Strategy for Solid Waste Management for the Municipal Council of Embu

By

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DECLARATION

Student's declaration

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

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Supervisor's declaration

This thesis has been submitted for examination with my approval as the university supervisor.

Signature…………………………………

Date…………………………………………

Name: Dr. Dulo S. Otieno

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DEDICATION

To my Parents, Margaret and Collins, who are,

My teachers, mentors, role models and above all,

Gifts from God

To my Dear wife Rhoda and son Collins,

To my siblings, Francis, Susan, Lydia and Sammy who are,

My best friends, my inspiration and

Blessings from God

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ABSTRACT

The purpose of this study was to evaluate the sustainability of solid waste management practices for the Municipal council of Embu and develop a solid waste management action plan for the local authority.

This research applied a framework on integrated sustainable waste management (ISWM) to select the solid waste management (SWM) actors, system elements, sustainability aspects, and indicators relevant at a local Authority level. These provide the basis of the fieldwork which seeks to explore the sustainability of adopted Local Authority based waste management interventions, within the Municipal Council of Embu (MCE). In-depth interviews, site visits and review of secondary data are used for data collection. Respondents included households, local authority staff and other relevant government officials from MCE.

Some of the key findings from field work reveal that there is no existence of important partnerships or networks forged by the MCE within Embu and its environs which are considered necessary to provide avenues to address certain issues pertinent to an ISWM system.

The residential solid waste generation rate was found to be 0.57 Kg/person/day, totaling to approximately 9,344 tonnes per year out of which only 15% is collected and transported to the dumpsite annually. On average the composition of residential waste in Embu constituted 52.5% organic/biodegradable waste, 10.4% paper, 15.8% plastics, 3.4% glass, 2.2% metal and 15.7% others. The results revealed that the socio-economic status of the people influenced the generation rates and even waste characteristics. MCE generates about 9,266 tonnes of non-domestic solid waste out of which only 64% is collected and transported to the dump site annually. The waste composition varied with the source of sampling and the type of generator.

The research goes further to propose some recommendations for consideration by a way of action plan. There is also the issue on the need to address an emerging grey area with regards to the SWM permit and license issued by NEMA and MCE respectively. Both legal documents are required by solid waste managers, but they address the same issue. In addition, a recommendation to establish a general but standard quantitative approach to measure in how far SWM systems are sustainable is proposed.

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ABBREVIATION AND ACRONYMS

CBD	-Central Business District
CBO	-Community Based Organization
CDF	-Constituency Development Fund
CIGs	-Community Initiative Groups
DEC	-District Environmental Committee
EEA	-European Environment Agency
EMCA	-Environmental Management and Coordination Act
ESAs	-External Support Agencies
EWASCO	-Embu Water and Sewerage Company.
GNP	-Gross National Product
ISWM	-Integrated Sustainable Waste Management
KNBS	-Kenya National Bureau of Statistics
Ksh	-Kenya Shillings
LAs	-Local Authorities
LASDAP	-Local Authority Service Delivery Action Plan
LATF	-Local Authority Transfer Fund
MCE	-Municipal Council of Embu
MoH	-Ministry Of Health
MoLG	-Ministry of Local Government
MSF	-Multi-stakeholders Forum
MSWM	-Municipal Solid Waste Management
NEMA	-National Environment Management Agency
NGOs	-Non Governmental Organizations
OECD	-Organization for Economic Co-operation and Development
PPP	-Private Public Partnership
RMS	-Resource Mobilisation strategy
SIDA	-Swedish International Development Cooperation Agency
SWM	-Solid Waste Management
SWOT	-Strengths, Weakness, Opportunities & Threats
UN HABITAT	-United Nations Centre for Human Settlements
UNDP	-United Nations Development Programme
UNEP	-United Nations Environment Programme
UNESCAP	-United Nations Economic and Social Commission for Asia and the Pacific
USAID	-United States Agency for International Development
USEPA	-United States Environmental Protection Agency
UWEP	-Urban Waste Expertise Programme
WHO	-World Health Organisation

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Local authorities are statutory, semi-autonomous institutions representative of the central government, and charged with the responsibility of development and provision of urban service such as water and sanitation and solid waste management, at the local level. They are categorized as Municipalities, Town, County or Urban Councils. Municipalities are established in large urban areas to provide a wide range of urban services (Bubba and Lamba, 1991).

Local authorities in Kenya have been riddled with challenges of adequate service provision. For instance, the increasing amount of solid waste generated within the urban areas is proving to be a management problem to the local authorities, resulting to indiscriminate dumping and open burning by residents (Karanja, 2005). Many factors contribute to the inability of service provision by the local authorities including interference by the central government, poor and inflexible resource base, lack of proper equipments, lack of qualified staff, poor intra relationships and policy failure due to poor implementation (Bubba and Lamba, 1991, Practical Action, 2004, Karanja, 2005).

From a historic perspective, Stren &White (1989) indicate economic stagnation, rapid urban population and the infamous structural adjustment programmes in the 1980s as a starting point of failure in urban services; the Government of Kenya echoes similar sentiments (Republic of Kenya, 2004). These programmes required African governments to reduce heavily on subsidized urban services such as Solid Waste Management (SWM). As an enduring consequence, African local authorities are not able to sustain adequate levels of urban services, because of strained facilities and under investment in new ones (Karanja, 2005, Peters, 1998, Republic of Kenya, 2004, The World Bank, 1994). Ironically, expenditure by local authorities on urban services has increased progressively with pressure of an increasing urban population, but these services have not kept up with population growth (Bubba and Lamba, 1991).

Solid waste is a major consequence of development and modernization, yet some of the greatest challenges to its management are felt mostly in the developing countries. This is part of the

larger paradox of development. Factors which create the most intransigent problems currently facing the developing countries are invariably those that derive from development itself. This irony is based on the gap between the patterns of growth and modernization in the developing world on the one hand, and the capacity to pay for, plan for and effectively manage solid waste as part of an integrated national system, on the other (Thomas, 1998).

Municipal solid waste management (MSWM) is one of the critical environmental challenges of rapid urban development facing the developing countries including Kenya. Solid waste arising from domestic, social and industrial activities is increasing in quantity and variety as a result of growing population, rising standards of living and development of technology (Suess 1985; UNEP, 1991; Dickerson 1999).

The need to manage this increasing waste in an environmentally effective, technologically feasible, economically affordable and socially acceptable manner is a problem faced by all nations of the world today. It is hard to reconcile the trade-offs between the four dimensions presented above, partly because some of them actually conflict and the problem is also linked to the paradox of the sustainability concept itself.

