. The other villages include High ridge, Gitathuru, Grogan A & B, Korogocho A & B, Nyayo and Kisumu Ndogo.

Administratively, Korogocho falls within Gitathuru Sub location, Korogocho location, Kariobangi North Division, Nairobi North District. Politically, Ngomongo falls within Korogocho ward, Ruaraka sub county, Nairobi County.



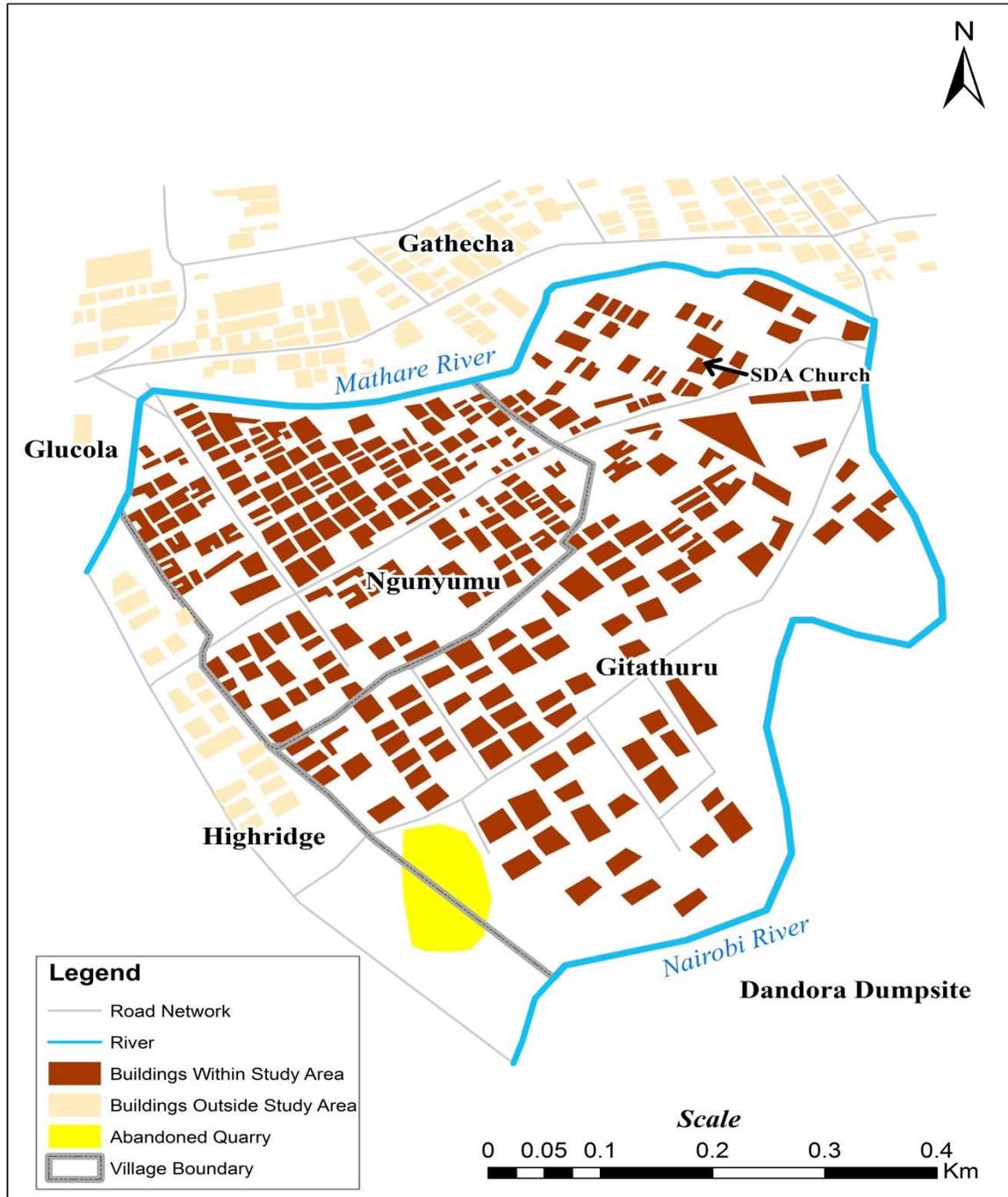
Map 1: Nairobi in the National Context

Source: JICA (2014)



Map 2: Ngomongo in the context of Nairobi

Source: Adapted from Google Earth (2016)



Map 3: Ngomongo in the local context

Source: Adapted from Google Earth (2016)

4.3 Climatic conditions

The climate in Nairobi City is usually dry and cool between July and August but hot and dry in January and February. The average annual rainfall in Nairobi is about 900 mm. The first peak of monthly rainfall occurs in April and the second peak takes place in November. The mean daily maximum temperature by month ranges from 28°C to 22°C and the minimum ranges from 14°C to 12°C (JICA, 2014).

Temperature is especially important to decomposition of organic component of MSW. UNEP & UNITAR (2013) state that warm climate contributes to fast and efficient composting using simple technology. In Nairobi therefore decomposition of organic component would arguably peak in January and February thereby calling for rapid collection of municipal waste. The warm temperatures coupled with the wet conditions speed up decomposition of organic component of waste translating in high demand for frequent collection.

Similarly, rainfall as pointed out by Hoornweg & Bhada-Tata (2012) influences waste volumes especially where waste is un-containerized. This means that waste collection cost peaks during the months of April and November assuming the volume is used to determine cost of solid waste collection.

Nairobi is situated approximately 140 kilometres south of the equator and on the central highland and therefore enjoys a tropical highland climate. The tropical like conditions affects issues like solid waste collection rates especially where the bulk of MSW is organic. UNEP & UNITAR (2013) observe that in developing countries, organic waste constitutes 60-70% of MSW. In Nairobi organic matter remains the highest content over the years with an average of 62.1% (Njoroge et al., 2014). Owing to the high organic component, the tropical conditions make the rate of decomposition of waste to be very high hence requiring frequent collection.

4.3.1 Temperature

The average temperature is 17.7⁰C and the average temperature range is 3.5⁰C. The highest monthly average high temperature is 26⁰C in February while the lowest monthly average low temperature is 10⁰C in July, August and September. Temperature is especially important to decomposition of organic component of MSW. UNEP & UNITAR (2013) point out that warm climate contributes to fast and efficient composting using simple technology. This means that organic portions of solid waste collection from households and neighbourhoods should be as efficient as possible during warm temperature months in order to reduce the possibility of such wastes decomposing and releasing bad odours during such times.

4.3.2 Rainfall

Nairobi receives an average of 925 mm of rainfall per year. There are two rainy seasons with the heavy rains running from March to May and lighter rains in November to December. The wettest month is April while the driest month being July. Rainfall amount influences waste volumes. Hoornweg & Bhada-Tata (2012) argue that rainfall influences waste volumes especially where waste is un-containerized, it can absorb significant amounts of water from rain. As such therefore one would argue that waste collection systems should be designed in such a manner that takes into account the prevailing rainy conditions. Rainfall is also important to MSWM especially in relation to flooding. According to UNEP & UNITAR (2013) poor waste management contributes to flooding when storm water channels are used for dumping waste. City managers should therefore be more alert to the issue of illegal dumping of MSW in drains in the rainy seasons to avoid flooding of the city.

4.3.3 Humidity

The average annual relative humidity is 72.8% and average monthly relative humidity ranges from 64% in October to 79% in July (JICA, 2014).

4.3.3 Sunshine

Average sunlight hours in Nairobi range between 4.3 hours per day in July and 9.5 hours per day in February. There is an average of 2525 hours of sunlight per year with an average of 6.9 hours of sunlight per day.

In conclusion, Climate and solid waste management affect each other in several ways. For instance, Hoornweg & Bhada-Tata (2012) point out that the level of methane from landfills varies by country, depending on waste composition, climatic conditions (ambient temperature, precipitation) and waste disposal practices. According to Hoornweg & Bhada-Tata (2012), methane gas with a global warming potential of 21 times greater than carbon dioxide, is the second most common greenhouse gas after carbon dioxide. Therefore, encouraging waste minimization through MSW programs can have significant up-stream GHG minimization benefits (Hoornweg & Bhada-Tata, 2012).

4.4 Topography

The city of Nairobi is characterized by undulating hilly topography with an elevation in a range of 1,460 m to 1,920 m. Lowest elevation occurs at the Athi River at the eastern boundary of the city and highest at the western rim of the city. It is unique that the city has the Nairobi National Park with the area of 117 km² within its administrative area, extending along the western boundary and attracting a large number of international and domestic tourists annually (JICA, 2014).

4.5 Population and Demographic Characteristics

According to 2009 population and housing census, Gitathuru sub location where Ngomongo is found had a population of 21, 735 and 6, 480 households over an area of 0.5km². Ngomongo village alone, according to information obtained from the Community Health Unit Health Information System (CHIS), Ngomongo Unit, has a total population of 11,120 and 3,750 households. Information obtained at Ngomongo assistant chief's office indicate that Ngomongo village sits on 84 acres which translates to approximately 0.34km² piece of land. This therefore means that Ngomongo has a population density of approximately 32,706 persons per square kilometre.

4.6 Economic Factors and Land Use

The land use in Nairobi has been summarised as below.

Table 3: Land Use Composition in Nairobi

Land Use	Area (sq. km)	Percentage
Residential	105.2	15.1%
Commercial	5.9	0.8%
Industrial	22.2	3.2%
Mixed Commercial & Industry	3.6	0.5%
Mixed Residential & Commercial	4.2	0.6%
Institutional	39.8	5.7%
No structures	0.3	0.0%
Open space	332.0	47.8%
Recreational	8.7	1.3%
Res slum	7.8	1.1%
Transportation	15.5	2.2%
Unknown	42.3	6.1%
Water	10.9	1.6%
Total	598.2	86.1%
National Park	96.9	13.9%
Grand total	695.1	100.0%

Source: JICA, (2014).

From the table above, it can be noted that residential land use is only second to open space at 15.1 %. Residential land use is particularly important in the sense that households are major generators of MSW since as Hoornweg & Bhada-Tata (2012) observe residential waste collection tend to be more expensive per tonne as compared to the Industrial, Commercial and Institutional (ICI) sector due to the fact that residential waste is often more dispersed.

4.7 Socio-Economic Indicators

In most social indicators, Nairobi City is positioned higher than the average of Kenya. Although estimated GDP per capita of Nairobi City varies on sources of data, it is assumed to be 3.0 times the national GDP per capita, because it is the average of the collected estimates excluding an exceptionally high figure. The assumption means that for 2009 the GDP share of Nairobi is 24.4% of Kenya (KNBS, 2013). This economic dominance exhibited by Nairobi could be used to explain population concentration which coupled with poor planning translates to poor solid waste management.

4.8 Industries

In Kenya, Nairobi still remains the main industrial town accounting for 48.8 per cent of all employees of the industrial sub sector. This is followed by Mombasa (6.1%), Nakuru (6.0 %), Thika (4.7 %), Machakos (3.7 %) and Kiambu (3.5 %), with the rest of the firms scattered in other small towns (KNBS, 2013). This means that the Nairobi accounts for nearly half of industrial sub sector employment and with it comes population concentration in the city. Population concentration most likely adds to strain on the services available including solid waste management. In cases where the majority of industrial employees are casual labourers and may not be in a position to afford better housing, this dominance of industrial sector employees by Nairobi could be adding to the number of persons living in slums and other informal settlements where the problem of solid waste management is already acute (Njoroge et. al., 2014).

CHAPTER FIVE: RESEARCH FINDINGS

5.1 INTRODUCTION

This chapter presents analysis and findings of the study as set out in the research methodology. The results have been presented on challenges and possible intervention measures for effective SWM in Ngomongo village of Korogocho informal settlement, Nairobi City County. The research sought to answer these research questions; What SWM systems are in place in Ngomongo village, what are the main challenges and possible interventions for effective SWM in Ngomongo, what planning interventions can be implemented to ensure effective solid waste management in Ngomongo village. The study targeted 138 household and 40 business enterprises within Ngomongo village, Korogocho informal settlement, Nairobi County. Out of the 138 household questionnaires, 137 were successfully completed, representing a success rate of 99%. Business enterprise questionnaire had a 100% response rate.

