ASSESSMENT OF SOLID WASTE MANAGEMENT AT WAKULIMA MARKET IN NAIROBI CITY, KENYA

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DEDICATION

This thesis is dedicated to my parents Mr. and Mrs. Mugo, my husband Eric and my entire family members. Special thanks to my siblings for all their tireless support during the entire process.

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EMCA	-	Environmental Management and Coordination Act
ISWM	-	Integrated Solid Waste Management
JICA	-	Japan International Cooperation Agency
KAP	-	Knowledge Attitude and Practice
MSW	-	Municipal Solid Waste
NEMA	-	National Environment Management Authority
NCC	-	Nairobi City County
NGO	-	Non-Governmental Organization
SWM	-	Solid Waste Management
UN	-	United Nations
UNEP	-	The United Nations Environmental Program
UNESCO	-	United Nations Education Scientific and Cultural Organization
UNPFA	-	United Nations Populations Fund Agency
USEPA	-	United States Environmental Protection Agency
WMD	-	Waste Management Department

ABSTRACT

The market place is one of the most important places where trade of goods occurs among the general public. Wakulima market is characterized by heaps of unattended sites of solid waste. Poor waste disposal practices have resulted in an unsightly and unsanitary market. The purpose of this study therefore was to assess solid waste management at Wakulima market in Nairobi City County. The overall objective of this thesis was to analyse the factors hindering effective solid waste management at Wakulima market. The research adopted a descriptive design and data was collected using preliminary field observations, face-to-face interviews and questionnaire survey. Data was collected from the sellers, buyers and other stakeholders in the market. Stratified sampling along products was used to interview 100 respondents from the market. Results of the study indicated that the factors hindering effective waste management at Wakulima market were: lack of enough skips for storage of waste (88%), lack of regular waste collection from the market (85%), poor waste management methods (74%) and lack of enough resources for institutions mandated to collect waste generated from the market (65%). From the findings, 78% of the respondents disposed their waste in undesignated areas such as near the roads, in drainage areas as well as leaving the waste in the market hall. Only 22% of the respondents placed their waste in skips and bins. Results indicated that most of solid waste in the market was organic according to 65% of the respondents which was followed by plastic bags at 27% and sacks at 8%. The study findings indicated that the methods of storage of produce left unsold in the market was a key determinant towards reducing waste at Wakulima market. The research recommendations include: need to supply enough bins and skips in the market, regular waste collection from the market of and incorporation of the Integrated Solid Waste Management

CHAPTER ONE

INTRODUCTION

1.1   Background of the study

Management of waste is done to minimize its adverse effects on the health of humans, the environment and for aesthetic purposes. Improper waste disposal and accumulation results in increase of environmental diseases, environmental pollution, emission of foul smells and an unattractive environment (Muniafu and Otiato, 2010). A study conducted by the UN-Habitat and the Imperial College London in 2010 came up with a conclusion that organic waste is on average the most common type of waste produced in 20 cities in the world. Results from the study indicated that in high income areas, organic waste was about 29% of the total waste generated while in areas with middle-income earners, organic waste was about 54% of total waste generated and in low-income areas, organic waste contributed to 63% of total waste generated (UN-Habitat, 2010).According to the 2012 report on Global solid waste management, by 2025 the cities and urban centers in the world will generate over 2.8 billion tons of waste. This is more than twice the current amount of 1.3 billion tones especially in low income generating nations.

In Kenya, food waste contributes to the highest percentage of solid waste generated in markets (NCC, 2002). Private companies as well as the Nairobi City County provide services for solid waste management to high income areas, middle income areas also get relatively good waste collection services from both the private and public waste collectors compared to low-income areas where waste collection services are very irregular and in other places they are non- existent.

Waste management is the process of gathering the waste, storage, separation of waste and finally transporting it to the final disposal point (UNEP, 2014). With this in mind, management of solid waste is crucial in maintaining a healthy environment and is a fundamental part of basic urban services. Waste collection, transportation and final disposal have generally been ignored by county governments in the developing world. Solid waste in most urban areas is done by the government itself or by private collectors. Despite spending around 20 to 40 per cent of their revenues on management of waste, developing countries have not been able to completely deal with the problem of waste (Zerbock, 2003). The World Health Organization (WHO) made a request to African countries to state the problems they were facing with regards to maintaining healthy environment. The outcome from the study showed that solid waste was an important problem as it was ranked second after the water quality problem (Senkoro, 2003 in Zerbock, 2003).

Evidence reveal that urban waste is mainly composed of 68% from domestic sources, 14% is from industrial sources, 8% from roads, 2% from hospitals, 3% from education institutions/schools,1% from markets and the remaining 4% from other sources (UNFPA, 2001). Packaging material such as plastic constitute a large proportion of waste. For example, more than 260,000,000 tons of plastics are produced every year globally, which accounts for almost 8% of all production in the world (Oyake, 2016). The same report indicated that almost 1 trillion plastic bags are manufactured and utilized in one year globally. This points to the importance of the use of plastic materials above all others by the packaging sector. The urban waste streams end up being the recipient of nearly a half of these produced plastic bags constituting something between 5% and 10% of the solid waste stream. This is also the case in most Kenyan cities (NEMA, 2003). Although plastic bags were banned in Kenya, the clogging of drainage

systems has not stopped and it will take time to clear water ways coupled with illegal dumping of plastic waste.

The burden of managing waste is negatively impacted by the high rate of population growth in cities like Nairobi. Less than 26% of all solid wastes are collected on a daily basis in Nairobi (Ikiara *et al.,* 2014). The challenges that complicate waste management centers encompass poor sanitation, regulation implementation, limited financial support and in urban areas, lack of appropriate methods to manage wastes according to Troschinetz and Mihelcic, (2009). The wetlands and low lying lands form majority of the dumping site locations in many nations according to global solid waste management report (2012). In developing countries, these sites are not protected from human access. They are left open and unfenced hence increasing the risk of human exposure to environmental and public health hazards (Oyake, 2016).

1.2 Statement of the Research Problem

Developing countries face more problems in management of waste compared to the developed countries (Zerbock, 2003). Lack of financial resources and infrastructure to deal with solid waste creates a vicious cycle of; lack of resources which leads to low quality of service provision which leads to fewer people willing to pay for the services, which in turn further erodes the resource base and so on (Kuniyal *et al*., 1998; Zerbock, 2003). The problem is further complicated by rapid growth in population and urbanization, which adds greatly to the volume of waste being generated and to the demand for waste retrieval service in municipal areas. An increase in population is not matched with an equal increase in revenue for the local municipalities for waste management (Zerbock, 2003). Another significant factor that contributes to the problem of solid wastes in a developing country scenario is the lack of proper collection and

transportation facilities. Improper planning coupled with rapid growth of population and urbanization serves to add congestion in streets and as a result the waste collection vehicles cannot reach such places, thus allowing filth to build up over time. Lack of monetary resources at times results in improper or no transportation vehicles for waste disposal thus adding another dimension to the ever rising cycle of problems (Jain *et al*., 1994; Zerbock, 2003). In any developing country, the threats posed by improper handling and disposal of solid wastes (though often ignored) contribute to the high level of mortality and morbidity (Medina, 2002).

Effective waste management is a major problem at Wakulima market in Nairobi. This is occasioned by irregular collection of waste generated, lack of proper systems for handling the waste, lack of adequate solid waste management laws and lack of knowledge on proper waste disposal methods. It is estimated that 4000 tons of wastes is produced from the market place every day. Out of this, only a fraction of it is collected and this means that there is a deficit which is left uncollected. This has resulted in littering, heaping and overflowing of wastes in the market places which has made the markets unattractive and filthy for carrying out business. In addition, the traders sell their wares on heaps of garbage. The study will enable generation of information on problems faced by waste managers and the approaches that could be adopted.

1.3   Research Questions

    i.   What types of waste is generated at Wakulima market?

    ii.   How do people dispose of waste from the market?

    iii.   How often is the waste collected?

    iv.   What resources are available for collection of wastes disposed at the market?

v.   What can be done to achieve a cleaner and healthier market?

1.4 Overall Objective

To assess dynamics of waste generation and management at Wakulima market, Nairobi City.

1.4.1 Specific Objectives

i.   Identify different categories of solid wastes produced from the Wakulima market.

ii.   Analyse the current solid waste management system.

iii.   Assess opportunity for improved waste management.

1.5 Justification of the study

Nairobi is home to over 4 million people (Kenya Bureau of Statistics, 2017). Wakulima market is located in the central business district and is the largest fresh produce market in Nairobi. The persistent negligence of proper waste management raises a great concern in the market. The choice of this subject area therefore stems from the need to urgently come up with a solution to the prevailing situation, where market waste has continued to accumulate in various open dumpsites and the existing formal waste management institutions have failed.

1.6 Scope and limitations

The study was conducted at Wakulima Market in Nairobi County. This thesis focused on the waste generated in the market both organic and inorganic. The study also focused on the role of traders and the county government in waste management. It also focused on the current status of waste management in the market. The busy schedules of the traders were a limitation with erroneous and biasness due to human nature forming additional factors that limited the study.

2.0 Introduction

This chapter entails a review of various literatures on waste management particularly in the market place. The chapter highlights the type of wastes in the market places and how the waste is handled.

2.1 Market Place Waste

Waste is defined as something that is no longer useful to the owner or something that has already been used but does not fulfill its intended purpose (Gourlay, 1992 in Freduah, 2004). Wastes may be generated during raw material extraction, processing of the raw materials into intermediate and final products, the use of final products and other human activities. Goods that are reused or recycled at the place of generation are excluded (UN Statistics Division, Glossary of Environmental Statistics 2014). Market waste is any material that is produced from the market place for which the initial user has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose (UNEP, 2008).

2.1.1 Solid Waste

Solid wastes are materials that arise as a result of humans or animals' activities that are often thrown out as they are regarded useless (Tchobanoglous *et al.,* 1993). These solid waste materials fall outside of liquid nature, gaseous and non-hazardous and consist of both organic and non-organic material. These materials are generated from commercial establishments, markets places, institutions such as schools and industries (Arukwe, 2012). The characteristics of solid waste depend on its source and nature (USEPA, 2009). Solid waste can be made up of different things. Some are:1) industrial waste- which is waste that has been generated from industries that can either be hazardous or

non-hazardous 2) residential waste- which is waste generated from households and may include refuse, trash and other forms of hazardous waste such as plastics, batteries and even electronics 3) municipal waste- which is waste generated from clean-up of streets, parks and open spaces 4)commercial waste-which is waste generated from business places such as hotels, malls and even market places 5) Agricultural Waste- which is waste that has been generated as a result of farming activities.

Solid waste can either be combustible or non-combustible. The components of solid waste that are combustible include plastics, papers, sacks, food waste, and other organics. Non- combustibles components of solid waste include bones, glass and metals (Denison and Ruston 1990; Kreith 1994, Zerbock 2003). The composition of waste in an area is determined by factors such as the population of the area, climate, production from industries, social behavior as well as the level of income of the population (Baldisimo, 1988). The amount of solid waste generated in Nairobi's municipalities is estimated at about 4016 tones on a daily basis with about 45% of this being composed of organic waste (Allison, 2010).

2.1.2 Organic Waste

Organic waste is anything that comes from plants or animals that is biodegradable. Biodegradable waste is a type of waste which can be disintegrated into its base compounds by micro-organisms and other living things within a short time regardless of what those compounds may be (Ngera, 2014). Biodegradable waste can be used for making compost manure for agricultural purposes, as a resource for production of heat, fuel and electricity through incineration or anaerobic digestion to produce biogas, (Ngera, 2014). Organic waste accounts for the highest waste produced in Nairobi city at about 45.9%, paper waste comes in second at 20.7% followed by plastic waste 14.2%

then glass at 2.7% metals are fifth at 2.1% (Table 2.1). Other types of waste account for 14.4%.

Table 2.1: Waste characterization at immediate source and at communal waste collection points for Business, Commercial and Institutional generators.

Waste Type	Source of Waste						
	Retail Shop	Office and Workplace	Institutions	Hotels	Business Areas	Waste collection points adjacent to markets	Average
Organic	43.6	25.9	48.9	69.2	36.4	51.3	45.9
Paper	22.0	42.1	19.8	10.2	18.9	11.1	20.7
Plastics	19.8	17.1	10.9	8.7	14.3	14.3	14.2
Glass	2.3	0.0	3.7	1.4	5.5	3.1	2.7
Metal	2.1	0.8	2.7	1.6	3.4	2.2	2.1
Other	10.2	14.0	14.0	8.9	21.5	18.0	14.4

Source: NCC, (2010)

According to the Nairobi City County, organic matter in the County accounts for the highest content and therefore more emphasis needs to be put in place on the management of this kind of waste. Organic waste is composed of both fruit and vegetable waste.

2.1.3 Municipal Solid Waste

According to a study conducted by JICA in Nairobi County, (1998) municipal waste is defined as solid waste and consists of: business waste, household wastes of small amount less than 50kgs, wastes produced from institutions such as markets, schools and hospitals that do not need to be treated and dead animals with an exception of domesticated animals. According to Syagga, (1992), about one half of the solid waste generated in Nairobi is made up of organic matter. Toxic materials are estimated to be 0.2 percent of the total. For markets alone, it is estimated that more than three-quarters of the waste is organic material. The daily generation of solid wastes from the city is estimated as a whole range from 19,000-24,000 tonnes (NCC, 2010). The volumes of solid wastes generated in Nairobi has increased as the population increases in the city. With the large amounts of municipal refuse generated daily, there is need for a highly efficient system to manage its collection and disposal. The Environmental Management Coordination Act (1999) advocates for adequate solid and hazardous waste disposal from households as well as institutions.