Waste management is also not glamorous; yet without it, every city would cease to exist (Zurbrugg, 2002). Hence all cities, the world over, have developed some way of dealing with the problem. The degree of success with which the developed and the developing countries, including Kenya, are coping with the problem is, however, very different. While the developed world has sought effective solutions through greater efforts to move up what is called the "solid waste hierarchy", the developing world countries are simply overwhelmed with the waste problem or can now barely grapple with its elementary stages (Beukering et al., 1999).

The solid waste hierarchy is an internationally accepted and recommended ranked priority of waste handling using the following ascending order of preference: open burning, dump, landfill, incinerate, recycle, reuse, and prevent (Beukering et al. 1999; Adams et al. 2000; Wright 2000; Hansen et al. 2002). The first two (open burning, and dump) are least preferred and actually not recommended even though the methods are highly used by many developing countries.

Increasingly local authorities of low and middle income countries acknowledge solid waste as an immediate and serious environmental health problem. However, local authorities are faced with

continued challenges in collecting the growing amount of waste generated by the rapidly expanding cities (Pfammatter and Schertenleib, 1996).

Domestic waste removal is one of the key factors in ensuring the health and safety of the population, but is often neglected in rapidly growing cities of the developing countries (Karanja, 2005, UNEP, 2007).

Improper waste disposal constitutes a source of water, land, and air pollution, posing risks to human health and environment (Karanja, 2005). Eventually, out of a need to safeguard own public health including employment opportunities and economic benefits, local community initiatives to manage solid waste are established (African Development Bank, 2002, Karanja, 2005, Peter, 1998). These initiatives serve as alternatives to the local authorities' elusive solid waste management services (Pfammatter and Schertenleib, 1996).

1.2 Problem statement

Solid waste management is considered important in the Municipal Council of Embu (MCE) because it is a visible and politically sensitive service. Inadequacies in the service have resulted in severe implications for the credibility of the Council. Solid waste management absorbs a considerable share of the council's budgets and is a major provider of public sector employment (Ministry of Local Government, 2008).

The management of solid waste in Embu town is primarily the responsibility of the Municipal Council. Areas within towns have access to these services, although they are neither efficient nor effective. Solid waste management in Embu is increasingly proving to be a challenge as collection and coverage rates are not directly proportional to the increasing amounts of solid waste generated (Municipal Council of Embu, 2010). Waste generators tend to dissociate from waste at the earliest opportunity even if that means indiscriminate dumping or open burning as means for waste disposal (Municipal council of Embu, 2010).

Proper management of solid waste is important for public health, environmental, economic and political reasons and therefore deserves increased attention from the council. Improper solid waste management can have negative effects on public health, the environment and natural resources. The focus of this study is therefore to develop a strategy for solid waste management and action plan for MCE.

1.3 Justification of the Study

MCE is facing a number of problems with regard to solid waste management. It lacks a comprehensive policy frame work for solid waste management and a shortage of tools to analyze and improve efficiency, effectiveness and sustainability (Ministry of Local Government, 2008).

In addition, the council lacks guidelines on issues such as private sector participation and waste minimization. The by-laws applied by the council are inadequate and are hardly enforced. Frequently quoted practical problem include inadequate, poorly maintained or obsolete equipment or spare parts; or equipment that is inappropriate for local conditions, all of which are exacerbated by the increases in population and household solid waste generation (Ministry of Local Government, 2008).

Other obstacles in solid waste management within the MCE are connected to non performing employees who are not motivated or difficult to find because of low status, low salaries and difficult working circumstances (Ministry of Local Government, 2008).

The preceding discussions show that municipal solid waste management by the Council is a crucial problem that needs urgent attention. This rationale justifies its study.

1.4 Objectives of the study

The broad objective of the study is to develop a strategy for solid waste management for the Municipal Council of Embu and develop a solid waste management action plan.

The specific objectives of the research are to:

1) Review the information of the existing solid waste management systems of the Municipal Council of Embu
2) Evaluate the sustainability of the existing solid waste management systems within the Municipal council of Embu
3) Develop an action plan for implementation of an effective solid waste management system and provide a baseline for all future plans for solid waste management for the Municipal council of Embu

1.4.1 Research questions

The aim of the research is to answer the following questions:

Research question 1(a): What are the existing domestic solid waste management systems within the Municipal Council of Embu?

Research question 1(b): Do the current methods applied work effectively?

Research question 2: How far are these domestic solid waste management systems technically, financially, socially, environmentally, institutionally sustainable?

Research question 3: What are the strategies for best managing the future domestic solid waste management services does the Municipal Council of Embu plan to adopt?

1.5 Scope of the research

This research sought to review, evaluate, explore, consolidate, and document, the sustainability of existing domestic waste management practices as adopted by the MCE, within Embu County and develop an action plan for the local authority.

With reference to the three major dimensions of Integrated Sustainable Waste Management (ISWM), this research focused on these key dimensions but limited to the following aspects:

a) **Stakeholders:** Focus was on the Local authority, NEMA and other Government agencies, NGOs, CBOs and service users (households) only.

b) **System elements:** These involved the collection, storage, transportation, processing, treatment, recycling, recovery, reuse and final disposal of waste

c) **Sustainability aspects:** These included technical, financial, social, environmental and institutional.

The concept of ISWM has been explored in detail in chapter 2 of this report.

1.6 Research hypothesis

Integrated solid waste management at a local Authority level can be improved through the sustainability principles by Klundert &Anschütz (2000) for solid waste systems in general.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Solid waste can be defined as superfluous refuse, no longer serving a purpose, left over after use, or, useless by-product of manufacturing or physiological process (Brown, 1991). Municipal solid waste (MSW) refers to the material discarded in the urban areas for which municipalities are usually held responsible for collection, transportation and final disposal.

Solid waste management (SWM) involves planning, forecasting, organization and execution of functions of collection, transfer, treatment, recycling, resource recovery and disposal of solid wastes (Tchobanoglous et al., 1977) and starts from generation and storage of the solid wastes at the various sources. The major driving forces behind waste generation are population, consumption, affluence and technology (UNESCAP, 2000).

This chapter will explore the concepts on solid waste management systems, trends changing the face of solid waste management, integrated sustainable waste management systems, and application of sustainability principles developed for assessing solid waste management interventions.