5.2 Demographic Information

The study first sought information on various aspects of the household respondents' background, i.e. the respondents' age, marital status, gender, level of education and occupation among others. This information aimed at ensuring that only household heads participate in the study. The study used Ngomongo village in Korogocho informal settlement in Nairobi County.

5.2.1 Respondents' Distribution by Gender

The study sought to establish the gender of the households and the findings are as shown in Table 2 below.

Table 4: Respondents' Distribution by Gender

Respondents	Frequency	Percentage
Male	37	27
Female	100	73
Total	137	100

Source: *Field Survey, (2016)*

According to the findings, 27% of the household respondents were males while females were 73% of the total sample.

5.2.2 Households' Education Qualification

The research sought to know the education qualification of households and the findings are as presented in Table 3 below:

Table 5: Highest Education Qualification

Level of Education	Percentage
Primary	56.6
Secondary	36.6
Tertiary college	6.7
University	0.7
Total	100

Source: *Field Survey, (2016)*.

According to the findings, approximately 57% of the household heads had primary education, 37% secondary school education, 7% tertiary college and 1% had university education.

5.2.2 Households' Occupation

The study also sought to get the occupation of the household and the findings are presented in Table 4 below:

Table 6: Households' Occupation

Occupation	Percentage
Unemployed	27.6
Formal employment	6.5
Informal employment	65.9

Source: *Field Survey, (2016)*

The findings revealed that about 28% of the household respondents were unemployed, 7% had formal employment while 66% were employed in the informal sector.

5.3 SOLID WASTE MANAGEMENT SYSTEM IN NGOMONGO VILLAGE

5.3.1 Major Solid Waste Generated in Ngomongo

The research sought to identify what kind of waste was generated by the residents of Ngomongo. The results are as presented in the chart below.

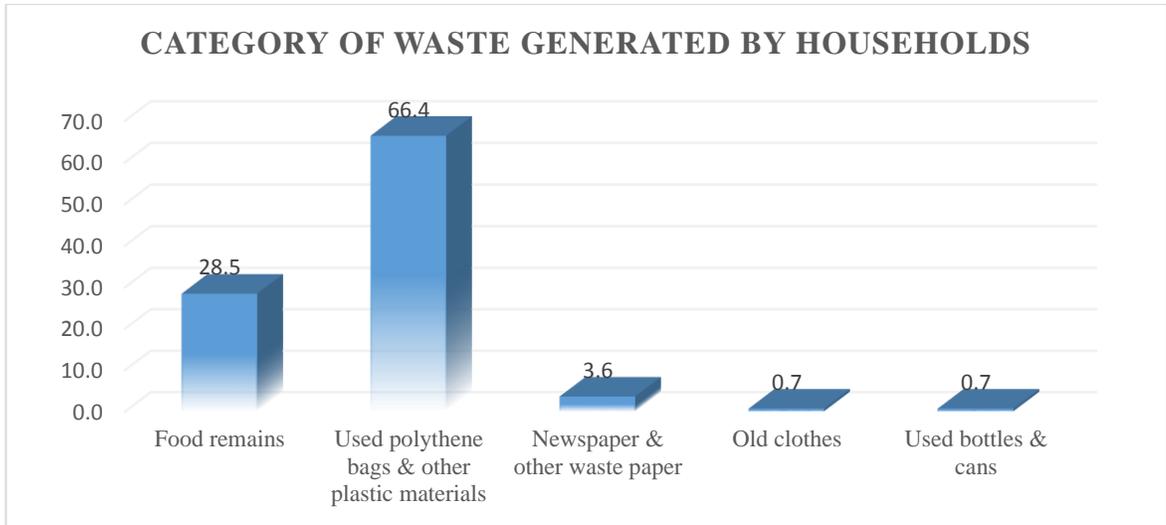


Chart 1: Categories of Wastes Generated by Households

Source: *Field Survey, (2016)*

Categories of solid waste generated in Ngomongo village majorly consists of polythene & other plastic materials, food remains, old newspapers and other papers, old clothes, and used bottles and cans. Of the categories of wastes generated, 66% of the households indicated that polythene and plastic materials formed the bulk of solid waste they generate most of the time. This was followed by 29% for food remains and 4% for newspapers and other non-plastic papers. The least generated solid wastes by households were old clothes and used bottles/cans each at 1%.

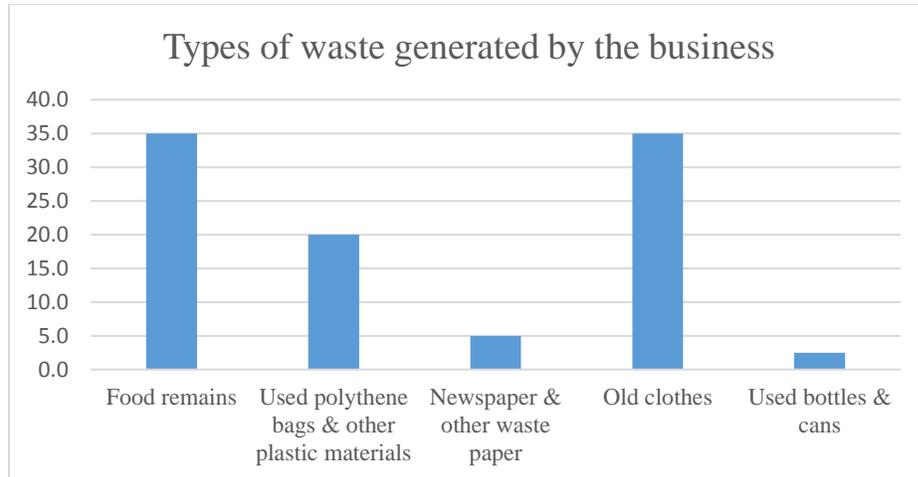


Chart 2: Types of Wastes Generated by the businesses

Source: *Field Survey, (2016)*

Business enterprises composed of shops, butcheries, bars, food kiosks and grocery shops. Among these business enterprises, 35% of them indicated that old clothes were the major solid waste generated, another 35% identified food remains 20% polythene bags and other plastic materials. Newspapers/non plastic papers were indicated by 5% and lastly 3% pointed at used bottles/cans.

5.3.2 Solid Waste Storage System in Ngomongo

The researcher enquired how residents of Ngomongo store their wastes. Findings are as illustrated below.



Chart 3: Types of Wastes Generated by the businesses

Source: *Field Survey, (2016)*

Approximately 78% of households use polythene bags, followed by plastic bins at 18%, gunny bags at 3% and lastly 1% households indicated that they do not store their waste but rather throw it away as soon as it is generated. The various waste storage techniques are illustrated in the plates below:



Plate 1: The various storage techniques

Source: *Field Survey, (2016).*



Chart 4: Wastes Storage Methods by the Business Enterprises

Source: *Field Survey, (2016).*

Among business enterprises, 48% use polythene papers followed by gunny bags at 24% plastic bins at 18% while 8% do not store their waste but instead throw it as soon as generated.

5.1.3 Solid Waste Separation in Ngomongo

The study sought to know whether the residents of Ngomongo separate their wastes or not and how they separate the waste. The results are as presented in the figure below.

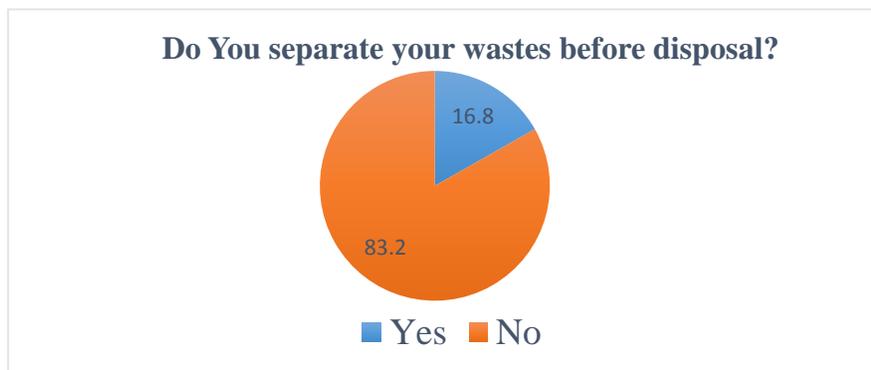


Chart 5: Wastes Separation at Household Level

Source: *Field Survey, (2016).*

The research found that only 17% of the households separate their wastes while 83% of the households do not carry out waste separation.



Chart 6: Wastes Separation by Business Enterprises

Source: *Field Survey, (2016).*

Among business enterprises only 7% separate their wastes while 93% do not.

The study further sought to discover how the residents separate their waste and the results are presented in the figure below.

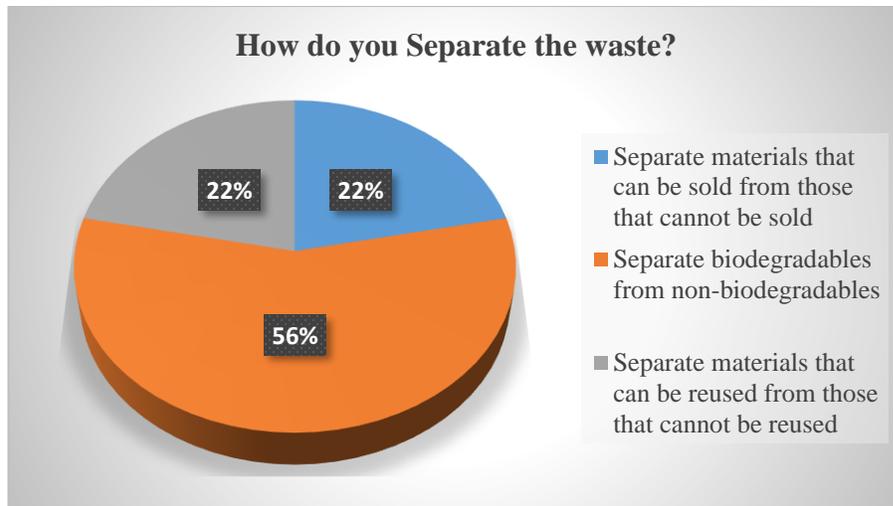


Chart 7: Methods of Wastes Separation at Household Level

Source: *Field Survey, (2016).*

Among households, the research indicates that 56% of households separate their wastes into biodegradables and non-biodegradable clusters, while 22% separate wastes into those which can be sold vis-à-vis those that cannot be sold. Another 22% separate their waste into reusable and non-reusable clusters.

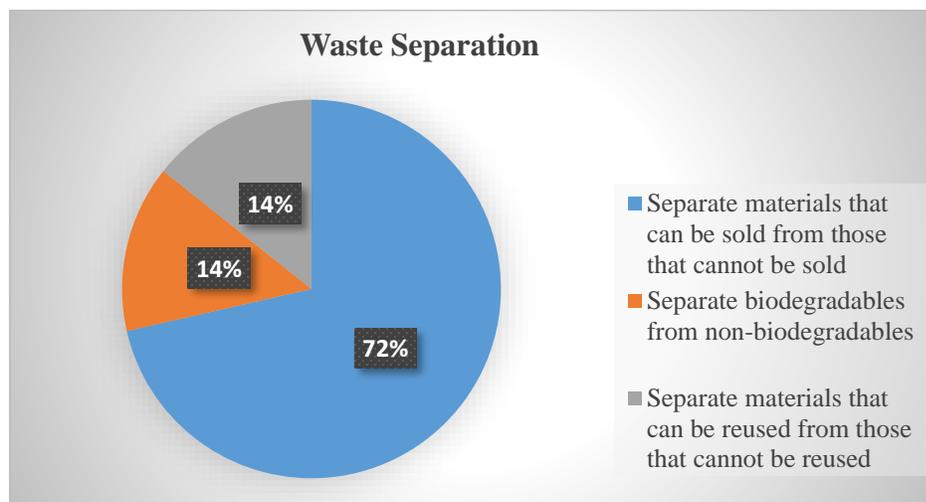


Chart 8: Methods of Wastes Separation by Business Enterprises

Source: *Field Survey, (2016).*

Among business enterprises, the study indicates that 72% separate their waste into those that can be sold vis-a-vis those that cannot be sold, while 14% separate their wastes into biodegradables and non-biodegradable clusters. A further 14% separate their waste into reusable and non-reusable categories.