2.2 Waste Management in Developing Countries

Numerous researchers have documented that the collection of solid waste (SW) in most African cities does not exceed 25% (UNEP, 2016). Due to the high level of uncollected garbage, this has an effect on the environment as well as human health. There are different forms of waste management and collection in different parts of the world. In Latin American cities, waste collectors use carts, donkeys, bicycles to collect waste. They sort the waste and pick out recyclables before disposing off the waste that remains (Beall *et al*., 2010). This is a big contrast to what happens in African Cities where waste is hardly segregated and this makes recycling very difficult. In Mexico City's low income areas, informal waste handlers collect waste on behalf of the municipalities.

The municipalities on the other hand carry out street sweeping and cleaning of public places (Weiner and Mathews, 2003). Dumping of solid waste is a common phenomenon in developing countries and thus street sweeping is carried out to manage the waste. Wastes from households are usually put in plastic bags and waste collectors pick up the waste on a regular basis. Solid waste management is treated as a local government responsibility in Sri Lanka (EPA, 2009). However, municipal solid waste management continues to be a challenge as there are no well laid down structures for management of solid waste. Rapid urbanization and industrialization have also aggravated the problem of waste management due to an influx of people in urban areas and lack of proper waste management structures. Solid waste management is treated as a local government responsibility in Sri Lanka (EPA, 2009).

2.3 Market Waste Management in Developing Countries

The market place is one of the most important areas where trade of goods occurs in developing countries. According to Yhdego and Majura (1998), the main cause of mortality and morbidity in these countries is a result of infectious diseases. Various factors have contributed to this the main one being lack of proper waste management practices as well as poor sanitation in the market places. In developing countries, most markets lack basic facilities for waste disposal (Barnmeke and Sridhar 1989). The market designs are also not appropriate and often market corridors are too narrow hence waste collectors cannot pass freely. This situation contributes to indiscriminate dumping of waste in undesignated areas in the market which leads to breeding of various pests such as flies, rats and cockroaches. According to Omotara (1985), flies are major disease vectors especially in tropical countries and they transmit diseases such as salmonellosis, shigellosis, cholera and hepatitis. Flies are also major food contaminants in the market, while rats are known carriers of human plague.

2.3.1 Market Waste Management in Nairobi

Waste management is a process whereby various methods are used to effectively and efficiently regulate waste from the point of generation to the final disposal point. The main aim of waste management is to have a clean, safe and healthy environment at the lower cost (Igbinomwanhia, 2011). In Nairobi County, waste from the market places is not being managed effectively (Gakungu, 2011). The systems of waste collection and disposal that have been put in place are not friendly to the environment. More than 30% of solid waste generated in Nairobi's market places is left uncollected (Otieno, 2010). According to Allison (2010) only about 4% of waste produced is reused or recycled. This situation has been aggravated by the breakdown of about 80% of the trucks that are used to transport the waste. The County government of Nairobi does not treat the problem of waste management with the seriousness it deserves and this has resulted in the pilling of waste in different areas across the city (Kibwage, 2009).

Reliable information on the composition of waste generated is important in order to formulate effective strategies to meet the waste management targets. Kenya has made strides in waste management by reviewing the laws and policies related to waste management such as the Environmental Management and Coordination Act (EMCA, 2016). This Act states that every Kenyan has the right to live in a clean and healthy environment. It also states that it is the duty of every Kenyan to safeguard and enhance the environment for the benefit of the current generation as well as that of the future generation (UNEP, 2010). These laws have not been effectively implemented in Kenya and thus the problem of solid waste persists. Efficient and effective waste management can be expensive when time and resources are factored in and therefore it is useful to know the options that are available for waste management in a safe, effective and sustainable manner (El-Haggar, 2007).

The population of Nairobi County has been growing at a steady rate and so has solid waste generated. Over the last decade increase in waste generated from the city has been recorded at 7% (NCC, 2010). As shown in figure 2.1, waste collection by the City Council of Nairobi has almost stagnated despite the increasing population and quantities of waste produced.
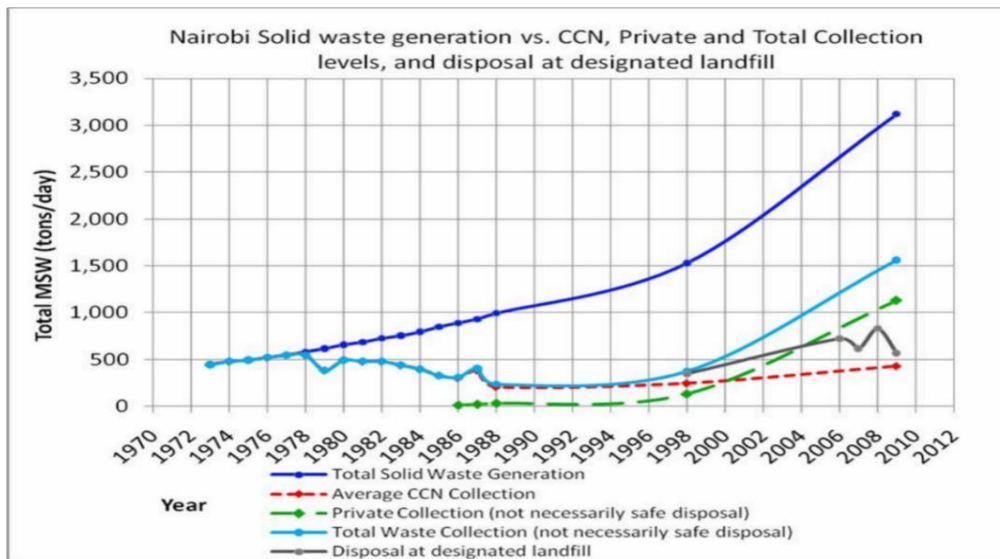
Source NCC, (2010)

Figure 2.1: Trends in Solid Waste Generation in Nairobi

Private waste collection from the city has increased tremendously from the year 1986 to date (NCC, 2010). The private collectors collect waste and transport it to final disposal sites. Most people have taken up the job of waste collection though they charge city residents a higher waste collection fee compared to what the city council charges. The emergence of community based organizations at around 1998 also helped in waste collection though most of them did not transport waste to designated areas (NCC, 2002).

Combined on the collection front, the joint effort of private collectors and community based organizations (green line in Fig 2.1) have experienced similar growth rates as the

overall growth in waste whereas the council operated system of waste collection has been lagging behind in terms of waste collection with only minimal growth. Overall, the average waste composition at source was estimated to be 51% biodegradable, 38% recyclable (metal, glass, plastic and paper) and 11% residual (NCC, 2010). The analysis of composition of waste from the point of collection indicated that there was a decrease in organic fraction and paper (down to 43%), this was a clear indication that more than 50% of the organic fraction of waste decomposes or rots or is disposed of between source and collection points (NCC, 2010).

2.3.2 Market Waste Management Practices

Municipal market waste is usually organic in nature and thus can be composted (Mshelia, 2015). Many youth groups have taken up making compost from market waste and collecting recyclable materials from the waste. They are however facing numerous challenges with the most important one being acquisition of land where they undertake their composting business. Another challenge that they are facing is lack of a proper market for the sale of their goods especially the compost manure and the waste paper. An example of one such project is one that was established in Mukuru slums in 1998 (NCC, 2002). It generated about Ksh.1.55 million in 1998 from the recovery of 1018 tons of reusable and recyclable materials from waste. This revenue was however not enough to finance the projects of the self-help group which had 60 members as well as finance the investments required to improve efficiency (NCC, 2002)**.**

2.4 Challenges Facing Market Waste Management in Nairobi

The Nairobi City County is required through the Environmental Management and Coordination Act (EMCA) to provide Solid Waste Management services to all citizens. The Nairobi City County has the capacity to dispose off only about 400 tonnes of waste

generated on a daily basis (JICA, 1998); this represents only a small fraction of the total waste generated. The amount of waste disposed off by private companies in a month is about 50 tonnes. Waste collection services are rarely provided to market areas due to very high amounts of wastes generated in these areas, which overwhelm the available vehicles and equipment. Other problems encountered include: lack of finances, not acknowledging the importance of an effective waste management system by the policy makers and lack of trained personnel on waste management (Kim-Peters, 1998). As a result of the poor performance by the Nairobi City County and failure of private services to extend their services into low-income unplanned settlement, there was an emergence of community based organizations (CBOs). Majority of these CBOs are engaged in waste composting although the primary activity of about 44% of them is cleaning of urban neighborhoods (Ikiara *et al.,* 2004). In Nairobi, about 55.6% of the CBOs report having been sponsored or facilitated by local and international NGOs and United Nations Agencies such as the UNFPA and UNCHS (HABITAT) to run their activities of composting (Ikiara *et al.,* 2004). Some of the challenges in Wakulima market are discussed below.

2.4.1 Poor Market Design

Generally, the design of Wakulima market lacks onsite waste bins and skips. The market also lacks proper waste corridors which waste collectors can use during waste collection. There is also lack of stalls for displaying of goods and hence the traders place their goods on the floor which makes the goods susceptible to rodents and other pests (Yhdego, 1987).

2.4.2 Waste Storage

Traders who sell their goods near skips often place their wastes in the skips. However, traders who are not near skips often dump their waste by the roadside, in water drainages or leave their waste on the market floor. This makes waste collection from the market very difficult as waste collectors have to gather all the waste from undesignated waste disposal sites using wheelbarrows (NCC, 2002).

2.4.3 Waste Disposal

Market waste contributes to a huge amount of waste that is disposed of at the Dandora dumpsite (NCC, 2010). At the disposal site, waste is disposed off without prior sorting and this in turn leads to environmental diseases and health hazards. At the Dandora dumpsite, there is a lot of smoke from burning of waste as well as bad odour from waste decay. There are no proper waste management practices such as recycling and composting in place.

2.5 Processes in Market Waste Management

The main elements in the management of market waste include: waste generation, storage, gathering, transporting, processing of the waste and recovery of useful components and final disposal (UNEP, 2008). Waste generated is placed in either dustbins or skips before it is collected and taken to its final disposal point which can be a landfill. Waste can also be collected and put in small waste collection equipment such as carts, then transferred to tracks which transport the waste to the final disposal point. Waste collected can also be recovered and processed. Waste management elements are further elaborated in the next section.

2.5.1 Waste Generation

It involves the process in which materials are seen as having no value and are therefore discarded or compiled for disposal (Momoh and Oladebeye, 2010). According to UNEP (2008), in 2006 municipal solid waste (MSW) generated in total about 2.02 billion tones globally, this represented an annual increase of 7% since 2003.According to the UNEP (2008) report, global municipal waste generation is set to rise by 37.3% between 2007 and 2017 which is equal to about 8 per cent increase per year (UNEP, 2008).

2.5.2 Waste storage

According to Tchobanoglous *et al.,* (1977), waste storage site is where waste is kept before it is finally collected. Waste can be stored in a dustbins or skips and not thrown away indiscriminately. According to them, waste storage is very important first because of the aesthetic purposes as well as for environmental purposes. In Nairobi, market waste is stored in heaps near roads before it is collected and taken to the final disposal area.

2.5.3 Processing and Recovery

Processing and recovery is an element that includes all the equipment, technology and facilities used both to enhance the efficiency and recover materials that are usable, as well as the conversion of solid waste to other products or energy (Tchobanoglous *et al.*, 1977). Resources that are of value have been recovered from the solid waste in waste transfer stations and plants for processing solid waste (Tchobanoglous *et al.*, 1977). Waste disposal is the final stage in waste management. In Nairobi, most of the waste that is collected is usually disposed of at the Dandora dumpsite.

2.5.4 Transfer and Transport and Final Disposal of Waste

According to Kreith (1994), transfer and transport of waste is done in two steps: one is the transfer of wastes from the smaller collection vehicles such as carts and wheelbarrows to the larger transport equipment and two the transportation of the collected waste mostly over long distances to the final waste disposal sites. The most common method of waste management in markets in Kenya is through open dumpsites. Waste that is disposed of in open dumpsites is neither treated nor segregated. Many people in Africa consider open dumping of waste as the cheapest method of handling waste and that is why this method is the most common (UNEP, 2005). In Kenya, other than the temporary dumpsite at Kayole which was started in 2009, the Dandora dumpsite remains the only place where solid waste is finally disposed in Nairobi.

Dandora dumpsite can hold up to 1.8 million m^3 of solid waste. With rapid population growth in Nairobi as a result of urbanization, the dumpsite is nearly full. There are other dumpsites not authorized by the CCN that are scattered all over the city where most private waste collectors dump their waste. This has made the management of solid waste in the city a big challenge.

2.6 Actors in Waste Management

Waste management in Nairobi is carried out by various stakeholders. The stakeholders include; Ministry of Environment and Forestry, Nairobi City County, Ministry of Lands, Housing and Urban development, Community based organizations, Non-Governmental Organizations and private operators. The National government is mandated with the responsibility of coming up with legal and institutional framework for management of solid waste. County governments on the other hand have the responsibility of providing services for collection and disposal of waste.

Community based organizations are mostly found in informal settlements such as Kayole and Kibera where solid waste is dumped near roads, drainage systems and other undesignated areas. Non-Governmental Organizations act as the connection between the government and the private sector. Private sector operators can either be large enterprises or individuals contracted to collect waste in places where people live. In total, there are around 120 private companies that have been licensed by the former Nairobi City County and another 140 that are privately owned by individuals who participate in the management of waste (Ngau and Kahiu, 2009).

2.7 Sustainable municipal Waste Management

The sustainable solid waste management concept is aimed at constantly improving the environment, support economic productivity and growth, provide health benefits and provide dignified, safe, and secure employment to the people. Many developing countries have not succeeded well with the implementation of sustainable solid waste management due to different factors acting as barriers to municipal solid waste management (Ezeah, 2010). Sustainable solid waste management can be achieved through; providing clear functions to relevant agencies and enhancing their coordination, coming up with adequate and qualified human resources, developing self-financing schemes, supporting strategic planning and follow-up implementations and raising awareness of the public and decision makers.