2.2 Municipal Solid Waste Management in the Developed World

Comparing regional or national municipal solid waste management (MSWM) statistics is difficult because of varying definitions, methods, units and times of data collection. However, broad trends can be traced. Municipal solid waste (MSW) generation in the developed parts of the world that are characterized by high incomes, affluent life style, high consumption, is constantly increasing. According to De Tilly (2004), broad trends in municipal waste generation in the Organization for Economic Co-operation and Development (OECD) member countries continue to rise in absolute and per capita terms.

Whereas increases in population and the level of incomes continue to account for such increases in municipal solid waste generation, European Environment Agency (2001, cited by Braathen, 2004) underlines new emerging factors. These factors are linked to consumption patterns, family

structures and lifestyle. The author suggests that single households produce more waste per capita than families. Ready-made food produces more packaging than individually family-prepared food but traditional preparation results in more organic kitchen waste. Furthermore, increase in incomes results in the use of long-lived goods and services, which later produce other types of waste such as bulky waste and waste from construction and demolition (Braathen, 2004).

The composition of MSW in countries of the developed world may differ but the tendency is for non-biodegradable waste to dominate over biodegradable (USEPA, 2003).

2.3 Municipal Solid Waste Management in Developing Countries

Solid waste management in the developing countries demonstrates daunting problems partly due to this negligence in international circles, but more as a result of the inability of the national and local responsible sectors to cope with the problem. The per capita waste generation rates are generally less than those in the developed nations but are equally increasing in amount and variety. There is great city, national and regional variation. The daily average per capita rate for Africa is 0.50-0.87 kg (UNEP, 2000a; ENCAPAFRICA, 2004). In Asia it varies widely between less industrialized and industrialized regions, for example, from an average of 0.1-0.6 kg in India [less industrialized] to 5.5 kg in Hong Kong [more industrialized] (Bureking et al. 1999). Latin America and the Caribbean have averages of 0.3-1.0 kg per capita per day (UNEP, 2000d.) The composition is mostly organic biodegradable waste 70-90% (Yhedego 1995, UNEPA2000a; UNEP-IETC, 1996).

Management faces many problems as waste management authorities have, in a majority of cases, experimented with almost every strategy and with high and modern waste management technology acquired from the developed countries, with very little success.

This failure has been linked to the acquisition and use of incorrect and ill-adapted technologies with heavy costs of maintenance, lack of expertise and inadequate funding and staff. Some authors believe that even more pertinent are corruption and the autocratic 'command-and-control' approach to waste management issues (Kironde et al., 1997). Non inclusive management that excludes other stakeholders has also been a crucial issue. Management is concentrated on collection and transportation of which only 20-80% is collected using 20-50% of the city's operational budgets; yet servicing less than 50% of the city population or areas (HABITAT,

1996; Hardoy et al., 2001). According to Johansson (1999) land filling remains the most prominent technique with open dumps being the common practice. There are also many illegal dumps created in empty spaces, lakes and ponds, drains, canals, street corners, riversides, estuaries and coasts. Littering is a common phenomenon. These uncollected solid wastes deface the aesthetics of the city and bring about serious environmental and health hazards. According to Kironde (1994 in Halla, 1999) this phenomenon caused some African cities in the mid 1980s to be dubbed 'Garbage Cities' and 'Cities of Mess' (Halla, 1999)

The municipal council, which is the statutory authority mandated to manage wastes in the urban centres, is duty bound to play a leading role in addressing these critical issues including the organization, coordination and cooperation with the other actors. These other waste stakeholders include the national government authorities, external support agencies (ESAs), non-governmental organizations (NGOs), common initiative groups (CIGs), community based organizations (CBOs), formal and informal private sectors, scavenger and scavengers' cooperatives, households and individuals. These groups and individuals are usually termed informal until they are recognized and have been registered (Ali et al., 1999).

These groups are involved in waste collection and removal, recycling, composting and waste recovery for reuse. They are also involved in street sweeping, clearing drains and repairing, transforming and reusing discarded articles supplying waste collection equipment. All these groups and individuals do play an important role in municipal solid waste management. However, it is only relatively recently that some urban authorities in the developing countries have recognized, and eventually integrated them into their solid waste management systems. Elsewhere each group operates parallel to the others. In cities where they have been recognized and integrated, the waste management situation has greatly improved as in the cases of the many scavengers' cooperatives in Latin America and Asia (Furedy, 1992; Pacheco, 1992; Medina, 2000; Hardoy et al. 2001).

In the developing countries, the stronger driving force for waste increases is the high rate of urban population growth. Other sources also confirm that by 2015, half the world's population will be living in cities, growing at an average rate of 2.4% per year consistent with doubling within 29 years with the greatest increase being in Asia followed by Africa (United Nations Population Division, 2002).

Nevertheless the situation of solid waste management in many towns and cities of the developing countries remains inadequate and inefficient. Schübeler (1996) describes the situation as highly unsatisfactory. This suggests that the conventional management system and the unorganized informal sector in place are not based on sustainable strategies and methods. Unless the structure and causes of this failure are discerned and pointedly addressed our cities may become veritable agents of danger and overall human degradation, through epidemics, and visual as well as ecological devastation (Omuta, 1987). Another important issue, which comes into question, is the limited applicability of the theoretical recommendations so far put forward to address this predicament.

2.4 Waste management in Kenya

Solid waste management services in urban areas is characterized by uncontrolled dumping leading to serious pollution problems, unregulated private sector participation, lack of solid waste management infrastructure (that include well managed transfer facilities, waste separation etc), and lack of waste policies and strong waste recycling and recovery industry (UNEP, 2006). The per capita waste generation within urban areas ranges between 0.29 and 0.66kg/day. JICA (1997) points out that on average 21% of the waste generated in urban centers emanates from industrial areas while 61% from residential areas, 6% from roads and the rest is not stated where it comes from. There are several illegal dumpsites emerging in urban areas along the roads, in residential backyards and commercial premises. (CCN 2007).

2.5 Trends in SWM

Changes taking place at the global level are seen to have implications at regional, national and local levels. For example global influences on urban services such as municipal solid waste management are seen in the management of the flow of materials within the various stages in a city and beyond. Selected key global trends influencing SWM according to (Lardinois and Furedy, 1999) include: decentralization and democratization, privatization, increased environmental awareness and change in consumption patterns.

2.6 Sources, Compositions and Generation of Solid Waste

Knowledge of the sources, types along with data on the composition and rate of generation is basic to the design and operation of the functional elements of solid waste management. (Tchobanoglous et al; 1977).