The finding on low level of solid waste separation at the household level is also cited by Nairobi City County solid waste department.

5.1.4 Reuse and Selling of Solid Wastes in Ngomongo

The research wanted to discover whether residents of Ngomongo re-use and sell their wastes. The results are as presented in the pie chart below.

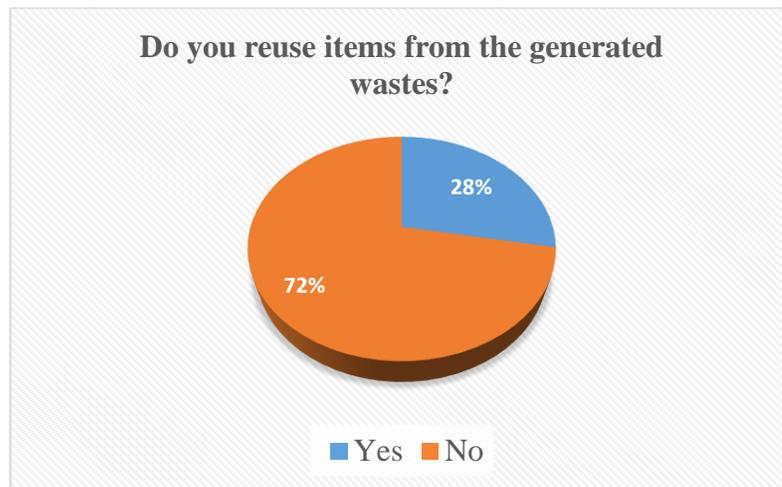


Chart 9: Reuse of Items Generated from Wastes by Households

Source: *Field Survey, (2016).*

The survey indicates that only 28.5% of the households reuse their wastes while 72% do not.

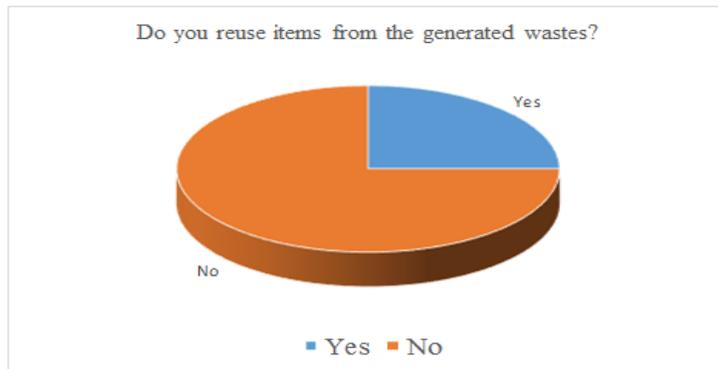


Chart 10: Reuse of Items from Generated Wastes by Business Enterprises

Source: *Field Survey, (2016).*

Within the business community re-use levels was reported at 25% while those who do not re-use their waste were 75%.

The study went ahead to investigate how both households and business enterprises reuse their wastes. The findings are presented in figure 11 and 12 below.

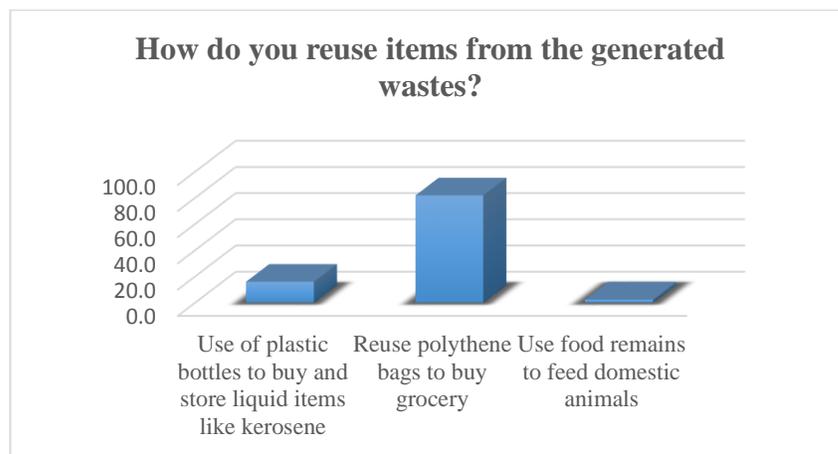


Chart 11: Reuse Methods for items from the generated Wastes by Households

Source: *Field Survey, (2016).*

Among households, 81% use polythene bags to carry grocery shopping, while 15% use plastic bottles to buy and store liquid items like kerosene and 2% use food remains to feed domestic animals.

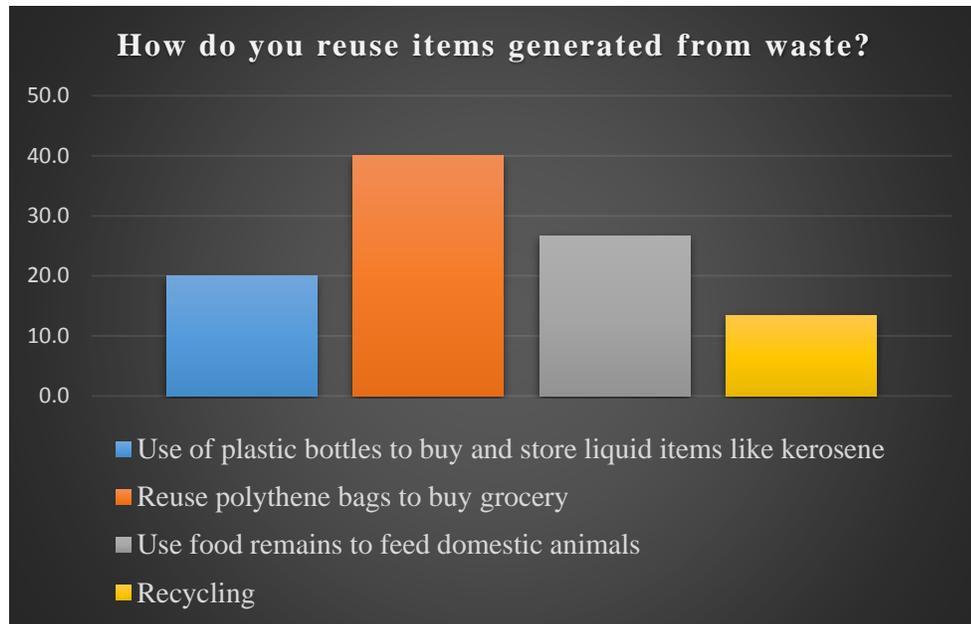


Chart 12: Reuse Methods for items from the generated Wastes by Business Enterprises

Source: *Field Survey, (2016).*

Within the business ranks, the study discovered that 40% of business enterprises use of plastic bags to buy and carry grocery, 27% use food remains to feed domestic animals, while 13% do some form of recycling.

Likewise, the researcher sought to know whether households and business enterprises sell part of their wastes. The results of the study are as presented below.



Chart 13: Selling of Wastes Generated to Recyclers by the households

Source: *Field Survey, (2016).*

Only 14% of households sell their wastes as compared to 86% who do not.



Chart 14: Selling of Wastes Generated to Recyclers by Business Enterprises

Source: *Field Survey, (2016).*

Similar to households, only 22% of the business enterprises sell their waste compared to 78% who do not sell. Recycling of generated wastes especially plastic papers is also a considerably common activity in Ngomongo Village as illustrated in the plate below



Plate 2: Plastic materials Collected for Recycling

Source: *Field Survey, (2016)*

5.1.5 Solid Waste Collection in Ngomongo

The study wanted to know who does collection of wastes from where the waste is collected both for households and businesses. The findings are presented in chart 15 below.

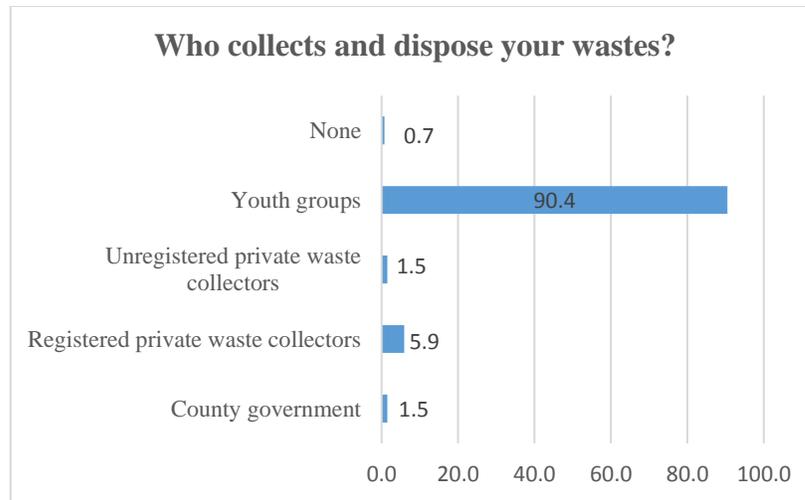


Chart 15: Solid Wastes Collection for Households in Ngomongo

Source: *Field Survey, (2016).*

About 90% of households reported that their waste is collected by youth groups, a position that was supported by the area community leader, assistant chief and community health worker. Six percent of the respondents indicated that registered private waste collectors collected their wastes while unregistered waste collectors and county government were reported by 2% each as the service provider as far as solid waste collection is concerned. Only 1% reported that they did not receive collection service.

The study revealed that there is high collection rate of solid wastes for both households and business enterprises in Ngomongo. The collection rate is however higher for households than it is for business enterprises with less than 1% of households reporting that they do not receive waste collection at all compared to 13% of business enterprises.

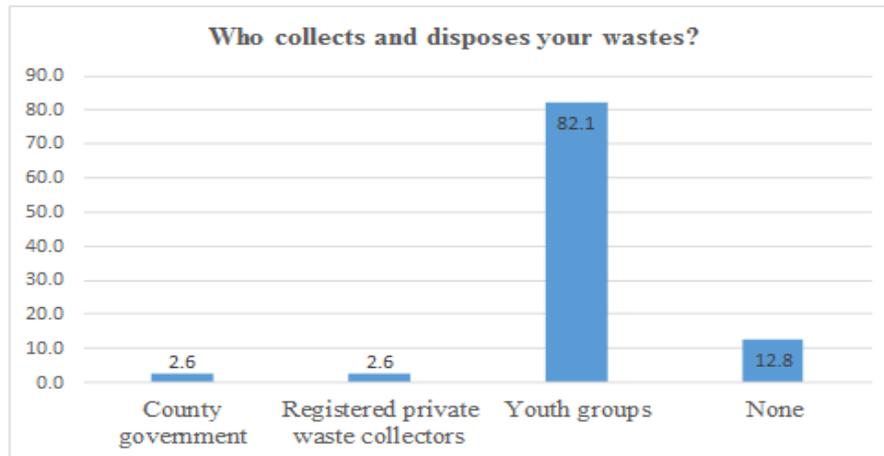


Chart 16: Solid Wastes Collection for Business Enterprises in Ngomongo

Source: *Field Survey, (2016).*

Like households, solid waste collection for business enterprises is dominantly done by youth groups at 82%. The county government of Nairobi and private waste collectors were each reported by 3% business enterprises as their service provider in terms of collection.