2.8 Solid Waste Management Hierarchy

The solid waste management hierarchy (Fig 2.2) is used to indicate the order that should be followed for the management system to be successful. The purpose of the waste management hierarchy is to ensure that maximum benefits are extracted from the waste.

Source: AESSL: 2001

Figure 2.2: Hierarchy of management of solid waste

2.8.1 Waste prevention and Reduction

According to Denison and Ruston (1990), waste reduction is defined as any actions that decrease the quantity or toxicity of solid waste before the waste is processed and disposed in landfills or burnt in incinerators. This definition concurs with the one given by Kreith, (1994) who states that the focus of source reduction is on decreasing the volume and /or toxicity of waste generated. Source reduction involves a transition to use products and packaging that are reusable. The most common example is the use of returnable soda bottles. Reduction of waste from the point of generation will help solve waste problems in the future, (NEMA, 2014). Reduction at consumption level includes; better

buying habits, reuse of containers (including bags) and reducing on the use of disposable products and packaging material (USPS, 2000).

Source separation and resource recovery are very important in management of waste. Waste may be of no value to the person who is disposing it. According to Tsiboe and Marbel (2004),

Denmark, Austria and the Netherland developed a process for waste management in 2004 to effectively deal with the problem of solid waste disposal. They did this by encouraging the citizens in their countries to carry out separation of their domestic waste into paper, plastic, and glass categories; this enhances easy waste collection and reuse (Tsiboe and Marbel, 2004). Waste prevention involves changing people's consumption patterns, redesigning the use of products and waste generation and reduces the toxicity of waste that is produced (USEPA, 1995).

The main issue that leads to a lot of waste in Wakulima market is oversupply of foodstuffs into the market. This often happens especially when a certain product is in season. In order to curb the problem of waste in the market, adequate measures need to be put in place. First is to ensure that what is brought in the market is what is actually needed. Second is to better understand the barriers to opportunities, potential partners and actors to minimize food wastage. Prevention could put more emphasis on product demand, products wastefulness during production, or actual product disposal. With regards to consumers, effort should be placed on trying to minimize the sale of certain products for example imposing tax on plastic taxes on plastic bags (Convery *et al.*, 2007).

2.8.2   Re-use

It is often possible to make use of a product multiple times without changing it and for the same purpose for which it was originally intended; this is known as reuse (USEPA, 1995). Some of the items that can be reused include: plastic bags and sacks which are used for packaging in the market. Once reused there is no need to buy other products and this helps to reduce waste. Advantages of reusing include prevention of pollution which arises as a result of reducing the need to get new raw materials. It also helps to save energy that would have been used to manufacture the product as well as reducing the emission of greenhouse gases which contributes to climate change and helps to ensure environmental sustainability for future generations among other benefits

2.8.3   Recycle

The process of recycling entails the collection, separation and processing of waste so that it can have a high productive value (Pattnik and Reddy, 2009). Theoretically, the components of waste that can be recycled include: plastic bags, plastic containers, gunny bags, glass, metals and organic materials which can be fed to animals or used to make compost manure for use in agriculture (William, 2005).

2.8.4   Composting

Composting is a process that takes up organic matter and converts it into nutrients that are useful for plants. Organic farmers make use of organic waste which is usually made by letting organic materials decompose for several days or months until they are decomposed by microbes. Composting is a very good method of disposal of waste as it converts organic materials that are unsafe into safe compost. As waste generated in developing countries is mostly organic in nature, composting may be a good method of waste disposal as it is easy, cheap and very beneficial as the compost manure generated

can be used in farms to enhance crop production. (Troschinetz and Mihelcic, 2008).

2.8.5   Energy Recovery

The US Energy Protection Agency defines energy recovery from waste as the conversion of materials that cannot be recycled into electricity, usable heat, or fuel through various processes. These processes include combustion, pyrolization, gasification, landfill gas recovery and anaerobic digestion. This process is usually referred to as waste to energy (US Energy Protection Agency). The process of energy recovery also helps to produce a fuel that is combustible. These fuels include combustible: methanol, methane, or synthetic fuels.

2.8.6 Land Filling

Land filling involves placing waste in confined areas, compressing and compacting and then placing soil on the waste to cover it. This process is repeated over on over until the landfill is filled to capacity. Landfills help to reduce burning of garbage which leads to production of air pollutants and also helps in land reclamation. The landfill can be converted into land for valuable use such as planting of trees or establishment of recreational parks and gardens. (Centre for Environment and Development, 2003). Zerbock, (2003) states that the use of landfills for waste disposal is one of the most ancient and the most prevalent method of disposal of solid waste. He also states that "landfills are also open dumps though they are controlled. According to him landfills can be differentiated from open dumps by the level of planning, engineering, and administration involved. Zerbock, (2003) states that open dumps can be characterized by lack of engineering controls, no management of leachate, no management of landfill, and very few measures on operation such as user's registration, control of the number of "tipping fronts" or waste compaction. Landfills are considered as a method of wastes

management that nobody wants but beneficial to everybody (Kreith, 1994). According to Kreith (1994), there are no waste management techniques that can work without the use of landfills. They are considered as the only waste management method that is sufficient and also necessary. According to Kreith (1994) some form of waste cannot be recycled. However, a lot of waste that can be recycled eventually gets to a point where its value is completely used and it cannot be converted into anything useful. He states that the use of modern landfills can help protect both human health as well as the environment.

Although landfills are considered a good method of waste disposal, they have some disadvantages which include: high construction and maintenance costs; can lead to ground water pollution through leaching, lack of land availability particularly in the cities (Kreith, 1994).

2.9 Integrated Solid Waste Management

Integrated solid waste management is the strategic approach to the management of solid waste in a sustainable manner (Fig 2.3). It covers all aspects of waste management which include: generation, separation, transfer, treatment, sorting, recovery of useful products and final disposal in an integrated manner, while emphasizing more on maximizing efficiency in the use of resources (UNEP, 2008).
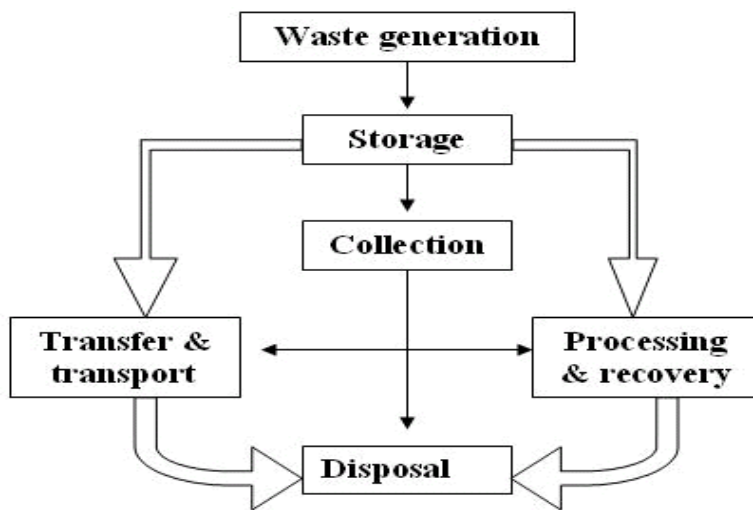
Figure 2.3: Integrated solid waste management Source: UNEP (2008)

There are many benefits that come about as a result of the use of integrated solid waste management. Some of these benefits include: neighborhoods that are safer and cleaner, efficiency in the use of resource, augmentation of resources and reduced costs of waste management which leads to savings among others (UNEP, 2008). With efficient use of waste recycling and segregation, a lot of waste can be converted into useful resources instead of being taken to landfills (UNEP, 2005).

2.9.2   Solid Waste Generation

The main type of waste generated at Wakulima Market is biodegradable waste. According to a recent survey conducted by the UNEP in 2016, Nairobi has a population of about 4.0 million people and produces about 3,200 tons of waste on a daily basis. Most of the waste generated is unaccounted for as only 850 tons reach Dandora dumpsite. In an effort to deal with the problem, in 2013, the Nairobi City County in collaboration with JICA and UNEP came up with a Solid Waste Management Plan which would be implemented in the city to try and deal with the problem of waste management. The solid waste management plan would involve doing away with the Dandora dumpsite and in turn building a sanitary landfill in Ruai as well as two other

transfer stations. The solid waste management plan would also involve educating various people in the food value chain in the market which would in turn help cut down on the amount of waste that goes bad in transit to the market as well as within the market. Another strategy which the Nairobi City County plans to adopt is further building public-private-partnerships (PPP) with private waste collectors as well as adopting the use of community based organizations (CBOs) (NCC, 2015).

2.9.3   Solid waste collection

Market waste is mostly biodegradable and therefore dumping of waste in undesignated areas makes the market an unpleasant site to look at. There is also bad odour that comes from the decomposition of the biodegradable waste which makes the market unsanitary. Waste that is often dumped in drainages leads to blockages and this causes flooding in the market especially during the rainy season. The use of open bins and skips for holding waste is a big threat as flies and other animals transfer the waste to the foodstuffs in the market. These types of storage facility need to be replaced with bins that are covered (UNEP, 2009).

2.10   Solid waste disposal

The means for dumping solid waste collected from the Wakulima market area is open dumping (NCC, 2010). Most of the solid waste in Nairobi is handled by the private sector as well as NGOs. The Nairobi City County solid waste department has few facilities for waste transportation. The few vehicles that are available often break down as they are poorly serviced.

Lack of skilled workforce in the environment department as well as understaffing is also a big challenge to effective management of waste. Lack of proper control leads to waste disposal in undesignated sites. The waste generated from the market areas is

usually dumped on open fields such as the Dandora dumpsite. The residents of Dandora are at a threat of suffering from environmental diseases as they are often exposed to environmental hazards from the dumpsite. Burning of plastics at Dandora dumpsite produces very toxic fumes, such as furans and dioxins, which are very harmful to human beings and the environment. Uncontrolled dumpsites are some of the major sources of greenhouse gases contributing to global climate change. (UN Habitat, 2007).

2.11   Waste Management Regulation and Policy

There are very few legal frameworks that deal with solid waste at the national level. They are spread through a number of Acts and NCC's by-laws (JICA, 1998). The act of Parliament provides for the establishment of an appropriate legal and institutional framework for the management of the environment and for the matter connected therewith and incidental thereto. The Environmental Management and Coordination Act, (1999) (revised 2016) provides guidance on waste management in Kenya. Institutions under EMCA: National Environmental Management Authority (NEMA) whose mandate is to exercise general supervision and co-ordination over all matters relating to the environment and to be the principal instrument of Government in the implementation of all policies relating to the environment. National Environment Council is responsible for policy formulation directions for the purposes of the Act. The Council also sets national goals and objectives, and determines policies and priorities for the protection of the environment and the regulations that guide waste disposal is the waste management. The waste management regulations apply to all categories of waste. These include Industrial wastes; Hazardous and toxic wastes; Pesticides and toxic substances; Biomedical wastes; Radio-active substances. These regulations outline requirements for handling, storing, transporting, and treatment/ disposal of all waste categories.

2.11.2 Theoretical Framework

Theory of Diffusion of Innovations (DOI on KAP Model)

The Diffusion of innovations theory by Rogers (1962) states that new methods and concepts develop with the passing of time by spreading in other areas. The time factor in this theory is instrumental as it accounts to the diffusion of the different methodologies and waste management concepts across the country and to a greater extent the world. Innovation diffusion theory have formed the basis of various researches in the recent past, integrating innovation into knowledge, attitude, and practice stages of innovation adoption as indicated by Hubbard and Hayashi, (2003).Continuous environmental awareness to the public is a key concept to this theory because it consists of creating awareness to the members of the public on environmental management through cultivating K (knowledge) to perception, A (attitude) to affective, and P (practice) to behaviour actions. Behaviour actions are a result of the public learning some skills while P (practice) leads to behaviour change and better practices (Wang *et al.*, 2009). A great variety of studies about attitudes and knowledge have procured a positive and significant relationship between the above two variables. Bowman and Roth (1984) studied how levels of knowledge and attitude towards nature conservation could be raised to positively affect visitor education. For all measured concepts, the findings indicate a positive correlation knowledge test scores as well as on attitude test scores. The other norm that is more subjective holds that a person's financial/economic status is a great determinant of his action and motivation in accomplishing a given task. Owing to this norm, in his/her financial affluence can be more motivated to undertake a task which he/she would otherwise decline from doing when he/she is financially emaciated. To achieve this, a carefully evaluated education and awareness strategy must be developed in order to change people's habits, behaviour

and traditions. However, other theories have indicated that having environmental awareness doesn't necessarily mean having better environmental attitude and practices. There is a need for the traders at the Wakulima market to identify gaps in these three parameters.

2.12   Conceptual Framework

The conceptual framework is guided by the integrated solid waste management system that promotes reduction, recycling and reuse of solid waste at all levels of waste management that is from when waste is generated until its disposal. The main emphasis of the framework is on management of waste from the Wakulima market as shown in figure 2.4. In the solid waste management stream, the issues that need to be considered include: Type of waste generated, various methods adopted in solid waste management (separation of waste at source, waste reuse, recycling, composting and landfill) and the role played by stakeholders in waste management.

Independent Variables   **Dependent Variables**

Type of Waste
- Organic Waste
- Inorganic Waste
- Categories of Waste
- Methods of Disposal

Waste Practices
- Waste Collection
- Waste Transportation
- Disposal Method

Waste Management
- Proper Disposal Methods
- Designation Collection Points
- Source Reduction, Reusing and recycling
- Regulatory Compliance
- Infectious / Hazardous Waste

Source: Researcher (2018)

Figure 2.4: Conceptual Framework

Proper waste disposal can only be achieved with the availability of adequate skips and bins and a change in the attitude of the people with regards to waste management. Waste produced from the market has to be transferred to landfills for final disposal and this is heavily dependent on availability of resources such as waste collection trucks and also the availability of workers in waste management. From the literature review, an effective methodology has to be developed to enable proper data collection with an aim of filling the gaps identified from the theoretical framework. Waste management should be approached from the perspective of the entire cycle of material use which includes production, distribution, and consumption as well as waste collection and disposal. Priority should be given to effective collection and disposal while waste reduction and recycling should be considered for implementation in future. The principles of sustainable waste management should therefore be to: minimize waste generation, maximize waste recycling and reuse and ensure environmentally sound disposal of waste.