Sources of solid waste in a community are in general related to land use and zoning. These can be classified into residential, commercial, institutional, construction and demolition, municipal services, treatment plant sites, industrial and agricultural. In most cases, residential and commercial wastes make up about 50-70 % of total amount of MSW generated in a community (Tchobanoglous et al; 1993). Composition gives the individual components that make up a solid waste stream and their relative distributions. Information on composition of solid wastes is important in evaluating equipment needs, systems and management programs and plans. Waste quantities generated and collected are of critical importance in selecting specific equipment, designing of waste collection routes, materials recovery facilities and disposal facilities (Tchobanoglous et al; 1977).

Factors that influence the quantities and the composition of waste are the level of income, sources, population, social behaviour, climate, industrial production and the market for waste materials (Baldismo, 1988)

2.7 Determination of Composition of Municipal Solid Waste

Considerable variation seems to exist in the methods used to measure refuse composition. Due to the heterogeneous nature of solid wastes, determination of the composition is not an easy task. Some of the analytical methods available are manual classification and photogram metric technique (Vesilind et al., 1981, Tchobanoglous et al., 1993)

2.8 Measures and Methods Used to Quantify Solid Wastes

Both volume and weight are used for measurements of solid waste quantities. However, the use of volume as a measure of quantity can be misleading. If used, the measured volumes must be related to either the degree of compaction of the wastes or the specific weight of the waste under the conditions of storage. To avoid confusion, solid waste quantities should be expressed in terms of weight. This is because tonnages can be measured directly regardless of the degree of compaction (Tchobanoglous et al; 1993)

Waste quantities are usually estimated on the basis of data gathered by conducting a waste characterization study, using previous waste generation data or some combination of the two. Other methods commonly used to assess solid waste quantities are Load count, Weight-volume and Materials mass balance analysis

2.9 Towards Sustainable Solid Waste Management

Since the Earth Summit in Rio de Janeiro in 1992, sustainable development has been a constant topic of scientific and political debate (United Nations, 1996). The concept of sustainability highlights key links between different sectors, geographic scales, potential synergies and conflicts between different goals. At its core, the concept of sustainability is about reconciling development (use of resource and the generation of wastes) with environment (finite limits on the use of resources and the capacity to absorb or break down wastes or render them harmless) at local, regional and global scales (Hardoy et al., 2001). The concept of sustainability is more importantly expected to address the considerable uncertainty surrounding the reaction of natural systems, to increased resource use and waste generation. Sustainable solid waste management can be said to be in line with concepts of sustainability. It recognizes that natural resources used for the production of consumer goods and services are diminishing at a fast rate, and that rationalization of resource use is required (Huysman et al., 2004).

Sustainable solid waste management advocates for waste minimization, recovery, reuse, recycling and disposal of remaining waste in a controlled manner that ensures that absorption capacity of local sinks are not exceeded (Baud et al., 2001). It is in response to: inadequate sanitation and inefficiency of SWM service resulting to threats to environmental and public health; challenging large scale-scope that SWM service requires including labour, technical and financial resources; and to mitigate excessive resource use (Van de Klundert and Anschütz, 2000). In seeking for more sustainable solutions to manage solid waste in developing countries and those in transition, the concept of Integrated Sustainable Waste Management (ISWM) was developed. This concept was specifically developed out of experience from learning that transferring SWM approaches tailor made for industrialized countries, to developing and transition countries was unsustainable and bound to fail (Van de Klundert and Anschütz, 2001).

2.10 Integrated Sustainable Waste Management (ISWM)

ISWM differs from conventional approaches to waste management by promoting stakeholder participation, advocating for waste prevention and resource recovery. In addition, it encourages analysis of interactions with other urban systems, and promoting an integration of different habitat scales (Van de Klundert and Anschütz, 2000).

Integrated Sustainable Waste Management refers to a waste management system that bests suits the society, economy and environment in a given location. It not only takes into consideration the technical or financial/economic aspect characterizing the conventional SWM, but also recognizes the socio-cultural, environmental, institutional and political aspects that influence the overall sustainability of waste management. Time is also included as an important aspect for consideration in ISWM. These aspects are said to have a cross cutting dimension. Schübeler et al (1996) further points out the broad organizational implications and close link of solid waste management to other sectors, which are said to constitute an important entry point for integrated urban management support. The idea of including these aspects is increasingly proving to pay off in the long run in terms of greater sustainability of waste management systems. Past projects are reported to have failed due to over emphasis on technical aspects alone (Coad, 2000). These aspects have been developed further into a number of principles, which can serve as guidelines or goals to achieve an integrated sustainable waste management system (van de Klundert and Anschütz, 2000). However, it should be noted that the principles are not blueprints but should be tailor made to the local context.

In general, ISWM can be described as an approach that is based on three important dimensions of sustainability that require integration: stakeholders, waste system elements and sustainability aspects.

With regards to the three dimensions of ISWM, the focus of this research is as follows:

a) Actors: Local Authority (MCE) ,CBOs, NGOs ,NEMA and service users
b) Solid waste management system elements: waste prevention, waste separation,   resource recovery and primary collection. This component also includes integration with other urban systems.
c) Sustainability aspects: operational/technical, institutional/legal, financial/ economic, environmental/public health, social/cultural

This research will use the ISWM model as an analytical model to assess the sustainability of solid waste management systems that have been adopted by the Municipal Council of Embu, in its area of jurisdiction, within Embu County.

2.11 Actors, functions and inter-relations

Actors are recognized as an important dimension of integrated sustainable waste management (Schübeler et al., 1996, van de Klundert and Anschütz, 2000).The involvement of stakeholders in the planning and implementation processes of ISWM serve to increase public awareness and commitment. This makes it possible for the different actors to complement each other, including co-operation amongst themselves (Karanja, 2005). Involvement of key actors in solid waste management is based on the premise that no single actor can successfully solve urban waste problems, thus establishment of partnerships among all actors is important for the sustainability of the SWM system (Huysman et al., 2004, Taylor, 1999).

Important actors or stakeholders in solid waste management include central government, Local government/Municipal Council, Private informal sector, Private formal sector, Service users, NGOs, CBOs and Donor agencies/external support agencies. (Schübeler et al., 1996, van de Klundert and Anschütz, 2000):

With exclusion to central government and local authority/Municipal Council, the other listed actors are often referred to as non state SWM actors.

According to Schübeler et al. (1996) and Taylor (1999) service users have an interest in the quality of solid waste management. When dissatisfied with the service, there is a tendency to the service users for instance households to organize themselves into CBOs with a direct goal to provide solid waste management through source separation, recycling, collection and composting. NGOs can add credibility to the important role that CBOs plays in SWM in the eyes of the government and formal private sector. Karanja (2005) describes NGOs as intermediate organizations that can be involved in community based SWM projects at various levels such as: advocacy, creation of public awareness and decision making.