The research also sought to know from where the solid waste was being collected for both households and businesses. The results are as indicated in chart 17 below.



Chart 17: Wastes Collection Point for the Households

Source: *Field Survey, (2016).*

From the chart above, about 95% of households indicated that their waste was being collected from their door steps while about 5% had their wastes collected from community waste collection points designated by the county government.



Chart 18: Wastes Collection Points for Business Enterprises

Source: *Field Survey, (2016).*

Approximately 85% of the business community in Ngomongo reported that they receive door to door collection service, 6% indicated that their waste was being collected from community collection points provided by the county while 9% pointed to depositing their waste on any available open space before it is collected.

5.1.6 Solid Waste Disposal in Ngomongo

The study was interested to know how and where solid waste disposal was done in Ngomongo. The study first sought to know how residents dispose of their waste in cases where they did not receive collection service. The results are presented for both households and business community in figure 19 below.



Chart 19: Wastes Disposal Methods by Households

Source: *Field Survey, (2016).*

In cases where there was no solid waste collection service, 35% of households indicated that they take their own waste to disposal site while 28% threw the waste in open plots or on the streets. Twenty four percent reported that they burn the waste while 14% bury the waste.



Chart 20: Waste Disposal Methods by Business Enterprises

Source: *Field Survey, (2016).*

For the business community, 71% indicated that they burn the waste, 24% take to disposal site while 5% bury their wastes.

On the issue of where the waste was being disposed, the findings are represented by chart 21 below.

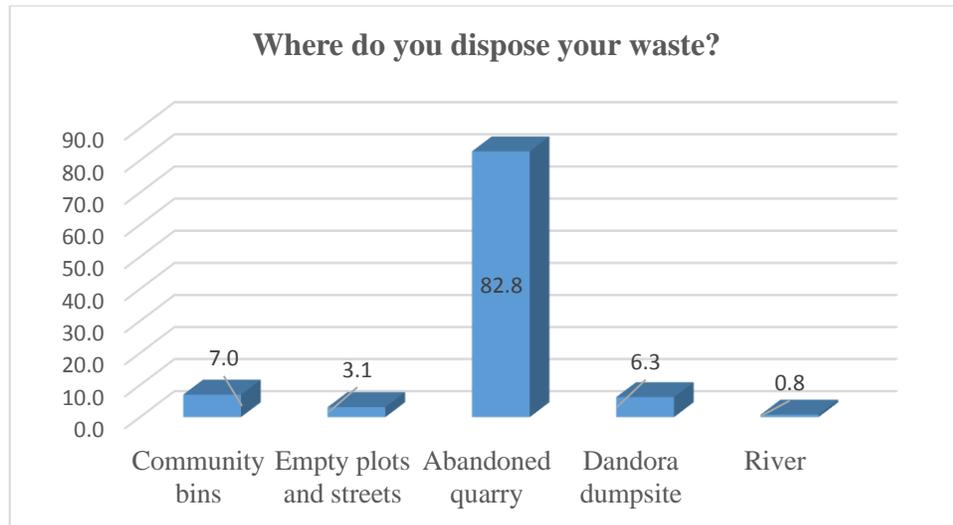


Chart 21: Waste Disposal Sites by Households

Source: *Field Survey, (2016).*

Eighty percent of households indicated that the final disposal point was an abandoned quarry, 7% pointed to community bins followed by 6% who indicated Dandora dump site. 3% and 1% reported that empty plots/streets and river respectively as their final disposal points.

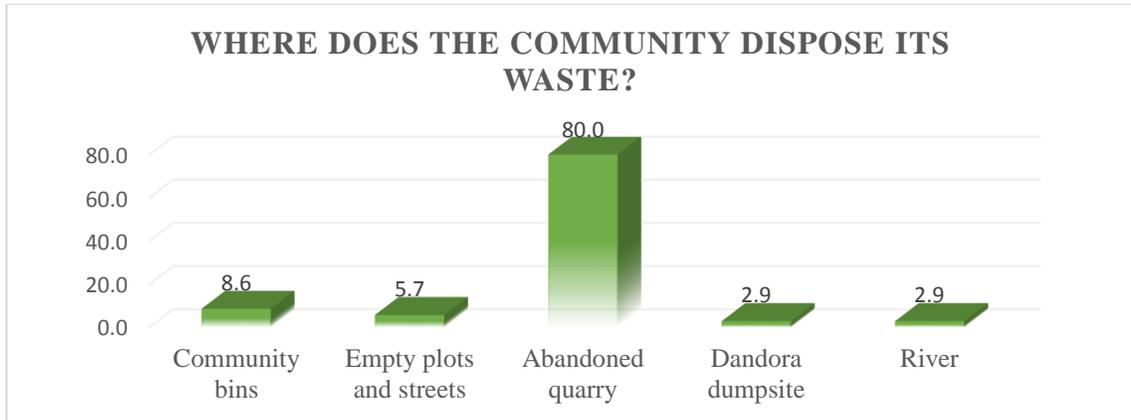


Chart 22: Community Wastes Disposal Sites

Source: *Field Survey, (2016).*

Within the business community, 80% indicated their final disposal site to be an abandoned quarry, while 9% said community bins and 6% reported empty plots/streets. Dandora dumpsite and river were pointed to by 3% of the business enterprises each. The plate below shows the common waste disposal sites used by the community in Ngomongo.



Plate 3: Common Disposal Places within Ngomongo Village

Source: *Field Survey, (2016).*

5.2 CHALLENGES AND POSSIBLE INTERVENTIONS ON SWM IN NGOMONGO

The study sought to discover the challenges facing SWM in Ngomongo and also possible interventions. This was done by examining challenges at collection and disposal levels of the SWM value chain.

5.2.1 Challenges to SW Collection

The study sought to know the challenges bedeviling solid waste collection in Ngomongo. The following charts highlight the findings.

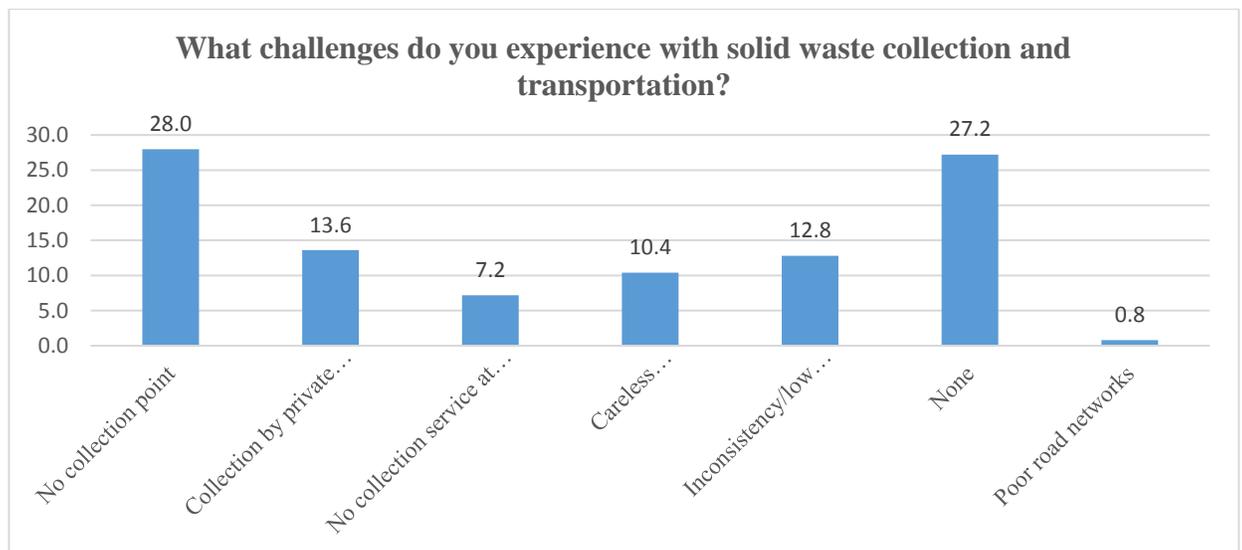


Chart 23: Solid Waste Collection and Transportation Challenges for the Households

Source: *Field Survey, (2016).*

About 28% of the households cited absence of collection point, 14% reported that collection service by private waste collectors is expensive. A further 13% cited inconsistency by private waste collectors, while 7% indicated lack of collection service

and 1% pointed to poor road access. Twenty-seven percent however, do not perceive any problem to the solid waste collection service.

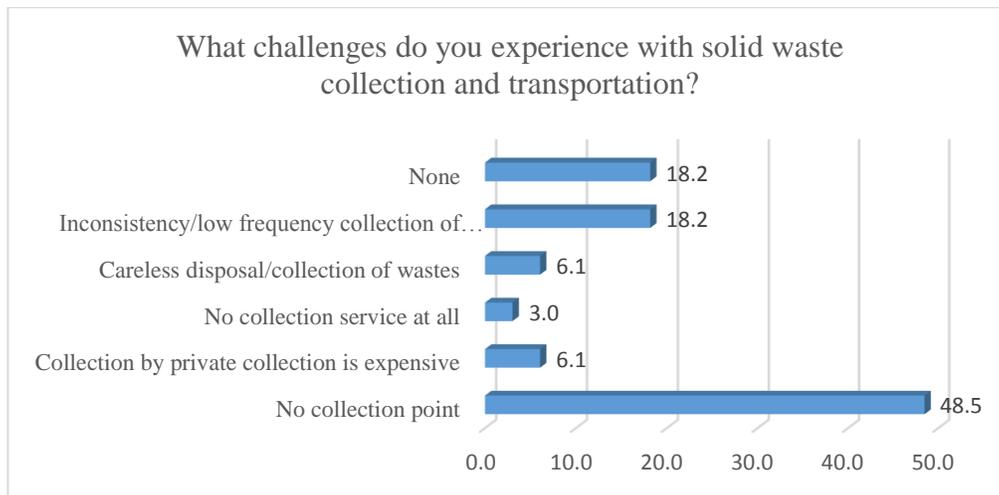


Chart 24: Solid Wastes Collection and Transportation Challenges for Business Enterprises

Source: *Field Survey, (2016).*

Among business enterprises, 49% of the respondents pointed to lack of collection point, followed by inconsistency of collection services by another 18%. Careless collection and disposal of wastes is another problem cited by 6% and a similar percentage point that private waste collection is expensive. Like in the case of households, 18% business owners did not pin point any challenge regarding SW collection in Ngomongo. Nairobi City County also pointed to lack of collection point which was attributed to lack of space to site solid waste collection and transfer points.

Other challenges facing solid waste collection in informal settlements according to Nairobi City County include lack of proper storage of waste before collection, inadequate resources to collect the ever increasing SW quantities and political interference on scheduling of SW collection service. The County’s solid waste department for instance indicated that the county not only has inadequate collection

trucks and other loading equipment, but also the available ones often break down and take days before repair. The officer at the solid waste department cited bureaucracy in the procurement process for repairs and maintenance of available trucks and other equipment, a situation that further worsens the SW collection in Nairobi, Ngomongo included.

Apart from the challenges above, NEMA also cited unwillingness to pay for collection services by low income residential.

5.2.2 Challenges of SW Disposal

The study enquired of the challenges facing solid waste disposal in Ngomongo village. The findings are presented in chart 25 below.