CHAPTER THREE

METHODS

3.0 Study Area

3.1 Location and size of Wakulima Market

Wakulima market is located in Muthurwa along Haile Selassie Avenue in Nairobi city (Figure 2.5). Nairobi is located on a high altitude of 1°18'S, 36°45'E, 1798 m. It experiences moderate climate. The annual rainfall averages 925 mm. Nairobi has two rainy seasons, between March and June and between October and December. Daily temperatures range between 12 and 26 degrees Celsius. The soils in Nairobi are as a result of weathering of volcanic rocks with resultant varying drainage. The city center, southern and eastern part of the city have clay soils with poor drainage, while the western side has red soils that are well drained. Nairobi has a population of about 4 million people with a population density of Nairobi is 4850 residents per square Kilometer (Kenya Bureau of Statistics 2017).
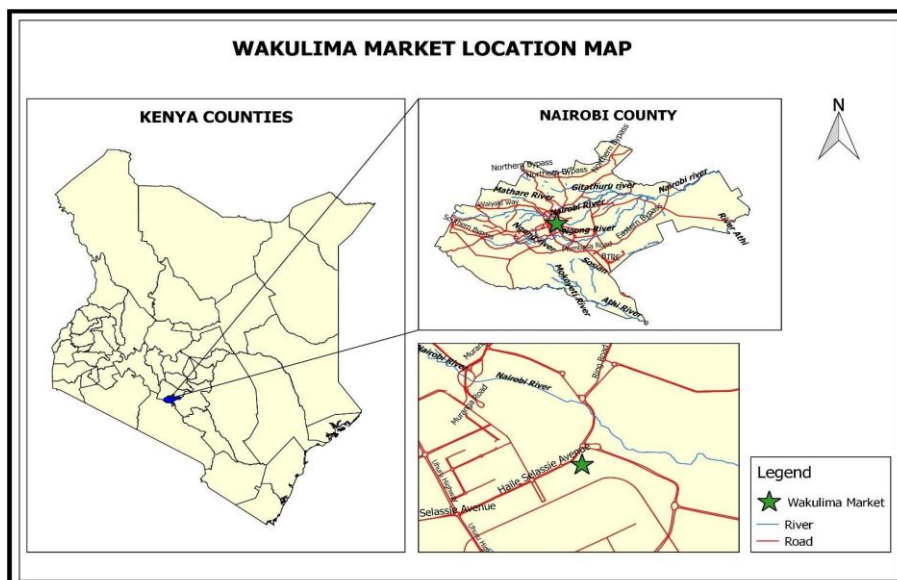
Source: Nairobi City County (2016)

Figure 2.5: Location of Wakulima Market

3.2 Layout of Wakulima Market

Wakulima market covers an area of about 0.9 ha with four buildings (designated as A, B, C, D) and an open enclosure (designated as E). Building A is close to the markets main offices and is separated from the record office at the entrance gate by a railway lane. Building B joins building A and the two are separated by an aisle. Building C, is the main building situated at the center of the market. Building D is situated to the western end of the market. Between this building and the fortification of the market is found an enclosed area E. In each of these buildings are to be found aisle ways originally intended to be used by produce shoppers. Building A, B, C and D have a total roofed area of 24,100 sg ft. between buildings A, B, C and D is a continuous pavement with parking bays alongside it, enough for a maximum of 70 vehicles. The market has three gates, two of which are used by vehicles and the third one is used by train wagons. Distinct commodity allocation is also apparent in this market. The items traded outside building A are sold on retail. This is one of the areas in the market where overcrowding is particularly serious. Similarly, the commodities being traded outside building D and area E are on retail. In general, commodities listed as being traded outside any of these buildings are stacked in the spaces originally designed for parking (NCC, 2016).
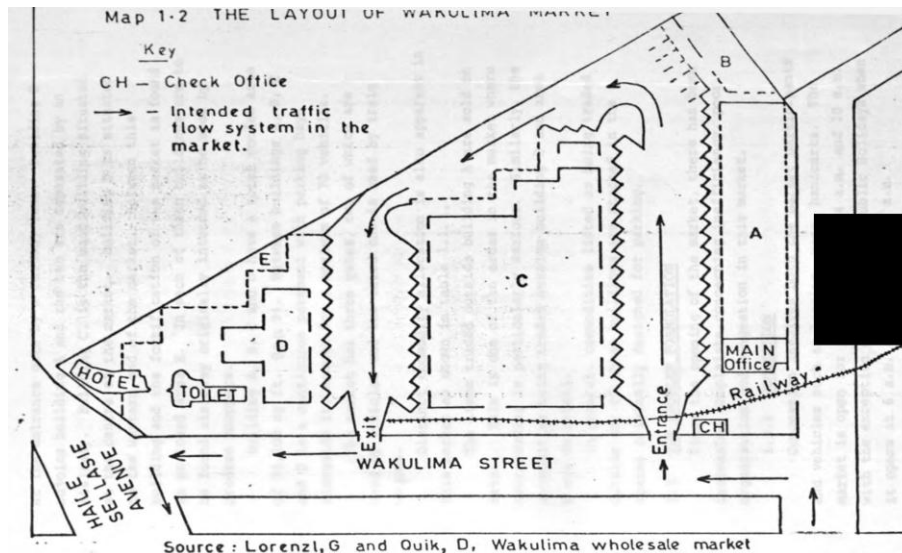
Figure 2.6 Layout of Wakulima Market

3.3 Produce sold in the market

The market has two gates one along Haile Selassie avenue while the other in on Muthurwa Market road. The market operates between 6 a.m. and 12 noon. The vendors in the market operate both on open air and under the shelter. More than 50% of Nairobi residents get their fresh produce from Wakulima market. Some of the fresh produce sold at the market include: Maize, peas, fresh potatoes, fruits, vegetables, garlic. Bananas, cassava, spices, groundnuts, rice beans and other cereals

3.4 Demographic Characteristics

According to the Nairobi City County statistics (2016), Wakulima market has a population of about 5000 traders. This is a huge increase from the 300 traders who were there when the market was built in 1966 (NCC, 2002). The growth in the number of traders has resulted from various factors. One is due to rapid urbanization, which has resulted in too many people moving to urban areas in search of jobs and business opportunities. Another factor is the location of the market, which is very attractive to many traders due to the large number of customers visiting the market on a daily basis (NCC, 2016).

3.5 Ownership of the Market

Wakulima market is solely owned by the Nairobi City County. The City Council was the one that constructed the market and they are mandated with the duty of waste management, collecting revenue from the market and offering waste collection services.

3.6 Research Design

The research design employed in this study is the descriptive one which refers to a systematic and empirical investigation where the researcher has no or little control of independent variables due to their inherent nature, thus non-manipulated (Mugenda and Mugenda, 2003). Systematic investigation is an activity that involves a prospective plan that incorporates data collection, either quantitative or qualitative, and data analysis to answer a question while empirical research is research that is based on observation and measurement of phenomena, as directly experienced by the researcher.

Methodology

3.7 Data Sources

3.7.1 Secondary data

Secondary data was obtained from newspapers, books, journals, as well as from the internet. Data was also collected from the city county offices.

3.7.2 Primary data

Primary data was collected directly from the field. Collection of primary data was done through conducting field investigation, face to face interviews and the use of questionnaires.

3.7.3 Field Observations

Preliminary field observations were conducted in the market.

3.8 Target Population.

The target population for the purpose of this research was traders at Wakulima market and the city county officials who were in the department of solid waste. Wakulima market has approximately five thousand traders (CCN, 2016).

3.9 Sampling Design

Data was collected using systematic random sampling where every 5th trader was interviewed. Simple random sampling technique was used for questionnaire distribution. Prior to data collection, the reconnaissance study was conducted a few days prior to the day of data collection. It involved walking around the market identifying key features that would be useful in the overall data collection process.

Sample Size

The sample size of the area where the study was conducted was arrived at by use of proportional allocation through the formula of (Kothari, 2011). The number of traders in the market was used as a determinant to the sample size

Formula for Calculating a Sample size

Cochran formula was used

$$m = \frac{M}{\frac{1+M(e)^2}{2}}$$

M=Population

m = Sample size

e = the desired level of precision (margin of error) (The margin of error is taken to be 10% for economical expediency purposes).

$$m = \frac{5000}{1+5000(0.1)^2}$$

m = 95

m= sample size of 95

Procedure for sampling

The sampling design used in the study was cluster sampling where traders were categorized based on the products that they sold. Data was collected from 35 traders who sold fruits, 30 who sold vegetables, 20 who sold dry crops and rice and 10 who sold other products such as packaging bags. Simple random sampling was used during data collection.

3.10 Data Collection Tools

Questionnaire survey

In administering the questionnaire for the purpose of capturing the primary data, two approaches were used: self-administered and the drop and pick approaches. In this research the self-administered approach was used. The informants were purposely selected for their ability to inform the study objectives. The questionnaires were issued by the researcher with the help of one research assistant. Prior to issuing a questionnaire to the respondent, a brief introduction was done. The introduction included the name of the researcher and the purpose of the research. The questionnaire were issued to traders between 12 noon and 1 p.m. when the traders were not too busy.

3.10 Field Observations

Field observations were made at all times when doing the field visits. Notes which summarized the observation were recorded in a notebook directly after field observations were made. The information included; time and place of the field observation, a summary of what was observed as well as the category of the observation. Observations included generation of waste, disposal and treatment, feature of the waste, waste collectors and other informal workers. These categories were helpful in highlighting the main items that needed to be observed during the field walks.

3.11 Data Analysis

Data obtained through questionnaires was processed through editing, coding and entering it into SPSS for analysis. Data was analyzed using descriptive statistics such as frequencies, mean and standard deviation and displayed using tables and figures. Inferential statistics used included regression and correlation analysis. Results were presented by use of charts, graphs and tables.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter is focused on the presentation of waste management at Wakulima market.

4.2 Trader Characteristics in Wakulima Market

Out of the 100 traders who were interviewed 39% were male while 61% were female. There were varied age differences among the respondents as follows: those aged 20-29 were (27%) according to respondents, 30-39 (41%) 40-49 (22%) 50-59 (9%) and lastly above 60years (1%) (Figure 4.1)
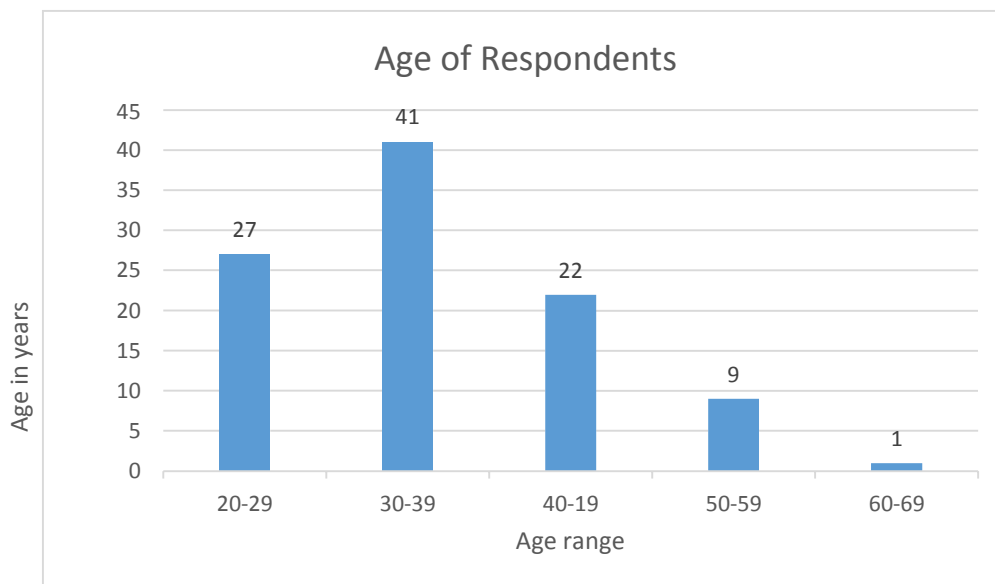
Figure 4.1: Age of respondents

4.2.1 Products sold in the market

Among the products sold in the market, fruits were the most common type of products sold in the market accounting for 43%. Vegetables followed closely at 41%. Other products sold in the market included: plastic bags at 9%, sacks at 6% and clothes at 1% (Table 4.1).

Table 4.1: Type of produce sold in the market

Type of Produce	Percentage (%)
Clothes	1
Fruits	43
Plastic Bags	9
Sacks/ Gunny bags	6
Vegetables	41
Total	100

This showed that many traders used plastic bags to package food items from the market. This further revealed why many plastic bags were seen scattered in and out of the market. Sacks were at 6% while clothes came in last at 1%. The study showed a significant positive correlation between the product sold and the type of waste produced (r=0. 119, P=0.238 and r=0.262, P=0.126). This implied that products that were mostly sold in the market produced the highest amounts of waste. The set level of significance was p=0.05. Plate 4.1 below shows traders selling different products at Wakulima market.

Plate 4.1: Traders selling different types of produce in the market

Source: Author's fieldwork (2018)

4.2.2 Factors contributing to sale of various products

Traders provided various reasons as to why they decided to choose the specific produce that they were selling. Most traders sold produce that they obtained from their farms (Table 4.2). The traders who obtained the produce from their farms carried produce in sacks and baskets to the market, which were later reused. On the other hand, traders chose the produce to sell based on the availability of the produce for example most traders would sell oranges if they are the ones in season. Other factors that led traders to choose their various produce included ease of sale of products and also selling products that require little capital to purchase.