In conclusion, lessons can be drawn from Lardinois and Furedy (1999). The authors indicate that the role of NGOs as innovators and experts in setting up projects that serve as alternatives for conventional waste management systems is extremely important. The role of the local authority

in such projects is underscored as they have an overall responsibility for regulating, monitoring SWM systems. They also have a role to play in decision making and execution of such projects. CBO and NGO participation is also said to be crucial for public education and motivation.

2.12 Elements of Solid Waste Management Systems

Van de Klundert and Anschütz (2001) describe waste management system as a combination of several stages in the management of the flow of materials within a city and the region.

However, it's important to note that conventional waste management systems lack the element of resource recovery as this is generally not a spelt out function of the local authority (Lardinois and Furedy, 1999). Traditional or conventional systems focus on collection, transfer, disposal or treatment, which are elements that Integrated Sustainable Waste Management (ISWM) recognize and builds onto, in addition to promoting waste minimization or reduction, reuse and recycling (van de Klundert and Anschütz, 2001). There are varied management options, and these are determined by the type of solid waste, likely environmental impacts, scale of sources of waste requiring collection and treatment (Habitat, 1989, Karanja, 2005, Lardinois and Furedy, 1999).

The highest and preferable waste management action is waste minimization of the quantities of waste produced. It reduces environmental burden, in addition to having financial benefits (Beukering et al., 2005). Reuse and recycling is the next preferred option. The latter option advocates for recycling or composting much of the waste as deemed appropriate and feasible. Just like waste minimization, reuse and recycling help to mitigate the adverse environmental impacts arising from waste deposition. Recycling reduces air and water pollution, saves energy, and reduces use of raw materials for industrial processes among others (Beukering et al., 2005, Karanja, 2005).

Resource recovery, reuse, trade in waste, recycling, composting contribute to the sustainability of SWM through cleaner neighbourhoods, financial viability, reduction of waste required for collection, transportation and eventual disposal, extension of dumping fields life, including livelihood support (Baud et al., 2001). The latter action is more prominent in developing countries where waste recycling is motivated by social and economic needs, rather than environmental goals as compared to developed countries where the motivation is clearly environmentally oriented (Karanja, 2005). Huysman et al. (2004) confirm this statement by indicating that informal waste recovery and recycling a common practice in the developing

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countries, provides income to a large number of people, ranging from household, traders, enterprise owners and the urban poor. It is acknowledged that these informal activities provide protection to the environment.

2.13 Sustainability principles

In compiling sustainability principles, van de Klundert and Anschütz (2000) build onto earlier works of different waste experts such as Schübeler et al. (1996). These principles are one of the important dimensions of an ISWM framework, and are listed in table 2.1.

Table 2.1: Principles of integrated sustainable waste management

SUSTAINABILITY ASPECT	PRINCIPLES
1.Technical/ Operational	• Selection of technology based on the local availability of spare parts • Selection of technology that is locally manufactured, close to indigenous knowledge and practices • Selection of durable technology , of good quality with a long expected life time • Adapt systems to the physical environment, topography and other physical requirements of the location • Establish systems that are efficient • Ensure optimum utilization of equipments • Establish preventive maintenance procedures
2. Institutional/ Legal	• Build capacities of operators and managers • Base incentives, recruitment and promotion on merit and performance • Clearly divide responsibilities • Have in place representative, functional organizations • Provide mechanisms for accountability and complaints • Provide mechanisms to involve all stakeholders in planning and implementation • Make professionalism a leading principle in service provision • Encourage co-operation among other waste actors • Plan waste management in a strategic way • Support decentralization of tasks and authority • Create favourable conditions for stakeholder participation • Create rules and regulations that are transparent and unambiguous • Support the 'waste management hierarchy' giving preference to waste prevention, source prevention, reuse and recycling, above mere collection and disposal

SUSTAINABILITY ASPECT	PRINCIPLES
3. Financial/ Economic	• Analyze and plan ISWM financing at a system level • Base financial and economic decisions on full knowledge, complete information and transparency in decision making • Quantify system costs and benefits fully, and in consultation with stakeholders • Analyze the units of cost and revenue differently per waste element • Set fees fairly, transparently and in a consultative process Match the capital to labour ratio to the needs and characteristics of the community • Define productivity of capital and labour in relation to the local context
4.Environmental/ public health	• Minimize negative impact on soil, air and water • Minimize generation of waste by adapting 'clean technologies' etcetera • Maximize re-use and recycling, and avoid loss of raw materials including energy and nutrients • Disposal of remaining waste in a controlled manner, not to exceed the absorption capacity of local sinks • Treatment of waste for instance through composting, and recovery of resources as close to the source as possible
5.Social/ cultural	• Provide service to all • Service should be adapted to user demands and priorities • Users are able to participate in decision making • Minimization of risks to public health • Maximize employment generation • Uphold safe and healthy working conditions • Use of management models acceptable to the people involved

Source: van de Klundert &Anschütz (2000) with slight modifications for applicability at a local authority level.

2.14 Measuring sustainability of solid waste systems

To measure sustainability of domestic waste management systems, the ISWM principles listed above are translated into indicators and applied to analyze elements of a SWM system adopted by the local authority. Indicators presented (table 2.2) are developed with guidance from the sustainability principles presented above, an extensive research carried out by WASTE (Anschütz, 1996), and secondary data collated and analyzed by other waste experts or institutions (e.g. Habitat, 1989, Taylor, 1999, van de Klundert &Lardinois, 1995). These studies provide a rich resource of various aspects of SWM activities, which are translated into indicators. These together form the basis for the fieldwork of this research.