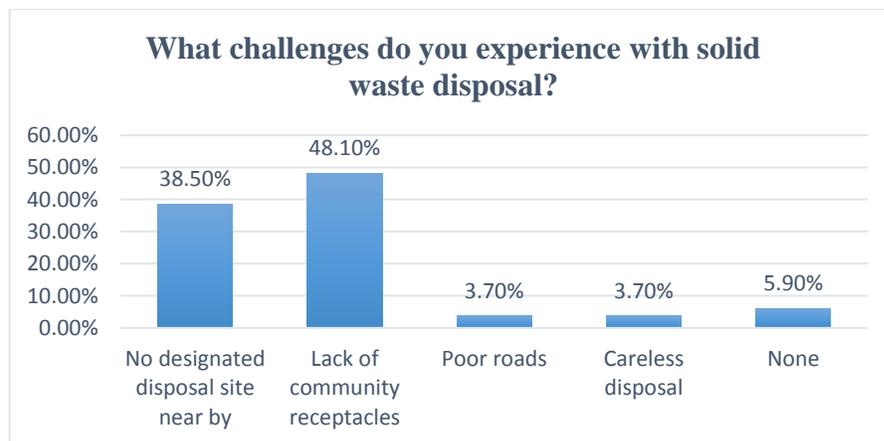


Chart 25: Solid Wastes Disposal Challenges for Households

Source: *Field Survey, (2016).*

About 48% households pointed to lack of community receptacles as the major challenge, 39% cited lack of designated waste disposal sites, 4% of the households pointed to poor roads and another 4% reported that careless disposal is the major solid waste disposal

challenge. However, 6% of households reported that there is no problem with solid waste disposal.



Chart 26: Solid Wastes Disposal Challenges for Business Enterprises

Source: *Field Survey, (2016).*

The study found that 44% reported lack of designated disposal site nearby, 33% point to lack of community receptacles. Five percent of the respondents indicated that poor roads are the main challenge to solid waste disposal and another 5% pointed to careless disposal. 13% of the business community pointed to no challenge as far as solid waste disposal is concerned. Due to the lack of designated disposal points and lack of community receptacles, the community has always disposed wastes anywhere including the river as illustrated in the plate below:



Plate 4: Waste Disposal at the River
 Source: *Field Survey, (2016).*

5.2.3 Possible Interventions to Challenges of SWM

A myriad of possible interventions was proposed by both households and business enterprises. The chart below gives a summary of the findings.

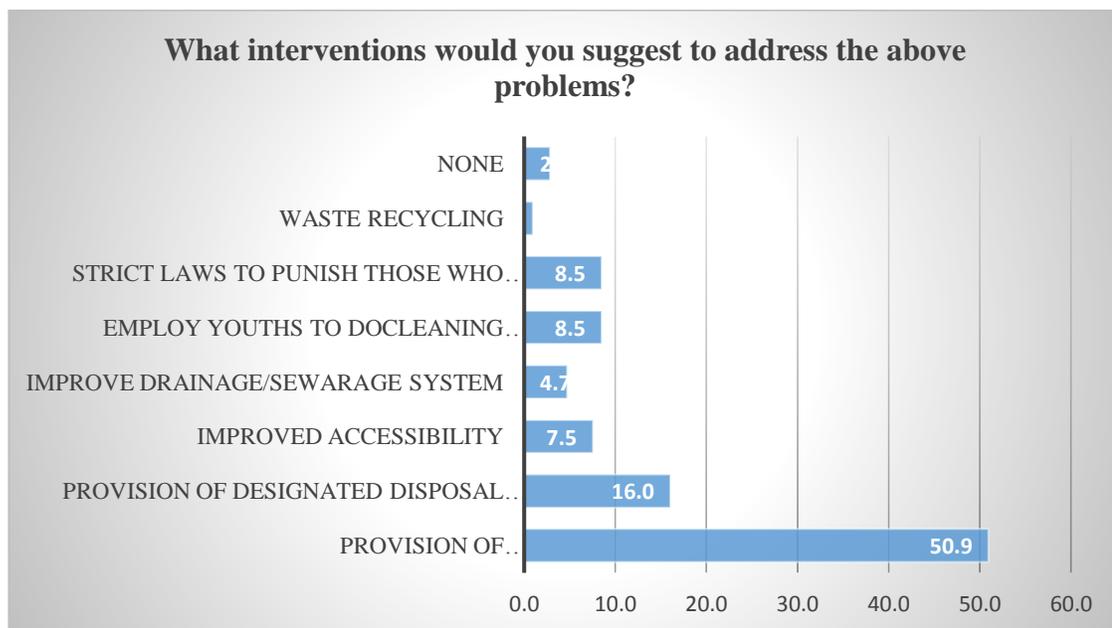


Chart 27: Proposed Interventions to the Problem of SWM at household level

Source: *Field Survey, (2016).*

Fifty-one percent of the households suggested that provision of waste receptacles followed by 16% who suggested provision of designated disposal site. Further, employment of youths at 9%, adherence to laws governing solid waste management also at 9% were proposed as possible interventions. Improvement of accessibility was cited by 8% while 5% suggested improvement of drainage system. A paltry 1% of the households suggested recycling as a major solution to solid waste management challenges.

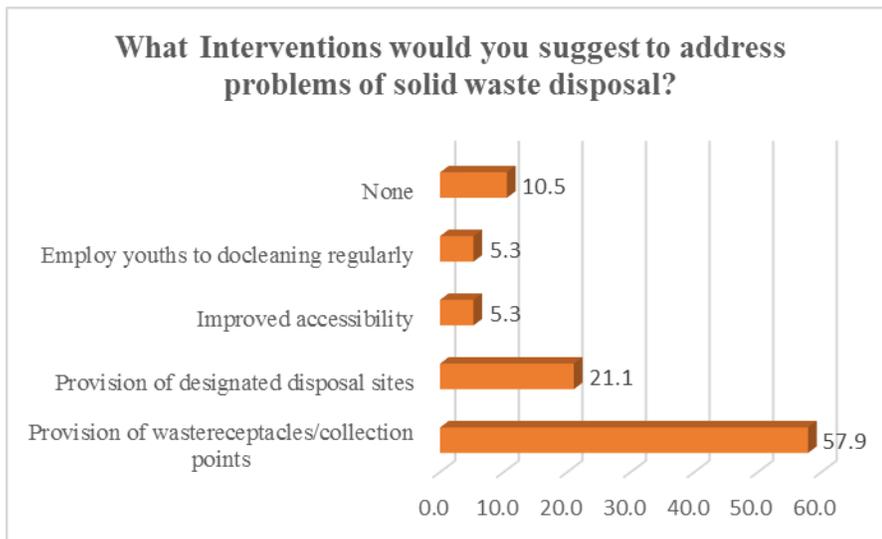


Chart 28: Proposed Interventions to the Problems of SWM by Business Enterprise

Source: *Field Survey, (2016).*

Within the business community, 58% suggested provision of waste receptacles/collection points followed by 21% who proposed provision of designated disposal sites as possible solutions to the problem of SWM in Ngomongo. Another 5% said improved accessibility and a further 5% cited employment of youths to do SW collection. Lastly, 11% of the business could not suggest any possible solution.

5.3 PLANNING INTERVENTIONS ON SWM IN NGOMONGO

5.3.1 Planning Issues that Affect SWM in Ngomongo

The research wanted to discover planning issues that affect SWM in Ngomongo. This was achieved by first asking the respondents whether they felt that the planning of Ngomongo has an impact on SWM in Ngomongo. The respondents were further asked on what planning issues they felt was affecting SWM and further to propose planning interventions that could be implemented for effective SWM.

First, the study discovered that 45% households feel that planning has an impact on solid waste management in Ngomongo while 55% felt otherwise. Among the business community on the other hand, 66% felt that planning of Ngomongo has an impact on SWM in Ngomongo while 34% had a contrary opinion.

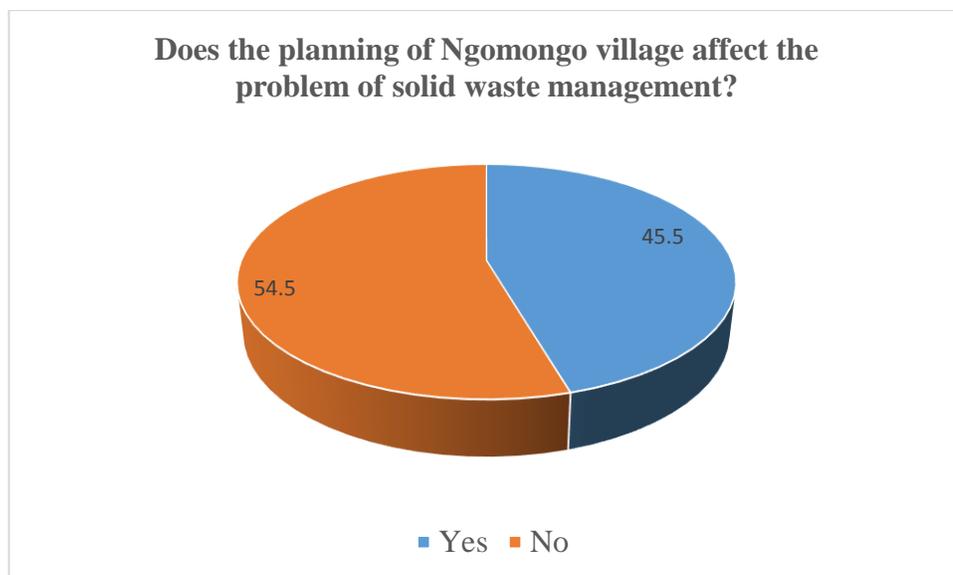


Chart 29: The link between Planning of Ngomongo village and SWM by households

Source: *Field Survey, (2016).*

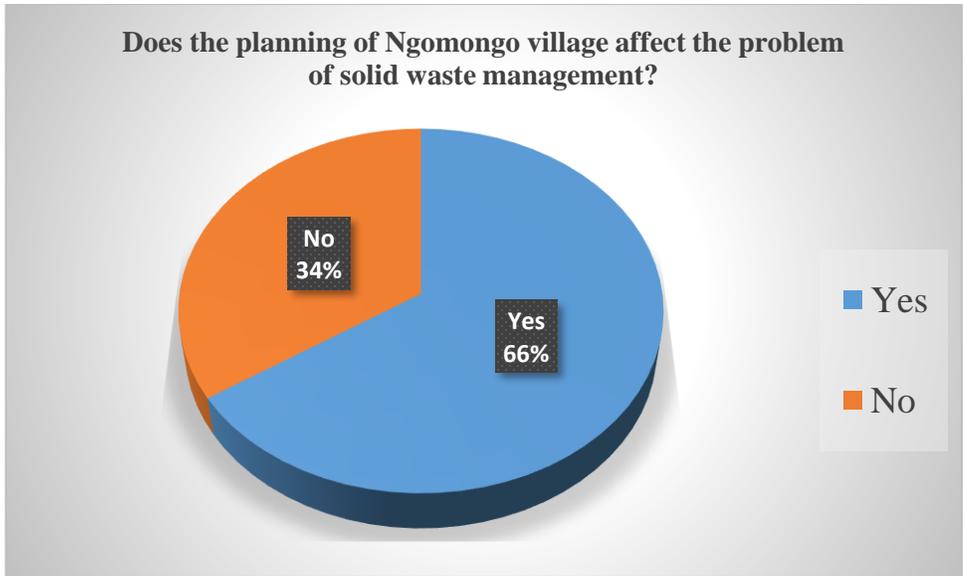


Chart 30: The Link between Planning and SWM in Ngomongo Village by Business Enterprises

Source: *Field Survey, (2016).*

On how planning affect SWM in Ngomongo the results are presented in the figures below.