Table 4.2: Factors contributing to sale of various products

Factors	Percent (%)
Easily Available	26
Easy to sell	16
Get from farm	35
Profitable	21
Requires little capital to start	2
Total	100

4.2.3 Source of produce

According to 45% of respondents, traders in the market obtained produce from suppliers (Figure 4.2). Most of the traders interviewed stated that it was cheaper to buy produce from suppliers and this enabled them to get more profits from their businesses. While 31% got produce from their farms.
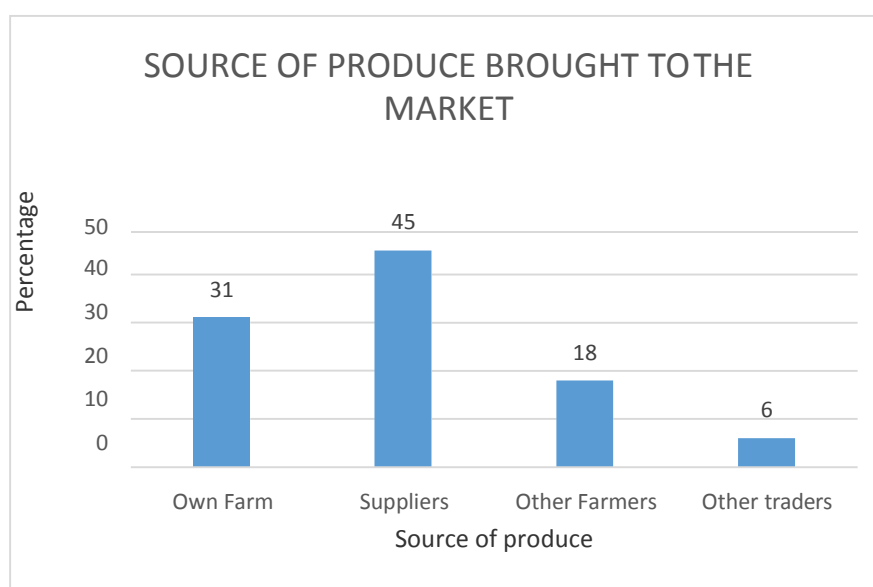
Figure 4.2: Source of produce

The traders who obtained produce from their farms were mostly farmers from the outskirts of Nairobi. They had their farms in places such as Kinangop, Gatundu, Kiambu and Muranga. From the traders interviewed, 18% of the traders bought produce from other farmers while 6% bought produce from other traders. The study revealed that there was non-significant positive correlation between the source of produce and quantity of waste produced (r=0.100, p=0.495and r=0.189, p=.203). This implied that the source of produce did not affect the quantity of waste produced in the market.

4.2.4 Packaging Material

Some of the traders in the market provided their customers with packaging materials. From the traders interviewed, 51% stated that they provided their customers with packaging material while 49% did not provide their customers with any form of packaging material. As shown in Figure 4.3 below, the most common type of packaging material provided to customers was plastic bags at 65%.
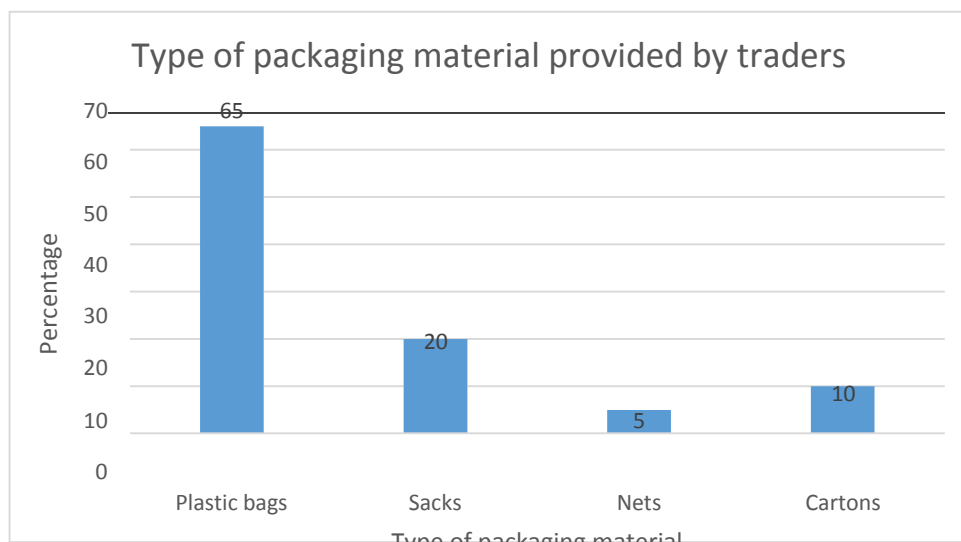
Figure 4.3: Types of packaging materials

The use of plastic bags contributed to the problem of waste pilling in the market as the plastics are inorganic and most people discarded them in the market, by the roadside or even in drainage systems. Sacks were the second most type of packaging material used at 20%. Sacks did not contribute too much waste in the market as most traders reused them over and over to carry goods to the market. Nets came a distant third at 5%. Nets were mostly used to package goods such as onions and fruits. Nets contributed to the problem of waste in the market as they are made of plastic material that is non-biodegradable. The least used type of packaging material were cartons at 10%. Cartons were mostly used to package goods such as apples and grapes. Cartons did not contribute too much waste in the market as they are biodegradable. Traders who did not provide their customers with any packaging materials were 49.4%. The use of plastic bags as packaging material contributed to waste in the market as plastic bags as they were commonly used and do not decompose. Plate 4.2 below shows some of the packaging material used to package products in the market.

Plate 4.2: Produce packaged in sacks

Source: Author's fieldwork (2018)

4.2.5 Proposed Plastic ban

The government of Kenya in collaboration with the Ministry of Environment and NEMA has come up with a proposed ban on all plastic bags (NEMA, 2017). This is in an effort to minimize the amount of inorganic waste produced in the country. Of all the traders interviewed in the market 66% were aware of the proposed plastic bags ban by the government while 34% of the traders were not aware of the plastic bag ban. The traders who stated that the proposed plastic ban would affect their businesses were 59%. They stated that they were not aware of alternative packaging material which they would provide for their customers. They also stated that the ban would reduce the number of customers since most customers do not usually carry their own packaging bags. The traders who stated that plastic bag ban would not affect their businesses were 41% of the people interviewed. Their reason was that they did not provide packaging material to their customers anyway. Most of the traders who did not provide packaging, material to their customers were mostly wholesale traders while those who provided packaging material sold their produce in retail.

4.2.6 State of produce brought to the market

Traders who brought already ripe fruits to the market were 47% compared to 27% who brought moderately ripe produce to the market and 16% who brought unripe produce to the market (Table 4.3).

Table 4.3: State of produce brought to the market

State of Produce	Percent
Moderately ripe	27.3
Ripe	47.5
Unripe	16.2
Total	100

Bringing ripe produce was a major contributor of organic waste into the market since produce took very few days before it went bad. This was evident in the market as piles of fruits such as mangoes, melons and avocadoes could be seen scattered in the market. Traders who dealt with tomatoes stated that their suppliers would package very ripe tomatoes at the bottom of the packaging boxes and pack the unripe ones on top of the box and sell to unsuspecting customers. Most of the very ripe tomatoes had a shelf life of only one day and so most of it often went bad especially on days when there were few customers in the market. There was positive correlation between state of produce brought to the market and the quantity of waste produced (r= 0.546, p=0.005 and r=0.349, p=0.005). The traders who brought produce that was already ripe to the market had more of their produce going bad compared to those who brought produce that was unripe.

4.2.7 Method of sale of produce

Selling goods in retail led to production of a lot of waste as most traders would provide each of their customers with packaging material. The traders who sold their produce in wholesale used sacks and nets as packaging materials. This helped reduce the amounts of waste in the market as shown in table 4.4.

Table 4.4: Method of sale of produce

Method of Sale	Percent
Retail	39
Wholesale	19
Both	45
Total	100

4.2.8 Storage of unsold goods

Information on the storage of produce that is left unsold is important as it will help determine whether poor storage of produce is a contributing factor to waste into the market, Table 4.5.

Table 4.5: Method of storage of unsold goods

Method of storage	Frequency	Percentage
Boxes	28	88
Left in the open	69	69
Shelves and Sacks	3	3
Total	100	100

From the study, 69% of produce that is left unsold in the market is left in the open. This method of storage of produce is not appropriate as it makes the produce vulnerable to pests and other climatic conditions such as heat and thus produce ends up going bad. Other methods of storage of unsold goods were boxes and sacks at 28% while shelves were at 3%.

4.3 Refrigeration in the market

When asked about refrigeration in the market, 55% of traders indicated that refrigeration would be important in the market while 45% indicated that they did not think that refrigeration would be important. Some of the reasons given by those supporting refrigeration was that it would help to keep produce fresh for long and this would help them sell their produce for more days thus reaping maximum profits from their produce. The traders who were against refrigeration indicted adopting this method of food storage would increase their cost of running their business as refrigerators were expensive and they would have to regularly pay power.

4.2.9 Components of waste at Wakulima Market

The product with the highest amount of waste was Fruit waste at 34%, followed closely

by vegetable waste 33% then plastic bags 24% and finally sacks at 9 % (Figure 4.4).
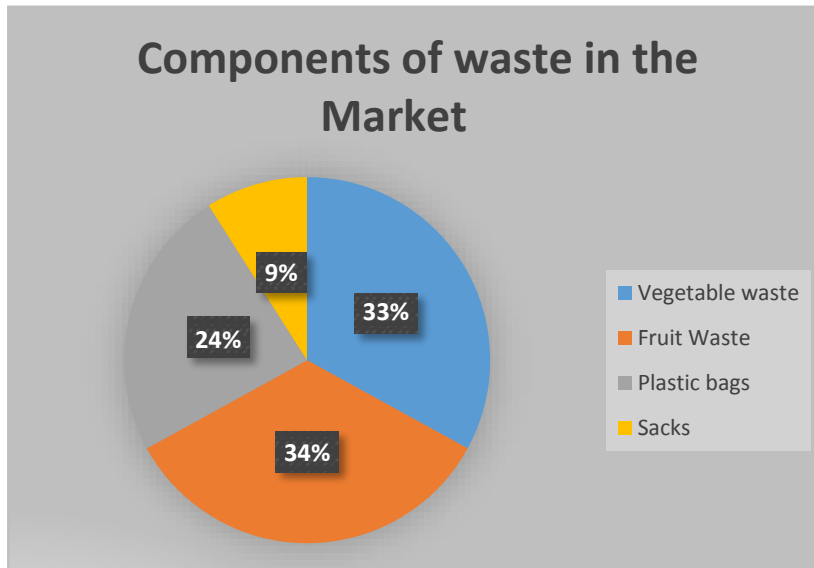
Figure 4.4: Components of Waste

Organic waste accounted for the largest percentage of waste from the market. This

explains why a lot of stale fruit and vegetables were seen scattered in the market. Sacks

accounted for the least waste from the market as many traders reused their sacks or sold

them to other traders. Sacks were also reused over and over again. Plate 4.3 shows the

components of waste at Wakulima market.

Plate 4.3: Components of waste at the market

Source: Author's fieldwork (2018)

As shown in plate 4.3, there was indiscriminate dumping of waste in the market. There was no separation of the various components of waste. This made proper waste handling increasingly difficult

4.2.10 Produce going bad

From the traders that were interviewed, it was evident that a certain percentage of the produce they bring to the market goes bad. Of all the traders interviewed 77% indicated that some of the produce they brought to the market went bad while 23% stated that their produce did not go bad. Various reasons were given as to what contributes to produce going bad. Some of the reasons included bringing goods to the market when they are already ripe. This reduced the life span of the goods and after one day some of the produce already starts going bad. Another factor that contributed to produce going bad was poor storage of goods in the market. When fresh produce is not properly stored it is affected by weather conditions and this led to the produce going bad.

Rodents were also highlighted as another factor that contributed to waste in the market. There were so many rats in the market and they fed on the produce that is left unsold in the market. The rodents not only led to produce going bad but also posed a danger to human health as they are disease vectors. Unpredictable market trends also led to the problem of waste in the market. This was so as traders are not able to approximate the number of customers that they expect and thus they oversupply goods to the market. The extra produce is left unsold for several days and it ends up as waste.
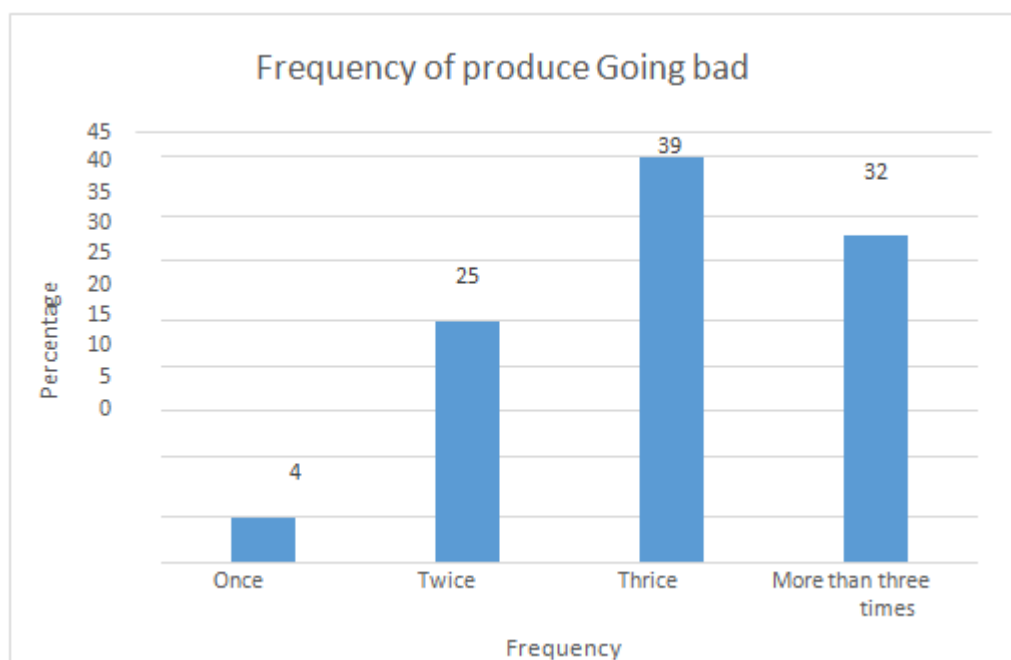
Figure 4.5: Frequency of produce going bad

As shown in figure 4.5 above, from the traders who were interviewed, 4% stated that their produce went bad at least once every month, 25% stated that their produce went bad at least twice every month, 39% stated that their produce went bad at least three times in a month while 32% stated that their produce went bad at least for times in a month.