Table 2.2: Indicators to measure sustainability of solid waste management systems

SUSTAINABILITY ASPECTS				
Operational/Technical	**Financial/Economic**	**Social/Cultural**	**Environmental/Public health**	**Institutional /Legal**
▪ Waste system able to remove all waste from the community neighborhood ▪ Waste management equipments designed according to local know-how ▪ Waste management equipments manufactured and can be maintained locally at a low cost ▪ Waste system operations are based on, and adapted to local user needs ▪ Waste system operations are based on physical characteristics of the serviced areas ▪ Waste activities are adequately linked to larger SWM system ▪ Waste system able to facilitate waste recovery, reuse and recycling ▪ Waste management services reliable	▪ The Waste system is able to sustain itself(cost recovery) e.g. through service charge ▪ Service users willingness to pay for the service (cash or in kind) ▪ Service users able to make timely payment of the service	▪ Workers handling waste provided with proper Working equipment and protective gear (working conditions). ▪ Workers are paid a regular salary (livelihood support) ▪ Waste service provided to all households in the community ▪ Activities / campaigns create awareness among service users on waste behaviour, waste reduction, reuse and recycling ▪ Capacity building for waste workers and MCE staff facilitated. ▪ Supervision of waste workers. ▪ Provision of incentives to waste workers to ensure efficiency and reliability.	▪ Waste system able to safely remove all waste from the community neighborhood ▪ Absence of air pollution (smells) ▪ Drainage clear of garbage ▪ Waste bins covered at household, street levels ▪ Waste bins emptied regularly (according to agreed schedule) ▪ Waste materials are recovered ▪ Practice of waste recovery, reuse and recycling by the MCE& its staff.	▪ Authorized by Government for involvement in SWM. ▪ Monitoring and evaluation of projects or activities including costs (operation & maintenance) ▪ MCE facilitates campaigns on waste education for community members ▪ MCE management team with clearly defined responsibilities ▪ MCE waste activities linked and synchronized to waste activities provided by other relevant actors(for instance synchronizing primary and secondary collection interfaces) ▪ Partnerships with other SWM actors promoted or established ▪ Community members participates in MCE matters

Source: author's construction based on Anschütz (1996), Habitat (1989), Schübeler et al. (1996), Taylor (1999), van de Klundert &Anschütz (2000), van de Klundert &Lardinois (1995).

2.15 Summary of literature review

Local authorities in developing countries increasingly face challenges in adequate provision of this service to her citizens for various reasons such as unanticipated increase in urban population, and lack of financial resources, and capacity among other reasons. As a result, communities establish initiatives whether formal or informal to manage waste, as waste production is unavoidable and its expeditious safe removal is important. It should be noted that the role of the local authority is required, especially in monitoring, coordinating these initiatives and providing incentives for actors in the private sector to be involved in SWM.

Integrated sustainable waste management provides a framework that is holistic in its approach, and would go a long way in ensuring SWM actors collectively establish feasible, sustainable and integrated tailor made waste management systems as a way of mitigating the inadequacies or gaps in the current system. In addition, the guiding principles developed by van de Klundert and Anschütz (2000) for each of the sustainability aspects, can be used to develop indicators to measure the sustainability of domestic waste management systems. However; studies need to be carried out to assess their effectiveness in the developing world such as selected towns of Kenya, since there is little evidence of research studies in Kenya

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This study was carried in July 2011. Various methodological procedures and techniques in data collection, processing and presentation were adopted. This chapter presents the methods used in data collection and analysis. The research design, location of the study, population, sampling procedure and sample size instrumentation, data collection and data analysis are discussed in detail.

3.2 Research Design

The research took a case study approach focusing on solid waste management systems by MCE. It was exploratory as it sought to find out the types of municipal solid waste management systems adopted by the council. The research used a framework developed by van Klundert &Anschütz (2000), to explore the different aspects of sustainability of identified waste management systems in the research area.

3.3 Research Area

The study was carried out within the MCE area of jurisdiction, Embu town and its environs; located approximately 120km northeast of Nairobi. It serves as the provincial headquarters of eastern province and also as the county headquarters of Embu County.

3.4 Population of the Study

Population is defined as the aggregate of all the elements (Shao, 1999). Embu municipality comprises of 4 wards with an estimated population density of 42,692 (KNBS, 2009). The subjects of the study were drawn from all the four wards. The respondents included local authority staff, households, waste workers, NEMA and other relevant government officials.

3.5 Sampling

Sampling is the process of selecting a number of individuals from a population such that the selected group contains elements representative of the characteristics found in the entire group

(Orodho and Kombo, 2002). The study sample was selected by use of purposive sampling technique.

3.5.1 Sample size determination

The study sample was determined using purposive sampling technique. Mugenda and Mugenda (1999) observe that the purpose of sampling is to secure a representative group, which will enable the researcher to gain information about entire population when faced with limitations of time and funds. The study uses a strategy adapted by Orodho and Kombo (2002), shown below for the computation of sample size of the respondents to be interviewed due to the big size of the target population.

The estimator of a proportion is $\hat{p} = X/n$ where X is the number of 'positive' observations. When the observations are independent, this estimator has a (scaled) binomial distribution (and is also the sample mean of data from a Bernoulli distribution). The maximum variance of this distribution is 0.25/n, which occurs when the true parameter is p = 0.5. In practice, since p is unknown, the maximum variance is often used to for sample size assessments.

For sufficiently large n, the distribution of $\hat{p}$ will be closely approximated by a normal distribution with the same mean and variance. Using this approximation, it can be shown that around 95% of this distribution's probability lies within 2 standard deviations of the mean. Because of this, an interval of the form $\left(\hat{p} - 2\sqrt{0.25/n}, \hat{p} + 2\sqrt{0.25/n}\right)$, Will form a 95% confidence interval for the true proportion. If this interval needs to be no more than W units wide, the equation $4\sqrt{0.25/n} = W$, Can be solved for n, yielding n = 4/W² = 1/B² where B is the error bound on the estimate, i.e., the estimate is usually given as within ± B. So, for B = 15% one requires n = 45,

The research therefore used a sample size of 45 respondents.

3.5.1.1 Household SWM Surveys

Multistage sampling method which uses a combination of sampling techniques was used for household surveys. The survey population was divided into clusters based on socio-economic status. The sampled clusters were those within the built up areas of the municipality and deliberately excluded the rural areas.

MCE has 4 major residential estates. A representative residential estate was selected based on its socio-economic status. Table 3.1 provides the distribution of the resultant sample size from the residential estates.

Table 3.1: Sampled Residential areas

SN	Sampled Residential Estates/Income Level	Frequencies
1	Blue Valley(High Income)	12
2	Dallas(Middle Income un planned	11
3	Majimbo(Middle Income planned)	11
4	Majengo(Low Income un planned)	11
	Total Sample	**45**

3.5.1.2 Non-residential Waste Survey

Major institutions (including hospitals, offices) within the town were surveyed to determine waste generation and management in such locations. Institutions and businesses were sampled using multistage sampling method. The various sectors were grouped together and samples taken for the various wards within the town.

3.6 Data Collection

Both primary and secondary data was collected in order to gain understanding of thecurrent quantities of solid wastes managed, The environmental considerations currently employed in ISWM, the financial and economic principles in solid waste management, socio-cultural principles of MCE, the existing organizational structure in solid waste management in Embu municipality, and the relevant policies and legislation and their requirements in ISWM.