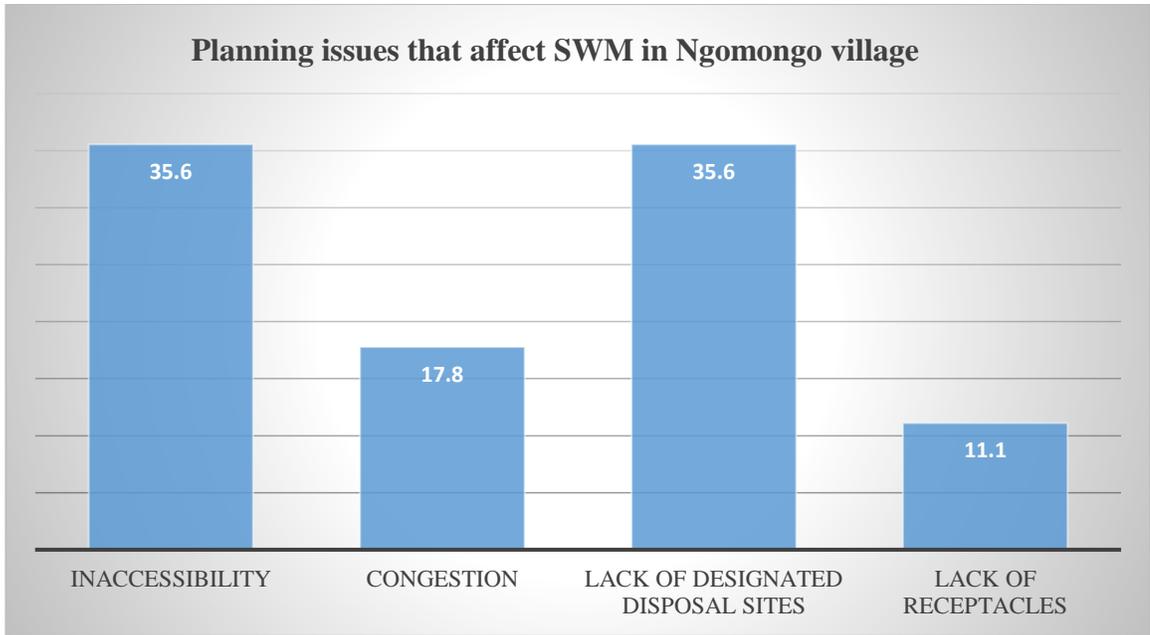


Chart 31: Planning Issues Affecting SWM as Proposed by Households

Source: *Field Survey, (2016).*

From the results above, 36% of households pointed to inaccessibility as the main planning issue affecting SWM, another 36% pointed to lack of designated disposal site while 18% pointed to congestion. About 11% cited lack of solid waste collection receptacles, accessibility as the main planning issue affecting solid waste management in Ngomongo.

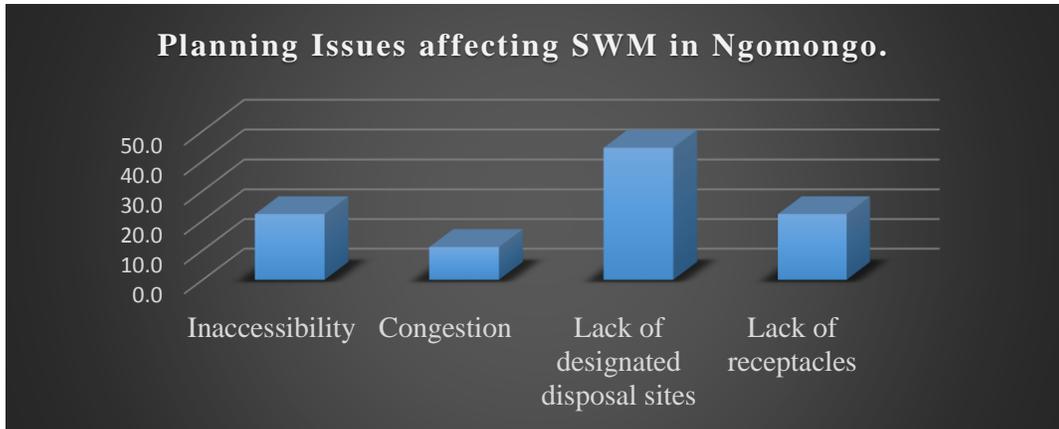


Chart 32: Planning Issues Affecting SWM as proposed by Business Enterprises

Source: *Field Survey, (2016).*

The study found that 44% of business enterprise owners indicated that lack of designated disposal site as the main planning issue affecting SWM. Inaccessibility and lack of solid waste receptacles were pointed out by 22% each. Lastly, 11% business identify congestion as the main planning issue affecting SWM in Ngomongo.

NCC also cited lack of land space for use in siting SW collection and transfer points not only in Ngomongo, but also in other informal settlements.

5.3.2 Planning Interventions to Ensure Effective SWM in Ngomongo

The respondents were asked to suggest planning interventions that could be implemented in order to ensure effective SWM. The findings are as presented below.

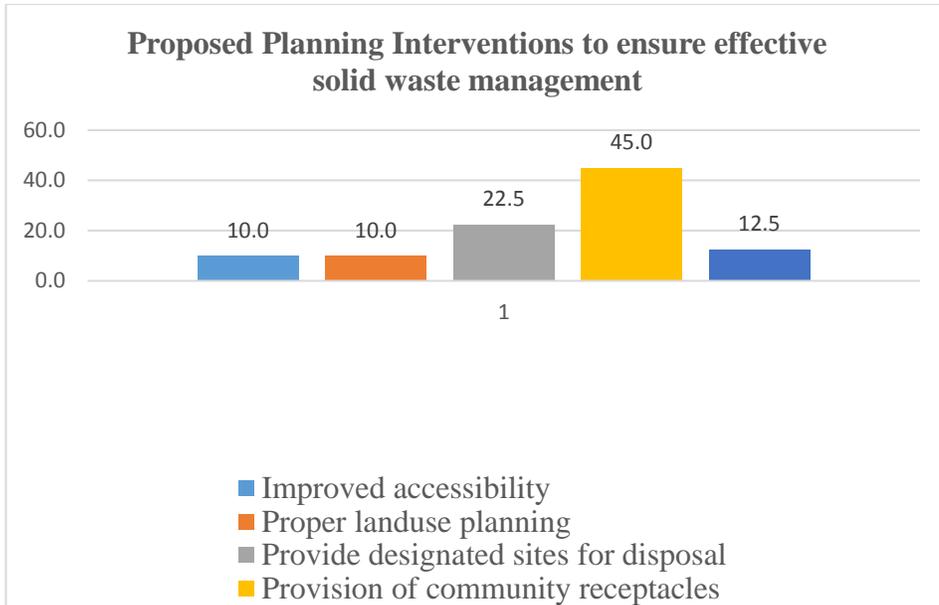


Chart 33: Proposed Planning Interventions for Effective SWM as Suggested by Households

Source: *Field Survey, (2016).*

Among household respondents 45% proposed provision of community receptacles, 23% proposed designated sites for disposal, while 13% proposed regular solid waste collection service. Ten percent proposed improvement of accessibility and another 10% proposed proper land use planning in Ngomongo.

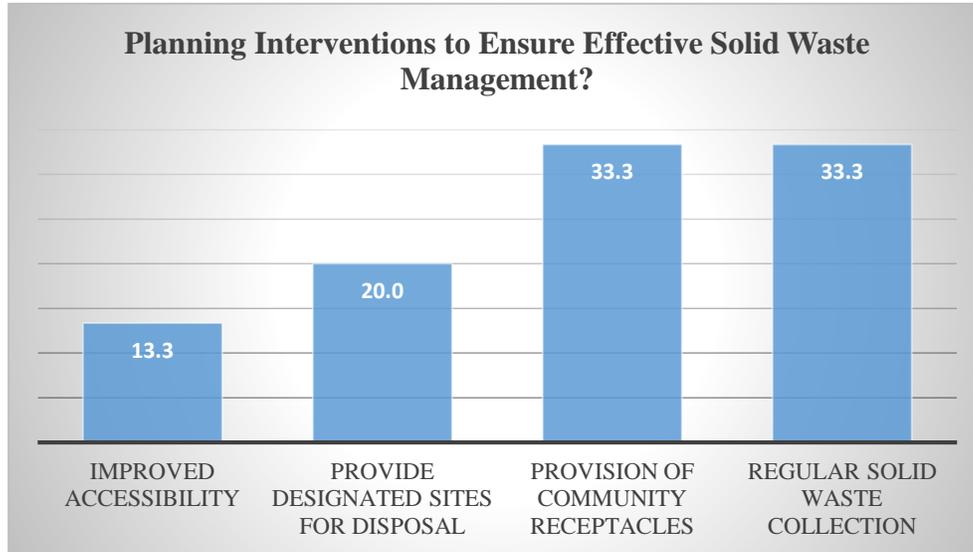


Chart 34: Planning Interventions for Effective SWM as Proposed by Business Enterprises

Source: *Field Survey, (2016).*

For business enterprises, 33% pinpointed that regular solid waste collection, and another 33% cite provision of community receptacles as planning measures to effectively manage SW in Ngomongo, 20% proposed provision of designated sites for waste disposal while 13% identify proposed improvement in accessibility as planning interventions for effective SWM in Ngomongo.

5.4 SYNTHESIS OF FINDINGS

5.4.1 Solid Waste Management System in Ngomongo

The study found that Ngomongo solid waste management system is characterised by high generation of polythene and other plastic materials followed by food remains at 66% and 29% respectively. On the other hand, business enterprises majorly produce food remains and old clothes both at 35% and polythene and other plastic wastes at 20%.

The SW storage system in Ngomongo is dominated by use of polythene papers as storage medium especially by households with 78% reportedly using this storage means. Polythene bags are also the most preferred means of storage among business community at 49% followed by gunny bags and plastic bins at 24% and 19% respectively. The study also found that there is very low level of solid waste separation, with only 17% households and 8% business enterprises separating their waste. Similarly, there is low level of waste re-use in Ngomongo with only 28% among households and 25% among business community reusing part of their solid waste. Related to reuse, selling of wastes is also low in Ngomongo village. Only 14% households and 23% business enterprises sell part of their wastes.

SW collection system in Ngomongo is majorly done on a door to door basis. Approximately 95% households and 85% business enterprises reportedly have their waste collected at the door step. The collection in Ngomongo is majorly done by youth groups with 90% households and 82% business enterprises having their wastes collected by youth groups. This is supported by information obtained from the area assistant chief, community elder and the community health worker (CHW). Nairobi City County also confirmed that out of approximately 2400 metric tonnes of wastes generated in Nairobi, only 1000 metric tonnes is collected and disposed of and out of the 1000 tonnes, only 20% is collected by the county government. This perhaps explains the glaring absence of NCC in solid waste collection service in Ngomongo.

In cases where residents do not receive collection service from any quarter, they dispose the waste using various methods of disposal ranging from burning, burying, taking to disposal site, and dumping on empty plots or by the roadside. Disposal by households is well spread within the four methods at 24%, 14%, 35% and 28% for burning, burying, taking to disposal site by self, and dumping on empty plots & roadside respectively. Disposal methods practised by the business community of Ngomongo are majorly dominated by burning at 71%. Twenty-four take their waste to disposal site with only

5% practicing burying of wastes as a form of waste disposal. On disposal site, the study discovered that an abandoned quarry site within Ngomongo is the main site which residents use as their main final disposal site. Eight-three percent of households and 80% of the business enterprises cited the abandoned quarry as the final disposal site for the community.

5.4.2 Challenges and Possible Interventions on SWM in Ngomongo

Challenges facing SWM in Ngomongo are two fold; those that affect collection and transportation on one hand and those that affect disposal.

On collection front, challenges include absence of collection service, expensive pricing by private waste collectors, absence of collection service, careless collection/disposal, inconsistent/low frequency in collection and poor roads. Approximately 63% of households pointed to at least one of the challenges listed above against 27% who did not point to any problem in the solid waste collection. Eighty-two percent of business enterprises also pointed to at least one of the challenges listed vis-à-vis 18% who could not pin point any challenge facing solid waste collection. The main challenge facing solid waste collection among households is lack of collection point at 28% while the least is poor roads at 1% while for business enterprises, the main challenge is lack of collection point at 49% and the least challenge is lack of collection service at 3%. Challenges facing SW disposal in Ngomongo include lack of designated disposal site, lack of community waste receptacles, and careless disposal to poor roads. The main solid waste disposal challenge cited by households is lack of designated disposal site nearby at 39% and the least is poor roads at 4%. For business enterprises, lack of designated disposal site nearby ranks highest at 44% while careless disposal and poor roads jointly rank lowest at 5%.