4.2.10.1 Methods of vegetable waste disposal

The most common place for waste disposal was in market corners at 29%. This could be as a result of lack of enough bins and skips in the market where traders can place their waste. The next most common place for waste disposal is by the roadside at 25% followed by leaving waste in the market at 24%. Only a few traders put their waste in bins and skips at 22%. (Table 4.6 and plate 4.4).

Table 4.6 Methods of vegetable waste disposal

Methods of vegetable waste disposal	Percentage
Heaped at a corner	29
Left by the roadside	25
Left in the market	24
Put in skips	22
Total	100

Plate 4.4: Skips used in waste storage

Source: Author's fieldwork (2018)

4.2.11 Methods of Storage of Fruit Waste

Table 4.7 Method of Storage of Fruit Waste

Method of fruit waste disposal	Percentage
Heaped at a corner	27
Left by the roadside	28
Left in the market	22
Put in skips	23
Total	100

From table 4.7 above, 28% of the respondents indicated that they left fruit waste by the roadside, 27% indicated that they heaped the fruit waste at a corner, 23% put fruit waste in skips while 22% of the traders left the fruit waste in the market. Plate 4.5 below shows fruits left by the roadside

Plate 4.5: Fruit waste disposed in the market

Source: Author's fieldwork (2018)

4.2.12 Methods of disposal of plastic bags Plastic Waste Disposal

As shown in table 4.8, 33% of the respondents indicated that they heaped plastic waste at a corner, 25% indicated that they left their plastic waste by the roadside.23% left the plastic waste in the market while only 19% put their waste in skips.

Table 4.8: Methods of disposal of plastic bags

Methods of plastic waste disposal	Percent
Heaped at a corner	33
Left by the roadside	25
Left in the market	23
Put in skips	19
Total	100

Plate 4.6: Disposal of plastic waste in the market

Source: Author's fieldwork (2018)

4.2.12.1 Methods of disposal of sack waste

Sacks contribute to the least amount of waste from the market as most of the traders reused them. The sacks that were too old for reuse were the ones that were often discarded. Table 4.9 shows the various methods of disposal of sack waste.

Table 4.9: Disposal of sack waste

Methods of sack waste disposal	Percent
Heaped at a corner	23
Left by the roadside	31
Left in the market	27
Put in skips	19
Total	100

Of the traders interviewed, 31% of them indicated that they left their sack waste by the roadside, 27% left sack waste in the market, and 23% of the respondents heaped the waste at a corner while only 19% put their waste in skips (Table 4.9).

Plate 4.7: Disposal of sacks in the market

Source: Author's fieldwork (2018)

4.3 Factors contributing to waste increase in the market

Factors that led to an increase of fruit and vegetable waste in the market included, Oversupply of fruits to the market, poor storage of fruits that are left unsold, poor transportation of the fruits, rodents that feed on the fruits and lack of customers. Factors that led to an increase in plastic bag waste were that most buyers did not want to carry their own storage bags and hence traders have to package the goods in plastic bags. The traders also indicated that compared to sacks and nets of plastic bags were cheap and that why they opted for the cheaper option.

4.4 Product with the highest increase in waste

Factors that led to increase of waste were that most traders brought their produce to the market when they were already ripe and therefore they had a shorter shelf life. Some of the products brought to the market got spoilt during transportation. This was as a result of breakdown of trucks bringing produce to the market thus they take more days to get to the market. The trucks used for transporting fruits to the market were also not well designed and lacked refrigeration facilities. The product waste which had increased the most in the last ten years was fruits 65%. Vegetables were second at 22% while plastic bags were third at 13% (Fig 4.6).

Figure 4.6: Product with the highest Waste increase

4.5 Product which had reduced waste

It was evident that the product waste which had reduced the most in the last ten years was sacks at 81%. Plastic were second at 12% while fruits and vegetables were third and fourth at 5% and 2% respectively (Fig 4.7).

Figure 4.7: Produce with reduced amounts of waste

Factors that led to a reduction of sack waste was that most traders reused their sacks and when they could no longer reuse the sacks they sold them to other traders who use the sacks to make tents and baskets. A reduction in waste from plastic bags had been contributed by the campaigns by the government and NEMA on the ban of plastic bags and hence some traders were already looking for alternative ways of carrying their produce.

4.6 Waste management system

Among the traders interviewed, 65% of them stated that there was a waste management system in the market while 35% of them stated that there was no waste management system. The ones who stated that they were aware of a waste management system stated that it was implemented in 2010 and the Nairobi county government was the institution mandated with the responsibility of waste management from the market. They stated that the city council sweeps and collects waste from the market. To ensure effective waste collection, the market is usually closed from 12 p.m. The traders stated that despite there being a waste management system, waste was not effectively collected from the market and this led to pilling of waste in the market. The traders stated that before 2010 there was no waste management system in the market. This contributed to pilling of waste in the market as no one was concerned with collecting the waste. The market was very filthy and acted as a breeding ground for rats and other rodents.

4.6.3 Availability of dustbins and skips

Lack of this essential facility led to littering of waste by the roadside, in open spaces and other undesignated areas. The ratio of skips to traders is 1:800. This low number of skips has also made it impossible to separate waste as there aren't enough skips where different types of waste can be put. The ratio of bins to traders is 1:100. This was a very

low number in comparison to the number of traders in the market. The bins and skips were not properly labelled and this also leads to failure by traders and buyers to separate waste. Plate 4.8 shows some of the skips at Wakulima market.

Plate 4.8: Skips at Wakulima market

Source: Author's fieldwork (2018)

4.6.4 Payment for waste collection

Most of the traders interviewed indicated that they paid for waste collection. Each trader was supposed to pay Ksh.40 which was collected by city council officials. Of all the traders interviewed only 70% stated that paid the waste collection fee. The traders proposed that the city county should use the money collected to employ more people in waste management, buy more bins and skips and invest in waste collection trucks. The traders also proposed that the city council should ensure that everyone including hawkers should pay for waste collection and those who fail to pay should not be allowed to sell in the market.

4.6.5 Disposal of vegetable waste

Vegetables accounted for the second highest type of waste in the market. Products that produced this type of waste included: spinach, kales, carrots, maize peelings and all root tubers such as potatoes and yams. The method used by the traders for disposal of vegetable waste included: Putting in skips at 46%, feeding to animals 32%, composting 14% and incineration 6% (Fig 4.8).
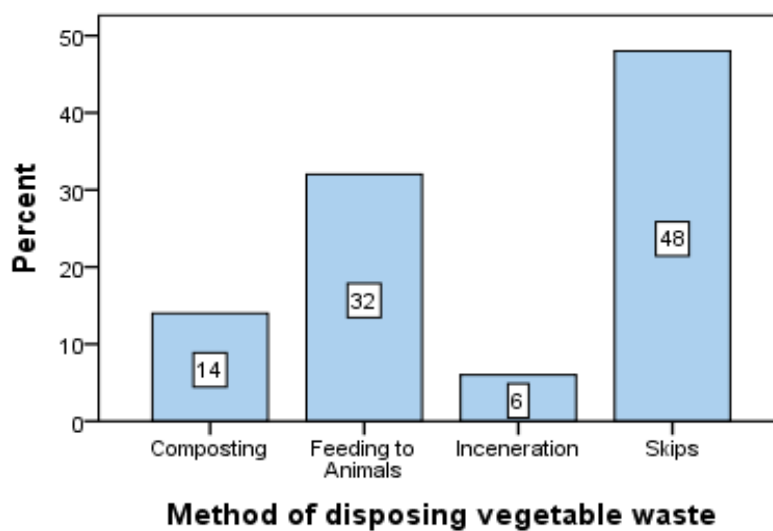
Figure 4.8: Methods of vegetable waste disposal

4.8: Methods of vegetable waste disposal

4.8.1 Disposal of fruits waste

Fruit waste was the most common type of waste at Wakulima market. The types of fruits at Wakulima market included mangoes, water melons, avocadoes, oranges, pineapples and apples.
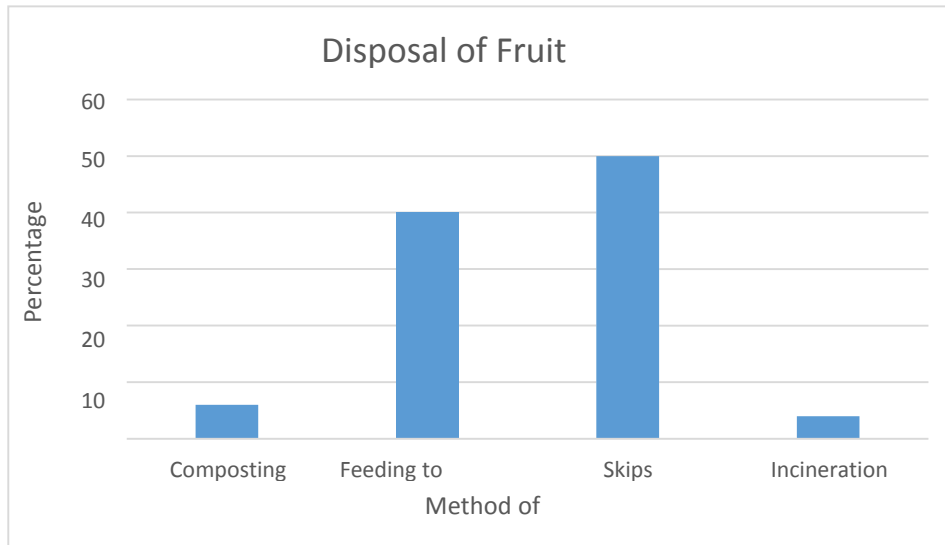
Figure 4.9: Methods of disposal of fruit waste

Of all the traders interviewed, 50 % indicated that they disposed their fruit waste in skips, 45% of them indicated that they feed their waste to animals while only 5% used the fruit waste to make compost manure (Fig 4.9).

4.8.2 Waste Separation

Waste separation is important as it makes it easy to use the waste produced for various purposes. Plastic papers can be recycled while organic waste can be used to make compost. Of the trader's interviewed, 82% said that they did not separate waste. Lack of enough bins and skips was stated as the main reason why the traders did not separate their waste. Only 18% stated that they separated their waste by placing different types of waste in separate bins

4.8.3 Collection of solid waste

The main method of waste collection from the market is through the use of trucks and wheelbarrows as shown in table 4.10. The waste is then transported to Dandora dumpsite. Most of respondents interviewed mentioned that the trucks used for waste collection were inadequate.

Table 4.10: Mode of waste collection

Mode of waste collection	Percentage
Carts/Trucks	2
Carts/Wheelbarrows	1
Carts/Wheelbarrows/Trucks	10
Trucks	58
Wheelbarrows	1
Wheelbarrows/Trucks	28
Total	100

The few trucks available were hardly maintained and they often broke down and thus waste would remain uncollected for weeks. The traders suggested the involvement of the private sector in waste collection from the market as they would complement the Nairobi City County.

4.8.4 Regularity of waste collection

Of the traders interviewed, 92% of them stated that waste collection was done weekly. This meant that heaps of waste remained uncollected in the market for a long time leading to obnoxious smells which lead to air pollution in the market. Most people interviewed advocated for daily collection of waste from the market. This would help alleviate the problem of overflowing of waste in skips and also help eliminate rodents from the market as they would have no place to hide.

4.8.5 Final Disposal of waste

Waste from Wakulima market is carried to Dandora dumpsite for final disposal. The Dandora dumpsite is in a bad state as it lacks essential components that a proper landfill should have such as a system for leachate collection, proper weigh bridges and location away from human settlements. Additionally, waste brought to the landfill is not separated. Waste brought to the dumpsite is not leveled as required for sanitary landfills

and this leads to large heaps of waste. Burning of waste also takes place at the Dandora landfill. Waste separation before transportation to Dandora dumpsite would help reduce the volume and toxicity of waste. Segregation would also help get useful products from the waste that can be reused and generally reduce the quantity of waste finding its way to Dandora dumpsite.

4.8.6 Cost of Waste management

Each trader from the market gives Ksh.40 to the City council for waste collection. This money is mostly used to pay the people involved in collection of waste. From the survey, no action is taken to the people who fail to pay for waste collection since most of them are hawkers. This has been a challenge especially in waste management since the hawkers produce the largest quantity of waste. In addition to the revenue collected from the traders for waste collection, the City Council also get money from the county government for waste collection.

4.9 Discussions

According to Harvey et al., (2002), waste generation is defined as the point at which materials are considered as having no value to the owner and hence they need to be discarded. However, things that are of no value to one person may be of value to another (Iboro, 2007). From the study findings, results indicated that the most common type of waste at Wakulima market was organic waste as a result of food items that were the main commodity sold in the market. The second most common type of waste was plastic bags which were the main type of packaging material used in the market. Sacks and cartons were third and fourth respectively.