To obtain the above information, the study targeted the municipal council staff, private waste collection companies , waste generators (householders, industries, hotels and restaurants, institutions, hospitals, etc), informal (street and dumpsite) waste pickers, waste dealers and some key informants. Surveys based on questionnaires and key informant interviews formed the foundation of data collection. Background information was collected through discussions with institutional staff and desk reviews of existing SWM data.

The following data collection instruments were used to acquire relevant data to the study;

3.6.1 Interviews

Key informant interviews were used to get information on certain aspects of livelihoods within the target population, which may not have been adequately obtained from a structured interview using questionnaires and to also address perception questions. The targeted sources of information were divided into the following categories:

Table 3.2Summary of key informants

S/No	Category	No. Of Respondents
1.	Street Waste Pickers	5
2.	Waste Dealers and Wholesalers	5
3.	MCE Staff i.e. Drivers, Supervisors and Refuse Collectors	9
4.	MCE Management Staff (Town Engineer; Cleansing Superintendent; Municipal Works Officer; Accountant	4

3.6.2 Standard Questionnaires

They had both open-ended and structured questions and were utilized at all levels of data collection. The questionnaires not only helped to maintain focus on the main topics of relevancy, but also allowed the interviewee to elaborate on points of interest. The use of structured questionnaires was aimed at obtaining comprehensive primary-data from the sample populations and other respondents. All scheduled questionnaires were self-administered to avoid misunderstanding of questions by the respondents.

3.6.3 Observation and photography

To understand fully the SWM practices and operations in the municipality, observations and photography were also used in the study. Observations and recording of activities and the events of daily life related to SWM were undertaken to understand the general lifestyle of actors involved in solid waste management, their living conditions, occupational hazards, modes of transportation of wastes and environmental issues surrounding SWM. Direct observations on SWM practices were a good way of cross-checking the respondents' answers .Photographs were also taken to represent some salient features relevant to the study. Photographs depicting actual activities and the existing constraints in SWM in MCE formed an important ingredient in the whole study. The relevant photographs have been pasted in various sections of the report.

3.6.4 Secondary Sources of Data

Secondary data was generated by making a critical review of relevant literature in various libraries, institutions/organizations like United Nations Environment Programme, World Health Organization, United Nations Development Programme, United Nations Centre for Human Settlements, Kenya National Bureau of Standards (KNBS), and the MCE Engineer's Department. Most of the current information was also downloaded from the Internet to supplement the above sources. The information gathered composed of both published and unpublished materials. Such materials included textbooks, journals, periodical reports, conference proceedings, dissertations and thesis.

3.7 Data Organisation, Analysis and Presentation

The data collected was organized and cleaned of errors made during data collection, coded, keyed into the computer and analysed using descriptive statistics with the aid of Microsoft Excel 2007 computer software. Qualitative statistical techniques were used during the analysis to describe and summarize data. The results of analysis have been presented and interpreted in the form of descriptive statistics. The findings have been presented in tables, percentages and graphs.

3.8 Reliability

To ensure that data collected during field work is reliable, more than one research tool was used. In-depth interviews of organizations involved in providing domestic waste management services were conducted including households that are provided with service. Local Authority staff, waste workers NEMA and other relevant government officials were also interviewed as a way of crosschecking the data collected from the organizations. Site visits and review of relevant secondary data for instance reports, were also conducted for additional information, and verification of response from interviews.

The interview questions were tested with supervisor and fellow colleagues for improvement and making appropriate changes before use in the field.

3.9 Validity

Validity of data collected has been facilitated through designing appropriate questions for the questionnaire and interviews. The questions were framed within the context of the developed

indicators, for each of the research questions. The questions were shared with the supervisor for review and comments, and appropriate adjustments or revisions made.

3.10 Limitations

Embu County, the focus of this study hasn't been extensively researched on. Current information on the Municipal council of Embu area of jurisdiction related to aspects such as socio-economic, environmental, population dynamics is scattered and not sufficient. Lack of updated records at the MCE was also a major challenge to the researcher. Similarly some of the key informants were very uncooperative and not willing to divulge any information. The author was therefore not able to get some of this information from the primary sources and had to rely on secondary data and other sources. This impacts on the depth of background information that can be provided in this report.

3.11 Ethics

Authorization was obtained from the university prior to carrying out the study. The researcher gave assurance to the respondents regarding confidentiality of information obtained.

CHAPTER FOUR

4.0 RESEARCH FINDINGS, ANALYSIS AND PRESENTATION

4.1 Introduction

This chapter gives an historic overview of Embu County and its headquarters, Embu. The history is linked to the unexpected population growth in the town, and consequently to the challenges in provision of urban services. The governance structure of the town is described in detail, paving way for discussions on existing legal SWM framework.

The chapter further focuses on findings obtained from fieldwork and addresses the three research questions.

4.2 History of Embu

Embu town is the headquarters of Embu County and occupies a total area of 729.4 km². Embu has a small airstrip (I km long) which is 7.1 km south east of the heart of the town. In terms of poverty, Embu County falls somewhere in the middle range in Kenya. In 2002 just under 56% of the population was calculated to be living in absolute poverty, giving the district a national poverty-level ranking of 25 out of the 46 districts in the country for which this information was available (Institute of Economic Affairs 2002: 61).

4.3 Topography and geology

Typical highlands, midlands, hills and valleys characterize the landscape of Embu municipality and the County as a whole. Altitudes range from 1500 to 4500 meters at the foot of Mt. Kenya. There are two distinct rainy seasons, the long rains falling between March and June and the short rains from October through December. The annual rainfall average is 1495mm and temperatures range from a minimum of 12 degree centigrade in July to a maximum of 27.1 degrees in March.