5.4.3 Planning Interventions for Effective SWM in Ngomongo

Possible planning intervention measures for effective SWM in Ngomongo include provision of waste receptacles/collection points, provision of designated disposal sites, improving accessibility, improving drainage/sewer system, employment of youths to do collection regularly, to legislating and enforcing strict laws to punish those who handle solid waste carelessly to waste recycling.

Among households, provision of waste receptacles/collection points ranks high at 51% while recycling is the lowest among intervention measures that can be implemented in Ngomongo in order to ensure effective SWM. Business enterprises, just like households, rank provision of waste receptacles/collection points highly at 58%. However, the lowest ranked planning intervention measures are improved accessibility and employment of youth to do regular collection, each at 5%.

5.4.4 Environmental and Health Implication of Poor SWM in Ngomongo

The SWM system in Ngomongo has environmental implications. First, the non-biodegradable component consisting of plastic materials and old clothes translates into littering and unsightly scenes especially in cases where collection and disposal is not done properly. The plastic component also leads to pollution of Mathare and Nairobi Rivers that traverse Ngomongo. The pollution can also find its way into the marine life of the Indian Ocean where the two rivers eventually drain into. The material also has the potential to constrict the river channel and cause flooding especially during the rainy seasons. The non-biodegradable component also creates breeding ground for mosquitoes and other disease vectors such as rats. This has the potential of negatively impacting on the health status of Ngomongo residents.

Similarly, food remains and other biodegradable component which also form a major component of SW generated in Ngomongo means that it generates bad smell when the

waste is uncollected or inadequately disposed of. The biodegradable component also has a potential to cause water pollution of the two rivers of Nairobi and Mathare. Where disposal is done on the river or when SW is washed by rain water into the water bodies, the decomposition of the waste has the potential to cause depletion of dissolved oxygen and therefore lead to death of aquatic and marine life. The leachate from the quarry also has polluting potential on river Nairobi and ground water as well. The polluted waters of Nairobi River also cause downstream pollution especially at the Indian Ocean. This means that poor SWM in Ngomongo poses not only local negative environmental impact but also regional.

The mixing of wastes as revealed by the study also means that there is potential of mixing of hazardous waste and municipal solid wastes. According to Hoornweg & Bhada-Tata (2012), this translates to danger on waste pickers and the environment. The dumping of mixed wastes in the Ngomongo quarry also has potential to generate carbon dioxide and methane (which are greenhouse gases) as a result of decomposition. According to UNEP & UNITAR (2013), uncontrolled dumping is a net emitter of greenhouse gases.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter presents the conclusion drawn from the findings of the study and recommendations made. The conclusions and recommendations drawn are based on the objectives of the study.

6.2 SOLID WASTE MANAGEMENT SYSTEMS IN NGOMONGO

The study concludes that major solid wastes generated in Ngomongo village are polythene and other plastic materials followed by food remains while for business community, the top two categories of waste are polythene bags and other plastic wastes. The existing SWM systems is also characterised by high usage of polythene bags as the storage medium for solid waste and therefore the study can conclude that the system is not adequate as far as solid waste storage by both households and business enterprises is concerned. Polythene bags can easily be torn while still at the doorstep and while being transported and hence spill over the wastes and create challenges to the SWM system.

The study also concludes that the low level of SW separation and reuse in Ngomongo could be a pointer, to among other things, the inadequacy of the SWM system in Ngomongo and low level of waste recovery in Ngomongo. Further, the study concludes that the collection system is majorly done by youth groups who do collection on a door to door system. The dominance by youth groups in solid waste collection and transportation is an indication that activities of players like the county government is very minimal. This was echoed by the county government who submitted that they only do periodic collection of wastes from illegal dumps.

On disposal of solid waste, the study concludes that the system is inadequate due to the fact that first, the disused quarry where majority of Ngomongo residents dispose of their waste is not an official dumpsite considering that Nairobi City County only recognizes Dandora dumpsite as the official designated disposal site for Nairobi.

6.3 CHALLENGES OF SOLID WASTE MANAGEMENT IN NGOMONGO AND POSSIBLE INTERVENTIONS

Challenges facing SWM in Ngomongo are two fold; those that affect collection and transportation on one hand and those that affect disposal. In terms of collection the study concludes that Ngomongo's most pressing challenge is lack of collection points from where all the wastes generated in Ngomongo can be collected. This could mean that even though residents receive door to door collection system they do not like the method but only opt for it due to lack of collection points. Similarly, the collection system could help reduce the negative impacts of the inconsistency in collection service cited by 13% households and 19% of business enterprises since the collection points could serve as transfer points from where scheduled collection can be carried out.

From the findings, the two major challenges cited by both households and business enterprises are lack of designated disposal site and community solid waste receptacles. The study therefore concludes that this perhaps, is the reason why a high percentage of Ngomongo residents dispose their waste into the abandoned quarry which in itself is an illegal dumpsite. The problem is worsened by the fact that Dandora dumpsite, which is the only official disposal site according to information from Nairobi City County solid waste management department, has since received wastes four times beyond what it was meant to receive.

On possible intervention measures, the study concludes that since majority of households and business owners cite that provision of waste receptacles and designated

disposal site as possible intervention measures, provision of facilities could see a reduction in illegal dumping in the quarry and on empty plots.

6.4 PLANNING INTERVENTIONS ON SOLID WASTE MANAGEMENT IN NGOMONGO

From the findings, the study concludes that there is higher perception of the implications of planning on SWM among business owners than households. The study also concludes that lack of designated disposal site; inaccessibility & congestion as are the main planning issues affecting solid waste management in Ngomongo. Addressing these planning issues could possibly therefore help in improving SWM in Ngomongo village.

6.5 ENVIRONMENTAL AND HEALTH IMPLICATION OF POOR SWM IN NGOMONGO

As already noted from the findings of the study, SWM in Ngomongo is characterised by inadequate SWM systems as manifested by low separation, low material recovery, and poor disposal system. The situation is also faced with challenges some of which have planning connotation. The study concludes that the inadequate SWM system as well as challenges facing SWM in Ngomongo negatively affect the environment and the public health of Ngomongo residents.

The study concludes poor SWM in Ngomongo leads to air, water (both surface and ground water) and land pollution. The uncollected wastes and the dumped wastes in the disused quarry is unsightly, generate bad odours as a result of decomposition and also generate leachate that pollutes waters of Nairobi river and also ground water. The quarry dumpsite also generates greenhouse gases like carbon dioxide and methane which are agents of climate change. The marine environment (notably the Indian Ocean) also suffers as a result of poor SWM in Ngomongo since, as UNEP & UNITAR (2013) point out, it is the ultimate repository.

Secondly, as underscored by Hoornweg & Bhada-Tata (2012), uncollected or inadequately disposed wastes can be a breeding ground for insects, vermin and scavenging animals and can thus pass on air and water-borne diseases.

6.6 STUDY RECOMMENDATIONS

In regards to the objectives of the study, the research put forward the following recommendations for effective solid waste management in Ngomongo village.

6.6.1 Solid Waste Management Systems in Ngomongo

Based on the findings, the study recommends the following:

- i. Residents of Ngomongo should be sensitized on the importance of waste separation so as to make it possible to recover valuable wastes from the waste stream.
- ii. Residents could be sensitised to get durable containers instead of using thin plastic papers which cannot be reused for subsequent waste storage. Similarly, residents should be sensitised to adopt re-use and recycling especially for plastic papers. Households could use plastic bags to carry shopping to avoid getting more of such bags from the shops and other traders. Business enterprises can reuse the plastic bags to package goods for customers who do not have their own packaging materials. Recycling on the other hand can be achieved by selling plastic materials that can no longer be used in the original form to recyclers.
- iii. On collection and disposal of solid wastes, the effort of youth groups should be strengthened so as to make them effective. The county government of Nairobi and other stakeholders could partner with the already existing youth groups and also encourage formation of others in order to increase the collection rates especially from the door step. The youth groups could be provided with hand carts in order to take the collected solid waste to Dandora dumpsite.

6.6.2 Challenges and Possible Interventions for Solid Waste Management in Ngomongo

The study recommends the following in order to address challenges to solid waste management in Ngomongo.

- i. Provide collection/transfer points where wastes can be transferred from the residents' door step before subsequent transfer to final disposal site. These transfer points could also provide opportunity for the youth groups to further sort and retrieve valuables from the waste stream that may not have been sorted at the household level.
- ii. Conduct sensitization to Ngomongo residents on waste reuse and recovery in order to reduce the amount of waste that need to be disposed. Residents especially children and the youth could be encouraged to come up with creative ways of using plastic papers in handicraft in order to deal with the high quantities of plastic paper wastes.
- iii. The youth groups should be given incentives to take the wastes collected to Dandora dumpsite. Alongside this the county government should develop a new suitable disposal site to replace Dandora dumpsite. These proposals will help in eliminating the use of the disused quarry in Ngomongo in the long run.

6.6.3 Planning Interventions On Solid Waste Management in Ngomongo

The following are some recommendations in regards to planning issues.

- i. Identification and acquisition of a piece of land to be used as collection and transfer point. Assuming that all stakeholders agree to this recommendation, urban planning could help in issues like arriving at the location considering

factors such as population projection and suitability of the site in terms of accessibility and environmental suitability.

- ii. In terms of accessibility and congestion, enforcement of planning standards especially for upcoming developments. The Nairobi City County should see into it that developments have minimum access even for non-motorised collection service.

6.6.4 Environmental and Health Implication of Poor SWM in Ngomongo

The study recommends the following in order to address the health implications of SWM in Ngomongo.

- i. The residents should reduce wastes by avoidance and recovery of materials from wastes stream as much as possible to reduce the waste that ultimately need disposal. Plastic bags can be reused to avoid getting new ones. Households who have excess plastic bags can also donate or sell to business people for use in packaging of goods for customers thereby also reducing the need to get new ones.
- ii. Organic component of the waste stream could be used in making compost for use in gardening or selling to farmers. This will however be achieved when separation is strictly adhered to.
- iii. Nairobi City County should develop a landfill for proper disposal of waste that need ultimate disposal to receive wastes from not only Ngomongo but also other areas of Nairobi County.

6.6.5 Areas of Further Research

The study sought to identify the challenges and possible interventions for effective solid waste management in Ngomongo. However, from the findings and recommendations put forward, the study recommends further research in the following areas:

- i. The role and effectiveness of community based initiatives like Ngomongo youth groups should be studied to determine their effectiveness in SWM in informal settlements
- ii. Solid waste management is one of the functions of the county government according to the fourth schedule of the Kenyan constitution of 2010. As such therefore, studies should be carried out for solid waste management in informal settlements of every county with a view of informing policy framework for solid waste management in informal settlements.

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APPENDICES

APPENDIX I: HOUSEHOLD QUESTIONNAIRE

University of Nairobi

Department of Urban and Regional Planning

Master of Arts (Planning) 2015/2016 Thesis Field Research

“Challenges and possible interventions for effective solid waste management in Ngomongo Village, Korogocho Informal Settlement, Nairobi County.

Declaration: *The information sought herein will be used solely for academic purposes and therefore will be treated with confidence.*

Questionnaire Number.....Date of Interview.....

Respondents Background Information

- a. Name.....Tel
No.....
- b. Age.....
- c. Sex: 1. Male 2. Female
- d. Level of Education 1. None 2. Primary 3. Secondary 4. College 5. University
- e. Occupation.....

Information SWM systems

- A. What type of waste do you generate most of the time?
 - 1. Food remains

2. Used polythene bags & other plastic materials
3. Newspaper & other waste paper
4. Old clothes
5. Used bottles & cans
6. Other, Specify.....

B. How do you store your waste at the household level?

1. Use polythene bags
2. Use plastic bins
3. Use gunny bag
4. Throw as soon as generated
5. Any other method, specify

C. Do you separate your waste before disposal?

1. Yes.....
2. No.....

D. If yes in B above, how do you do it?

1. Separate materials that can be sold from those that cannot be sold
2. Separate biodegradables from non-biodegradables
3. Separate materials that can be reused from those that cannot be reused
4. Any other, specify.....