The type of produce sold in the market was a big indicator to the type of waste produced in the market. Packaging materials provided to the customers also contributed to waste in the market. Most traders provided their customers with plastic bags followed by sacks, nets and cartons. The solid wastes produced at Wakulima Market were similar to market wastes generated in other parts of the world. Links (2006) indicates the type of solid wastes from municipalities in America as paper, food, plastics metals, glass and wood which, compares well or contrast with Wakulima market.

Practices adopted to deal with waste at Wakulima market included putting waste in bins and skips, open dumping, incineration, feeding to animals, landfill site and composting waste. There were very few bins and skips in the market in comparison to the number of people in the market. This explains why waste was being dumped by the roadside and in other undesignated areas in the market. From the analysis it was evident that waste disposal in Wakulima market was similar to that -in Ado-Akiti in Nigeria by Momoh and Oladebeye, (2010), whereby waste was also dumped in drainage systems, by the roadside and in other undesignated areas. The waste disposal method would be determined by the type and nature of waste collected in the market. Adeyemi and Adeyamo (2006) studied waste management practices at the Bodija abattoir, Nigeria and found that the main waste disposal practice at Bodija abattoir was dumping. In addition, other management options included control of waste generation, separation of waste, waste collection, storage practices and transportation of waste in the most appropriate way.

Amdt (2001) stated that solid waste ought to be kept in containers made of firm and rigid material that have a well-fitting lid or a structure that is well ventilated with a door that allowed for easy accessibility. The door also helped to prevent spillage of solid and

liquid waste. The solid waste structure ought to be well secured to hold waste until the local authorities came to pick the waste. This was a big mismatch with the types of bins that had been installed by the city council at the Wakulima market for waste storage. The study revealed that waste from the market was often collected once or twice in a month. Keeping solid waste for long had the potential to cause harm to the people in the market. As per Harvey (2002), organic waste provided a breeding site for insects and other animals that could potentially spread diseases to people in the market.

For a solid waste management system to be termed as successful it must conclusively cover waste collection, treatment and disposal. The county government of Nairobi has been given the responsibility of providing solid waste management services to the traders at Wakulima market. The city of Nairobi has experienced tremendous population growth from around 300,000 people in 1960 to 4,000,000 people in 2016 (Kenya Bureau of Statistics 2017) and thus dumping sites have been moved further away from the city. This challenge has necessitated employment of more workers and deployment of garbage trucks. This has however not been the case as there are very few trucks for waste collection in the city. The few trucks available are also not well maintained hence they often breakdown and this leads to a lot of delays in waste collection resulting to waste pilling in the market. Generally, there was lack of a proper waste management plan for the market due to several factors which included; Inadequate capacity in terms of both personnel and technical expertise to deal with the problem of waste management, lack of incorporation of market vendors in the process of waste management and inadequate finances for the establishment and running of a proper waste management system.

Cointreau, (2005) indicates that waste collection is a significant expense for cities in developing countries. It often amounts to about 20% to 50% of revenue collected by the county government. In Nairobi city this is hardly the case as only a small portion of revenue collected is used for waste management the traders at Wakulima market paid for waste collection services as required by the county government. Despite this the traders at the market indicated that the city county did very little to ensure that waste was effectively handled in the market. Most traders preferred the services that were offered by the private waste collectors.

Harvey, (2002) classified safe waste disposal as the final stage of waste management process that would often be associated with minimization of risk. He gives several options for safe solid waste disposal which include land filling, burning or incineration, composting and recycling. The final disposal site of waste collected from Wakulima was the Dandora dumpsite which is a landfill site that is used for waste disposal by most Nairobi residents. The dumpsite was not in good shape.

According to Anamanyo, (2004), a standard sanitary landfill ought to have the following: a weigh bridge, an internal access, a treatment plant, gas recovery area, leachate collection system and it should be located far away from human settlement. The landfill at Dandora dumpsite did not have these essential features. Some of the facilities mentioned above such as a weigh bridge were present but most other facilities were not functional. In addition, the sanitary landfill lacked an internal access and the site was too close to human settlements. The dumpsite was also almost filled to capacity and this left a mountain of waste which was not appealing to look at. Burning of waste was done at the site which caused a lot of air pollution especially to people who lived near the site.

According to Bull, (2006), the waste hierarchy is now universally accepted as the guideline for making solid waste management systems internationally. The hierarchy encourages the notion that prevention is better that cure. From the findings at Wakulima market, it was evident that the traders were not aware of this fact. The respondents stated that they reused some of their products especially packaging materials such as sacks. However, they were not aware of ways which would help them reduce waste from the point of generation. The County government of Nairobi can borrow a leaf from The United States Environmental Protection Agency which created a guideline to help shopping areas improve their waste management practices and identify ways in which they would reduce waste generation.

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.0 Summary of findings

Insufficient bins and skips was a major factor affecting proper waste disposal. From the survey, almost 80% of the traders lacked access to bins and skips and this led to disposal of waste by the roadside, in open spaces and leaving waste in the market. The lack of enough bins and skips also affected waste segregation greatly as traders had no place to put different categories of waste hence recycling of waste from the market was close to impossible.

There was no regular system of waste collection from the market. Waste was mostly collected weekly but in some instances it remained uncollected for up to a month. This led to people dumping waste by the roadside and in other undesignated places as the few skips and bins available was already full. Clean up of own spaces by individual traders helped to solve the problem of waste collection to some extent of skips and bins to put their waste the problem of waste collection was only half solved.

The Dandora dumpsite does not meet the requirements of a standard sanitary landfill. It is more of an open dumpsite. People live so close to the landfill and this greatly compromises their health. The landfill also lacks leachate collection system and proper functioning weigh bridges hence the waste brought to the landfill cannot be properly accounted for. Waste is hardly separated before it gets to the landfill and thus useful components which would otherwise have been reused are buried or burnt in the landfill (UN-Habitat).

5.2   Conclusion

The first objective was to identify the different categories of solid wastes from the market. It can be concluded that the most common type of waste at Wakulima market was organic waste from fruits and vegetables followed by plastic bags and containers and finally sacks and cartons.

The second objective was to assess the factors hindering effective solid waste management at the Wakulima market. It can be concluded that lack of enough bins and skips, lack of enough waste collection equipment as well as lack of knowledge on proper waste management were the main hindrances to effective solid waste management at the market.

The third objective was to analyse the current solid waste management system at the Wakulima market. It can be also be concluded that that the Wakulima market lacks a proper waste management system and that is why waste was scattered all over the market. More options for composting of organic waste should be considered in the market. More bins and skips should also be installed in the market and waste should be collected on a regular basis.

5.3   Recommendations

5.3.1 Solid waste management education and information Project

From the study finding it was noted that most traders lacked knowledge on proper handling of waste from the market. An educational project on appropriate waste management should be launched in the market. This would help to enlighten traders on appropriate waste management practices, and also to increase their participation towards achieving a cleaner healthier market. The project should be aimed at: promoting solid waste reductions well as encouraging reusing and recycling behaviour.

Purchasing of additional bins and skips should be the number one priority for the City council of Nairobi as this would help solve other problems such as illegal dumping as well as encourage waste segregation. At least 400 traders for one skip and 30 traders for one bin should be adequate. The skips and bins should be placed within 10 Meters radius so that each trader can easily access them. When providing the equipment, the Council should consider the following:

(1) The types of container to be used

- A small container with a capacity of around 30 – 40 litters can be placed at each stall which is suitable for small quantities of solid waste.

- Waste should be stored separately in three types of bins, which will separately store solid waste of each type. Green garbage bins should be used to store organic waste, yellow garbage bins should be used to stored saleable waste and blue garbage bins should be used to stored general waste.

(2) The container location

- Blue and green waste bins should be located at each stall. The yellow bins could be located near every block.

- The waste bins should be labelled appropriately so as to aid the traders place waste in the right bins.

5.3.2 Solid waste management education and information with improvement of solid waste management equipment

The purpose is to minimize solid waste from the market through source reduction, then through reuse and recycling to further cut down the quantity of waste being transported to landfills. In this context, it should include both educating the traders and providing them with appropriate solid waste management equipment

REFERENCES

Adeyemi, P and Adeyamo, O. (2006) Waste management practices at the Bodija abattoir, Nigeria *'International Journal of Environmental Studies,* 64:1, 71 – 82

Allison M. (2010) Material efficiency: A white paper. *Resources, Conservation and Recycling*, *55*(3), 362-381. Elsevier B.V. doi: 10.1016/j.resconrec.2010.11.002

Amdt, C. (2007). *Organic Waste Recycling: Technology and Management.* 3rd ed. London: IWA Publishing. 9-16.

Arora, L and Agarwal, s. (2011) Knowledge, Attitude and Practices regarding Waste Management in Selected Hostel Students of University of Rajasthan, Jaipur, I*nternational Journal of Chemical, Environmental and Pharmaceutical Research* Vol. 2, No.1, 40-43

Bammeke, A. O. and Sridhar, M. K. C. (1989), Market wastes in Ibadan, Nigeria, Waste Management and Research, 7, 115-120.

Bell et al. (2010), *Strengthening markets for recyclables: A worldwide perspective*

Cointreau S.(2005), Private Sector Participation in Developing Countries ; http://go.worldbank.org/A5TFX56L50; 2009 The World Bank Group

Cointreau, S.J (1975), *Environmental Management of Urban Solid Waste in Developing Countries Indicators Programme:* Monitoring the City Volume 2 Urban Indicators Review: The survey Instrument, Final worksheet February 1995. A joint Programme of UN-centre for UNCHS Human Settlements and the World Bank**, and Cheremis in off, P. N. (1995).** *Hazardous materials and waste management:* Nairobi Kenya

El-Haggar, S. M. (2007), *Sustainable industrial design and waste management:*

Ezeah H. (2010), *Sustainable waste management: Cradle-to- cradle for sustainable development* (p. 424). Oxford: Elsevier/Academic Press. *Cradle for sustainable development* (p. 424). Oxford: Elsevier/Academic Press.

Gakungu P.M (2010), The benefits and costs of alternative solid waste management policies.*Resources, Conservation and Recycling*, *13*(3-4), 183-213. doi:

10.1016/0921- 3449(94)00021-V.

Harvey P., Baghri S., and Reed B. (2002), *Emergency Sanitation: Assessment and Programme Design.* Water Engineering and Development Centre. Loughborough University UK

Iboro, N., (2007), The Situation of Solid Waste in Ghana. Accra, Ghana

Ikiara, M. M., Karanja, A. M. and Davies, T. C. (2004), "*Collection, Transportation and Disposal of Urban Solid Waste in Nairobi*", JICA.

Japan International Cooperation Agency (JICA), (1998), *Solid Waste Management in Nairobi (1997); The study on Solid Waste Management in Nairobi City in the Republic of Kenya.* Japanese International Cooperation Agency (JICA); CTI Engineering Co. Ltd, Environmental Technology Consultants Co. Ltd. Nairobi City County, Ministry of Local Authority, and the Government of Kenya; Final Report August 1998 Nairobi

Japan International Cooperation Agency (JICA), (2007), *The study of Solid Waste Management in Nairobi City in the Republic of Kenya,* Interim Report, CTI Engineering Co. LTD Environmental Technology Consultants Co; LTD. Nairobi City County, Ministry of Local Government, The Republic of Kenya (1997)

Kibwage (2009), *Solid Waste Management and its Environmental Impact in Kenya.* In: Solid Waste management:

Kothari, C. (2004), Research *Methodology: Methods and Techniques*, 2nd edition. New age International Publishers, New Delhi, India

Kreith, F. (1994), Handbook of Solid Waste Management. McGraw Hill, USA.

Kumah, A.M. (2007), The Situation of Solid Waste in Ghana. Accra, Ghana.

Links J. M. PHD; 2006 Lecture Program for the Short Course on Integrated Solid Waste Management (John Hopkins University)

Momoh, J.J. and Oladebeye, D.H. (2010), Assessment of Awareness of Attitude and

Willingness of People to Participate in Household Solid Waste Recycling Programme in Ado-Eketi, Nigeria, in the Journal of *Applied Sciences in Environmental Sanitation*.Jakarta, Indonesia.

Mshelia A.D. (2015), Solid waste management: An urban environmental sanitation problem in Nigeria, Sky Journal of Soil Science and Environmental Management.

Muniafu M.J and Otiato, D.M 2010, Solid Waste in Ghana. Accra, Ghana

Nairobi City County (NCC), (2010), *Solid Waste Management in Nairobi:* A Situation Analysis Technical Document ac- companying the Integrated Solid Waste Management Plan.

Nairobi City County, (2002) *A survey on medical waste in Nairobi.* Final Report 2002 **Department of Environment**

National Environment Management Authority (N.E.M.A) (2005), *Ban Plastics?* NEMA News Nairobi; NEMA

National Environment Management Authority (N.E.M.A) (2005), Characteristics of Urban Settlements in Kenya; NEMA News Nairobi

Ngera, J. K. (2014), Challenges and opportunities of Inorganic solid waste re use and recycling in Thika Town, Kiambu County. Unpublished Master's Thesis KU.

Omotara, B. A. (1985), Epidemiology in the market place. Postgraduate Doctor and m dash; Africa, August,247-252.

Oyake-Ombis. L., (2016), *Innovations on plastic waste management in Kenya and role of universities*, Prentice-Hall, Upper Saddle River, New Jersey.

Sandra Cointreau- Levine and Maggie Thurgood; (1994), *Decision Makers' Guide to Solid Waste Landfills.* The World Bank Urban Management Programme: Private Sector Participation in Municipal Solid Waste services in Developing Countries Volume 1 The formal sector Published for the Urban Management programme by the World Bank, Washington DC 1994

Senkoro, H. (2003), *Solid Waste Management in Africa*: A WHO / AFRO Perspective. Paper 1, presented in Dar es Salaam at the CWG Workshop, March 2003.Available:http://www.skat.ch/sf-web/activities/ws/cwg/pdf/cwg-01.Pdf [Date accessed 14th Sept, 2010].

Syagga, P. (1992), *Problems of Solid Waste Management in Urban Residential Areas in Kenya* Proceedings of Africa Research Network for Urban Management (ARNUM) Workshop: Urban Management in Kenya, Joyce Malombe (ed.). University of Nairobi. August 20th, 1992.

Tamale Metropolitan Assembly (2007), Medium-Term Development Plan (2006-2009) under the Growth and Poverty Reduction Strategy. Tamale, Northern Region.

Tchobanoglous, G., Theisen, H. and Eliason, R. (1977), Solid Wastes: Engineering Principles and Management issues. McGraw-Hill Publishing Company, USA.

Tchobanoglous, G., Theisen, H. and Vigil, S. (1993), Integrated Solid Waste: Engineering principles and management issues. McGraw-Hill Publishing company, USA.

Technical University of Denmark: Centre for Developing Countries. Yhdego, M. and Majura, P. (1988), Malaria control in Tanzania. Environmental International, 14,

Troschinetz and Mihelcic.(2009), Research Methods *http://www.socialresearchmethods.net/kb/sampling.php*

Tsiboe, I.A. and Marbell, E. (2004), A Look at Urban Waste Disposal Problems in Accra. Roskilde University, Denmark

UN-Habitat (2007); Housing in Informal Settlements; http://www.unhabitat.org/

UN-Habitat (2010); Housing in Informal Settlements; http://www.unhabitat.org/

United Nations Environment Programme (UNEP) (2005), *Selection Design and Implementation of Economic Instruments in the Kenyan Solid Waste Management.* Sector (Online) Available http;//www.org/PDF Kenya Waste Management Sector/ appendix.pdf (2005, May 10th)

United Nations Environment Programme (UNEP) (2008), Waste Management *http://www.unep.org/sport_env/Documents/BeijingReport07/chapter9.pdf*

United Nations Population Fund (UNFPA) (2001); Management of Municipal Solid Waste http://www.epa.gov/epaoswer/non- hw/muncpl/reduce.htm..

United States Environmental Protection Agency (USEPA) (1999). "State and Local Solutions to Solid Waste Management Problems". (http://www.epa.gov). Accessed on 18th July,2013 USPS (2000). "Solid Waste Management Plan for Thimphu City", Bhutan, Draft version, April 2000. Bhutan: Urban Sector Programme Support Secretariat

United States. Environmental Protection Agency (EPA), and International Council of Shopping Centers (ICSC), A Guide to Waste Reduction at Shopping Centers; America 's Marketplace Recycles

Yhdego, M. (1987), Composting of organic refuse. Case study: Kariakoo market and Ardhi Institute. Research report. Dar es Salaam.

Yhdego, M. (1988), Urban solid waste management in Tanzania. Waste Management and Research,6, 175-180.

Yhdego, M. (1990), Environmental epidemiology in squatter settlements in Tanzania.

Zerbock, O. (2003). Urban Solid Waste Management, *Waste Reduction in Developing Countries*. Available http://www.cee.mtu.educ/peacecorps/documents-uly03.wastereduction FINAL. pdf. [Accessed 14th Sept, 2010]

APPENDICES

Appendix I: Market Waste Management Questionnaire

Questionnaire Number………………

Date of survey:_____/ ___/ 2017

Section A: Trader Characteristics

Name		
Market		
Business Type		
Age	20-30	
	30-40	
	40-50	
	50-60	
	60-70 70 and above	
Gender	Male	
	Female	
Number of people per business		
Where from		

B. BUSINESS CHARACTERISTICS /PRODUCT CATEGORY

1. When did you start this business?

………………………………………………………………………….

2. Do you run the business alone or as a group?

Alone ☐

As a group ☐

3. What products do you deal with?

Vegetables ☐

Fruits ☐

Plastic bags ☐

Sacks ☐

Others specify…………………………………………………………..…………

4. Why did you choose to sell this products?

………………………………………………………………………..………………

5. How long have you dealt with this product?

…………………………………………………………………………………………

6. Since you started operation here have you dealt with other products?

Yes ☐   No ☐

If yes, which ones ……………………………………………………………………

7. Where do you get your produce from?

Own farm ☐

Buying from other farmers ☐

From Suppliers ☐

Other traders ☐

8. If from farm, where is your farm located?

………………………………………………………………………………….…………….

9. What do you grow on your farm?

………………………………………………………………………………….…………….

10. Who delivers the produce to the market?

Self ☐

Others ☐

If other, specify…………………………………………………………….……

11. How often do you bring goods to the market?

Product	Quantity Brought into the market(Kgs)		Quantity Sold (Kgs)	
Vegetables	Daily		Daily	
	Weekly		Weekly	
	Monthly		Monthly	
Fruits	Daily		Daily	
	Weekly		Weekly	
	Monthly		Monthly	

Potatoes	Daily		Daily	
	Weekly		Weekly	
	Monthly		Monthly	
Others (Specify)				

12. How do you package your goods before bringing them to the market?

In sacks (gunny bags) ☐

Plastic bags ☐

Cartons ☐

Others ☐

13. Do you provide packaging material for customers?

Yes, ☐   No ☐

If yes, which kind of packaging, material do you provide your customers with?

……………………………………………………………………………..

14. Are you aware of the proposed plastic packaging policy?

Yes ☐   No ☐

15. How is the proposed plastic packaging policy likely to affect your business?

Yes ☐   N0 ☐

If yes, how?

....

What is usually the status of the produce that you bring to the market?

Ripe ☐   Unripe ☐   Moderately ripe ☐

Other…………………………………………..…………………………………

…

16. How many other traders in this market sell products that are similar to yours?

1-4 ☐

5-9 ☐

10-19 ☐

20-29 ☐

30-40 ☐

If other, specify…………………………………………………………………

17. How do you sell your goods on a daily basis?

Retail ☐   Wholesale ☐   Both ☐

If both specify how many kilograms you sell in retail and how many in wholesale

……………………………………………………………….……………………..

18. How do you store the produce that is left unsold in a day?

In refrigerators ☐

Left in the ☐

open Boxes ☐

Shelves ☐

Other, specify……………………………………………………..……………

19. Is refrigeration important in the market?

Yes ☐   No ☐

20. In your opinion, would refrigerators help reduce the amount of foodstuffs that go to waste from the market?

Yes [ ]   No [ ]

Please explain your answer …………………………………………………

Section C: Different Categories of wastes produced from the market

21. Which types of wastes are generated from the market?

Vegetable wastes [ ]   Food Wastes [ ]   Plastic [ ] Bags

Others, specify…………………………………….………..………………..…

…………………………………………………………………...……………….

22. Between organic (food) and inorganic, which contribute more waste in the market?

Organic [ ]   In-organic [ ]

23. Which are the most common types of waste in the market?

Plastic bags   [ ]

Stale   fruits   and   [ ]

vegetables Fruit and   [ ]

vegetable peelings

Others, please specify………………………………………………….

Indicate approximately how many Kgs in a week.

…………………………………………………………………..…..…………….

…………………………………………………………………………….……

…………………………………………………………………………….……

Which products generate the least amount of waste per week? Indicate approximately how many Kgs in a week**?**

…………………………………………………………………………………

……………………………………………………………….……………….

…………………………………………………………………………………

Do some of your produce go to bad and have to be thrown away?

Yes ☐   No ☐

If yes, which products often go to waste, please list them.

   …………………………………………..………………………………..

……………………………………………………………..…………………

24. How often does this happen per month?

   Once ☐   Twice ☐   Thrice ☐

Other, please specify……………………………………………….………

25. Why do products end up going to waste?

   ……………………………………………………………………..

……………………………………………………………………………..

……………………………………………………………………..……

26. Which products waste have increased in the last 10 years?

   Plastic bags ☐   Vegetables ☐   Fruits ☐   Sacks ☐

Other, please specify…………………………………………………………

……………………………………………………………………………..

27. What has led to an increase in waste from this products, please explain

……………………………………………………………………….…

………………………………………………………………………….

28. Which products waste have reduced in the last 10 years?

Plastic bags [ ]   Fruits [ ]

Vegetables [ ]   Sacks [ ]

Other,

specify………………………………………………………………….

………………………………………………………………,…………………….

29. What has led to a reduction in waste from this products, please

explain……………………………………………………………………

……………………………………………………………………………

30. Are packaging materials responsible for generating waste?

Yes [ ]   No [ ]

31. If yes, please explain which ones and how they contribute to generation of

waste

………………………………………………………………………………

………………………………………………………………………………

……………………………………………………….………………………

32. How are waste products from the market stored?

Waste	Method of storing waste	Amount per day (KGS)	Reason for choosing the method of storage
Vegetables	Heaped at a corner		
	Put in skips		
	Put in bins		
	Left by the roadside		
	Left in the market		
Fruits	Heaped at a corner		
	Put in skips		
	Put in bins		
	Left by the roadside		
	Left in the market		
Plastics	Heaped at a corner		
	Put in skips		
	Put in bins		
	Left by the roadside		
	Left in the market		
Sacks	Heaped at a corner		
	Put in skips		
	Put in bins		
	Left by the roadside		
	Left in the market		

Section D: Waste Management

33. Is there a waste management system in this market?

Yes ☐   No ☐

If YES, please describe it

…………………………………………………………………………………………………

……………………………………………………………………………..………......

If NO, why is there no system?

………………………………………………………………………………………………

………………………………………………………………………………..............

34.   When did the waste management system start?

....

……………………………………………………………….....................................

35. How has the waste management system been since 1970s, 80s, 90s, 2000s, and 2010s?

……………………………………………………………………..………………

………………………………………………………………………………………

36.   Who   is   responsible   for   waste   management   in   the   market?

……………………………………………………………………..………………

……………………………………………………………….…………………

37. Do you individual traders pay for the waste management?

Yes   ☐   No   ☐

38.. If YES, how much……………………………………………………………

39.Are there people who fail to pay? Yes   ☐   No   ☐

40. If yes, what happens to the waste generated by the people who fail to pay?

……………………………………………………………………………………

…………………………………………………………………………..…………

…………………………………………………………………………………………

41. How is waste handled before being removed from the market?

Product	Method of handling waste		Reason for Choosing the method of waste handing
Vegetables	Recycling		
	Composting		
	Incineration		
	Feeding to animals		
	Reusing		
Fruits	Recycling		
	Composting		
	Incineration		
	Feeding to animals		
	Reusing		
Fruits	Recycling		
	Composting		
	Incineration		
	Feeding to animals		
	Reusing		

42. Do you separate your waste before disposing it off?

Yes ☐   No ☐

43. If yes, please indicate which waste you separate and how you do it

……………………………………………………………………………

If no, please state why……………………………………………………………

44. What happens to the waste after it is has been gathered from the market?

Removed by the city
council ☐

Removed by private waste handlers ☐

Burnt ☐

Left there ☐

Do not know ☐

If other, please specify ………………………………………………….

45. Do you retain any packaging material so that you can use it another time?

Yes, ☐   No ☐

If yes which ones? ....

D. Availability of Resources for Managing waste

46. Is there adequate equipment for handling waste?

Equipment	Capacity(Kgs)	Number Available per trader	Ideal Number needed	Who provides
Dust bins				
Skips				
Brooms				
Wheelbarrows				
Council Trucks				
Private trucks				

47. Are the bins and skips properly labelled (For organic and non-organic waste)?

Yes, ☐   No ☐

48. Are the Skips adequate?

Yes ☐   No ☐

If the skips are not adequate, what happens to the extra waste that cannot be held in the skip?

……………………………………………………………………………………

Are the bins adequate?

Yes, ☐   No ☐

If the bins are not adequate, what happens to waste generated from the market?

……………………………………………………………………………………

49. When the bin is filled, who empties it to the skip?

Trader   ☐

Market cleaners   ☐

Others, Specify   ☐

50. How frequently are the skips emptied?

Daily   ☐

Weekly   ☐

Monthly   ☐

51. Are bins and skips properly maintained?

Yes   **No**   ☐

If yes, how ……………………………………………………………………….

52. Are wheelbarrows, brooms and trucks adequate?

Yes ☐   No ☐

53. Which waste management institution is responsible for collecting waste from the market?

(If more than one mention all)

1……………………………………………………………………..

2……………………………………………………………………..

3…………………………………………………………………….

4………………………………………………………………………

54. How many times is waste collected from the skips and the market at large?

Daily   ☐

Weekly   ☐

Monthly   ☐

Other, Specify…………………………………………………….

55. What is the mode of collection (If more than one, indicate all)?

Carts   ☐

Wheelbarrows   ☐

Trucks   ☐

Other, Specify…………………………………………………….

56. In your view, what are some of the factors affecting effective waste management at Wakulima market? (List at most four)

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

E. Options for improvement in waste management

1. What has worked in waste management in the market?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

2. Why has it worked?

…………………………………………………………………………………………..

…………………………………………………………………………………………

…………………………………………………………………………………………..

…………………………………………………………………………………………

3. What has failed to work and remains a challenge?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

4. Why do you think this has been the case?

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

.

5.What challenges would be attributed to 1. Traders

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

Suppliers

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

Customers

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

Waste collectors

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

In your opinion, what could be done to improve waste management at Wakulima

market?

…………………………………………………………………………………

…………………………………………………………………………………

…………………………………………………………………………………

What would be the role of the following stakeholders in with regards to waste

management

Stakeholder	Role
Traders	
Suppliers	

Customers	
County Government	
National Government	

6. In your views how many times should waste be collected from the market?

Daily ☐   Weekly ☐   Monthly ☐

7. In your views who should have the responsibility for

collecting waste from the market?

Private ☐

collectors ☐

City Council

Both ☐

Others………………………………………………

Provide reason for each

8. Are there enough personnel for managing solid waste at Wakulima market?

No ☐   Yes ☐

9. In your views what should be done to the waste once it has been

collected from the market?

Type of waste	Method of treatment

----------------------Thank you-------------------