E. Do you reuse items from the generated wastes?

1. Yes
2. No

F. If yes in D above, how do you do it?

1. Use of plastic bottles to buy and store liquid items like kerosene
2. Reuse polythene bags to buy grocery

3. Use food remains to feed domestic animals
 4. Any other, specify
- G. Do you sell part of your waste to recyclers?
1. Yes.....
 2. No.....
- H. Who collects and disposes your wastes?
1. County government
 2. Registered private waste collectors
 3. Unregistered private waste collectors
 4. Youth groups
 5. None
 6. Other, specify
- I. If your waste is collected by any of the above persons, from where do they collect the waste?
1. Community waste collection point designated by county government
 2. Collector(s) provide door to door collection
 3. Place the waste in any available open space
 4. Other, specify
- J. In case you do not receive any collection service from anyone, how do you dispose of your wastes?
1. Burn
 2. Bury
 3. Take to disposal site
 4. Throw in open plots or on the streets
 5. Other, specify
- K. Where do you dispose your waste?
1. Community bins
 2. Empty plots and streets

3. Abandoned quarry
4. Any other, specify

Challenges of solid waste management & possible interventions.

A. What challenges do you experience with solid waste collection and transportation?

1. No collection point
2. Collection by private collection is expensive
3. No collection service at all
4. Any other, specify

B. What challenges do you experience with solid disposal?

1. No designated disposal site nearby
2. Lack of community receptacles
3. Poor roads
4. Any other, specify

C. What interventions would you suggest to address the above problems?

Planning Interventions for effective SWM.

A. Does the planning of Ngomongo village affect the problem of solid waste management?

1. Yes.....
2. No.....

B. If yes in A above, enlist the planning issues that affect SWM in Ngomongo village.....

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C. What planning interventions would you suggest to ensure effective solid waste management?

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-End-

Thank you.

APPENDIX II: BUSINESS ENTERPRISE QUESTIONNAIRE

University of Nairobi

Department of Urban and Regional Planning

Master of Arts (Planning) 2015/2016 Thesis Field Research

This questionnaire is intended to gather data geared towards assisting Geoffrey Ochieng, a Master of Arts student in the Department of Urban and Regional Planning, School of Built Environment, University of Nairobi for his Research Thesis titled “*Challenges and possible interventions for effective solid waste management in Ngomongo Village, Korogocho Informal Settlement, Nairobi County*”

Declaration: *Information supplied herein will be used only for academic purposes and will be treated with utmost confidentiality*

Date of Interview.....

1. What type of waste does your business generate most of the time?

- a) Plastic packaging paper
- b) Non plastic packaging paper
- c) Plastic bottles
- d) Food waste
- e) Other, specify.....

2. Do you separate your waste?

- a) Yes

b) No

3. If yes in 2 above, how do you do it?

- a) Separate materials that can be sold from those that cannot be sold
- b) Separate biodegradables from non-biodegradables
- c) Separate materials that can be reused from those that cannot be reused
- d) Any other way, specify.....

4. How do you store your waste at the household level?

- a) Use polythene bags
- b) Use plastic bins
- c) Use gunny bag
- d) Throw as soon as generated
- e) Any other method, specify

5. Do you reuse items from the generated wastes?

- a) Yes
- b) No

6. If yes in 5 above, how do you do it?

- a) Use of plastic bottles to buy and store liquid items like kerosene
- b) Reuse polythene bags to buy grocery
- c) Use food remains to feed domestic animals
- d) Any other, specify

7. Do you sell part of your waste to recyclers?

- 3. Yes.....
- 4. No.....

8. Who collects and dispose your wastes?

- a) County government

- b) Registered private waste collectors
- c) Unregistered private waste collectors
- d) Youth groups
- e) None
- f) Other, specify

9. If your waste is collected by any of the above persons, from where do they collect the waste?

- a) Community waste collection point designated by county government
- b) Collector(s) provide door to door collection
- c) Place the waste in any available open space
- d) Other, specify.....

10. In case you do not receive any collection service from anyone, how do you dispose of your wastes?

- a) Burn
- b) Bury
- c) Take to disposal site
- d) Throw in open plots or on the streets
- e) Other, specify

11. Where do you dispose your waste?

- a) Community bins
- b) Empty plots and by the roadside
- c) Abandoned quarry
- d) Any other, specify

12. What challenges do you experience with solid waste collection and transportation?

- a) No collection point
- b) Collection by private collection is expensive

- c) No collection service at all
- d) Any other, specify

13. What challenges do you experience with solid disposal?

- a) No designated disposal site nearby
- b) Lack of community receptacles
- c) Poor roads
- d) Any other, specify

14. What interventions would you suggest to address the above challenges?.....

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15. Does the planning of Ngomongo village affect the problem of solid waste management?

- a) Yes.....
- b) No.....

16. If yes in 15 above, enlist the planning issues that affect SWM in Ngomongo village.....

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17. What planning interventions would you suggest to ensure effective solid waste management?

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-End-

Thank you.

APPENDIX III: INTERVIEW SCHEDULE DIRECTOR OF ENVIRONMENT-COUNTY GOVERNMENT OF NAIROBI

University of Nairobi

Department of Urban and Regional Planning

Master of Arts (Planning) 2015/2016 Thesis Field Research

This questionnaire is intended to gather data geared towards assisting Geoffrey Ochieng, a Master of Arts student in the Department of Urban and Regional Planning, School of Built Environment, University of Nairobi for his Research Thesis titled *“Challenges and possible interventions for effective solid waste management in Ngomongo Village, Korogocho Informal Settlement, Nairobi County”*

Declaration: *Information supplied herein will be used only for academic purposes and will be treated with utmost confidentiality*

Name/Title of Respondent.....

Date of Interview.....

1. What is the quantity of solid waste generated in Nairobi County in tonnes per day?
2. Of the generated waste, how much is collected and disposed of per day?
3. What proportion of collected wastes does the county government directly collect and dispose without contracting?
4. What proportion of wastes is collected and disposed of by City county contracted wastes collectors?
5. What proportion of wastes is collected by registered waste collectors directly contracted by households and businesses in the city?

6. In total, how many collection trucks and equipment for SWM does the county government have? (Please give summary of their working condition)
7. Ideally, how many collection vehicles and other SWM equipment does the county need to effectively manage solid waste in Nairobi?
8. How are county government collection trucks and other SWM equipment distributed within Nairobi?
9. Does the collection service by the county government cover informal settlements like Ngomongo?
10. If yes in 9 above, from where does the collection take place?
11. If you do waste collection services in Ngomongo, what is the frequency of the service?
12. Do you charge for collection services offered to residents of Nairobi?
13. How is the billing done?
14. Is the county engaged in kind of solid waste processing?
15. If yes, briefly explain how it is done.
16. Enlist the designated solid waste disposal sites in Nairobi
17. Who are some of your partners in SWM in informal settlements?
18. What role do the partners play in SWM in informal settlements like Ngomongo?
19. What challenges does the county government experience in solid waste management in informal settlements like Ngomongo?
20. What remedies would you suggest to address the above challenges?
21. In what ways do you think urban planning could help in achieving effective solid waste management in Ngomongo?

-End-

Thank you for your time and cooperation

APPENDIX IV: SCHEDULED QUESTIONNAIRE FOR HEAD OF WASTE DEPARTMENT, NEMA

University of Nairobi

Department of Urban and Regional Planning

Master of Arts (Planning) 2015/2016 Thesis Field Research

“Challenges and possible interventions for effective solid waste management in Ngomongo Village, Korogocho Informal Settlement, Nairobi County”.

Declaration: *Information supplied herein will be used only for academic purposes and will be treated with utmost confidentiality*

Date of Interview.....

- A. Briefly highlight the role of NEMA with regard to SWM
- B. In what ways do you participate in solid waste management in Nairobi County?
- C. In what ways are you involved in SWM in informal settlements like Ngomongo?
- D. How many SWM companies are registered with NEMA?
- E. What is the role of NEMA in controlling illegal dumping of wastes?
- F. What is the success rate in performing the above function for in the past years?
- G. How does NEMA relate with the county government of Nairobi as far as SWM is concerned?
- H. Moving forward, what plans do you have in place to ensure effective SWM in cities’ informal settlements like Ngomongo?
- I. What challenges does NEMA face in the area of SWM in urban areas and especially in informal settlements like Ngomongo?
- J. How best can the challenges be addressed?

K. Any other information concerning solid waste management as a whole.....
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.....

-End-

Thank you for your time and cooperation

APPENDIX V: INTERVIEW SCHEDULE FOR VILLAGE ELDERS

University of Nairobi

Department of Urban and Regional Planning

Master of Arts (Planning) 2015/2016 Thesis Field Research

This questionnaire is intended to gather data geared towards assisting Geoffrey Ochieng, a Master of Arts student in the Department of Urban and Regional Planning, School of Built Environment, University of Nairobi for his Research Thesis titled “*Challenges and possible interventions for effective solid waste management in Ngomongo Village, Korogocho Informal Settlement, Nairobi County*”

Declaration: *Information supplied herein will be used only for academic purposes and will be treated with utmost confidentiality*

Name/Title of Respondent.....

Date of Interview.....

1. What are the main wastes generated by residents of Ngomongo village?
2. Who is responsible for waste collection from your village?
3. How often is waste collected and transported from the village?
4. Where is the final destination point for disposing all wastes generated from your Ngomongo?
5. Do you think the current waste management system is adequate in your area?
6. According to your assessment, what are the challenges facing effective SWM in Ngomongo?
7. What is the best way that you think waste can be effectively managed in Ngomongo?

A. What do you think should be the role of the following institutions in effective solid waste management in Ngomongo?

- i. Residents (Households)
- ii. Landlords
- iii. Business owners
- iv. Community health Worker

-End-

Thank you for your time and cooperation

APPENDIX VI: INTERVIEW SCHEDULE FOR ASSISTANT CHIEF, NGOMONGO SUB-LOCATION

University of Nairobi

Department of Urban and Regional Planning

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Declaration: *Information supplied herein will be used only for academic purposes and will be treated with utmost confidentiality*

Name/Title of Respondent.....

Date of Interview.....

1. What is your assessment of the current solid waste management system in Ngomongo village?
2. Who is responsible for waste collection from Ngomongo?
3. How often is waste collected from Ngomongo village?
4. Where is the final disposal site from wastes generated and collected from Ngomongo?
5. What role does the national government through the office of the assistant chief play in SWM in Ngomongo?
6. Who does the office of the chief work with in any role(s) mentioned above?
7. What are the major challenges facing effective SWM in Ngomongo?

8. Suggest ways in which solid waste could be effectively managed in Ngomongo?
9. Any other information relevant to solid waste management in Ngomongo

-End-

Thank you for your time and cooperation

APPENDIX VII: INTERVIEW SCHEDULE COMMUNITY HEALTH UNIT OFFICER

University of Nairobi

Department of Urban and Regional Planning

Master of Arts (Planning) 2015/2016 Thesis Field Research

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Name/Title of Respondent.....

Date of Interview.....

1. What is your assessment of the current solid waste management system in Ngomongo?
2. Is the SWM system effective?
3. Who is responsible for waste collection Ngomongo?
4. How often is waste collected from Ngomongo village?
5. Does the community have central collection points where they put their waste before collection and transportation to a final disposal site?
6. Where is the final disposal site for wastes generated and collected from Ngomongo?

7. What role does the community health office play in solid waste management Ngomongo?
8. Who does the office of the community health officer work with in any role concerning solid waste management?
9. What are the challenges facing solid waste management in Ngomongo village?
10. Suggest ways in which solid waste could be effectively managed in Ngomongo?
11. How can planning help in addressing challenges in solid waste management?
12. Any other information relevant to solid waste management in Ngomongo

-End-

Thank you for your time and cooperation