4.4 Evolution of the council

The municipal council of Embu was created in 1971 to take over Embu urban council, which was established in 1964. It was curved from the African native council of Embu, currently the

Embu county council. Embu forms a municipality that has four wards namely Dallas/Stadium, Nthambo, Kamiu, and Njukiri all of which are in Manyatta constituency as shown in figure 4.1

Figure 4.1: MCE administrative boundaries
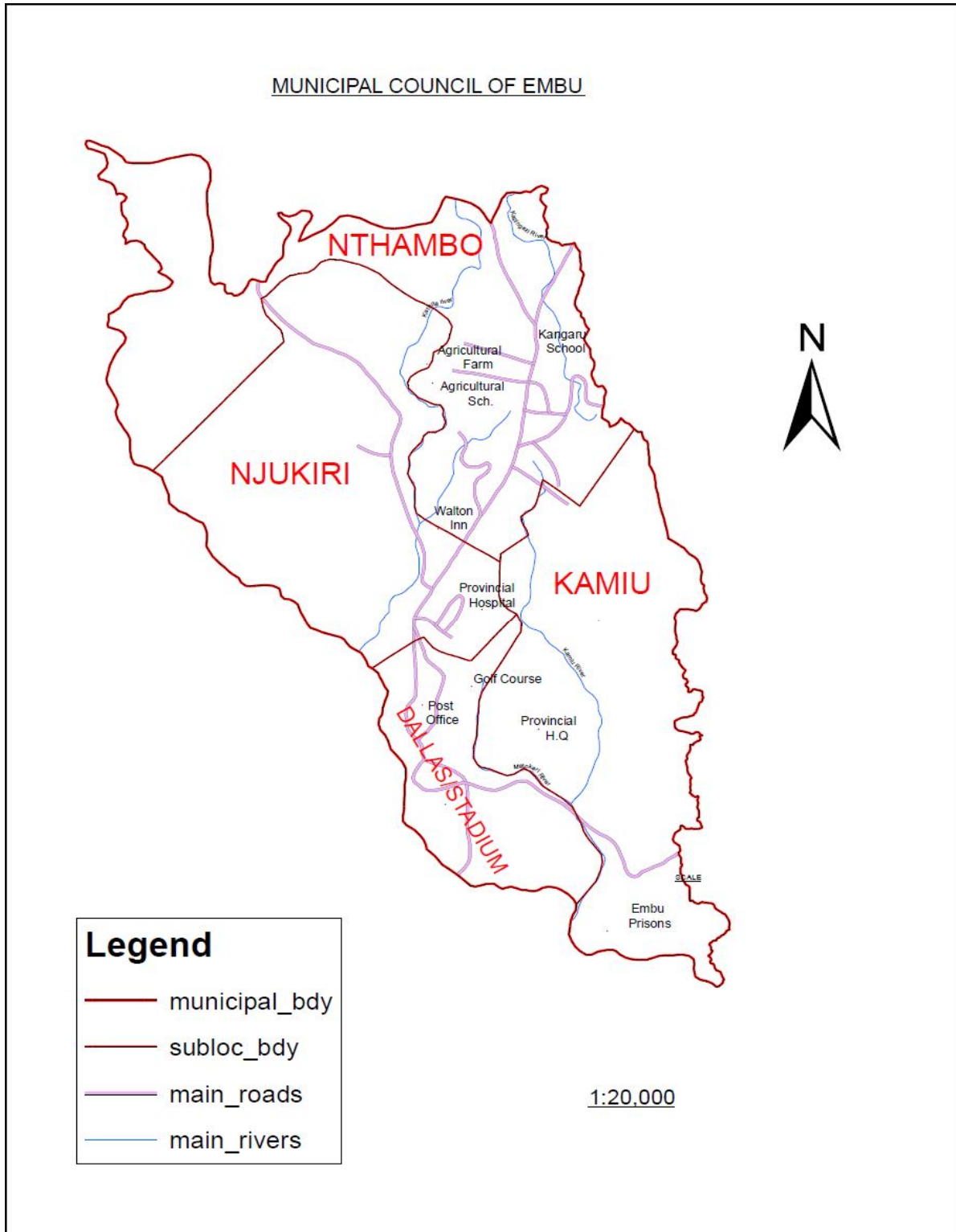
The council was created as part of the government effort to facilitate access to its services by the public by increasing the focal points of the implementation of development activities.

4.5 Questionnaires' response rate

Table 4.1: Response rate

Category of respondents	Target No. of questionnaires	No. of questionnaires returned	Response rate
Local Authority Officials	10	9	90%
Households	30	22	73%
Government Officials	5	4	80%

The study was able to get a response from 9 respondents out of the 10 questionnaires distributed to the Local Authority Officials; a response rate of 90%. The study was also able to get a response from 22 respondents out of 30 questionnaires distributed to the Households; that is a response rate of 73% from the questionnaires distributed as shown in table 4.1. Government officials had a response rate of 80%.

4.6 Presentation of findings

This section contains the presentation of findings arising from data analysis. It contains revealed facts in respect to solid waste management activities by MCE. The responses from the three categories of the respondents above were almost similar hence jointly presented.

4.6.1: Kinds of waste management activities provided by the Council

The study shows that collection (34%), Transportation (32%) and Disposal (28%) are the most common waste management activities provided by the Council. 6% of the responses (others) were not valid for this study.

4.6.2: Reasons for council involvement in waste management activities

The findings reveal that the majority of respondents consider job creation (18%) revenue generation (9%), keeping Embu clean (37%) as well as performing one of the local government's mandates (34%) as the main reasons for the council involvement in Waste Management Activities. 2% of the responses (others) were not valid for this study.

4.6.3: Duration that the council has provided SWM services and clients served by the council
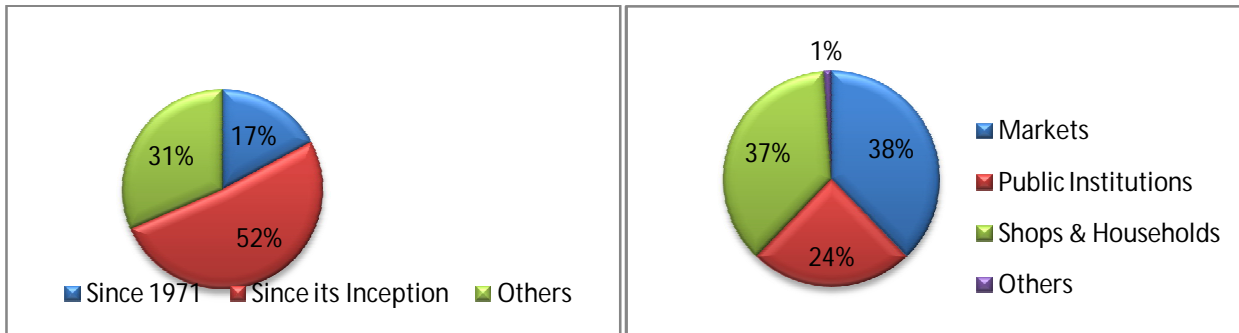
Figure 4.2: Duration of the Council Provision of the Services

Figure 4.3: Clients served by the council

4.6.4: Areas provided with SWM services by the council and sources of waste within areas served by the council
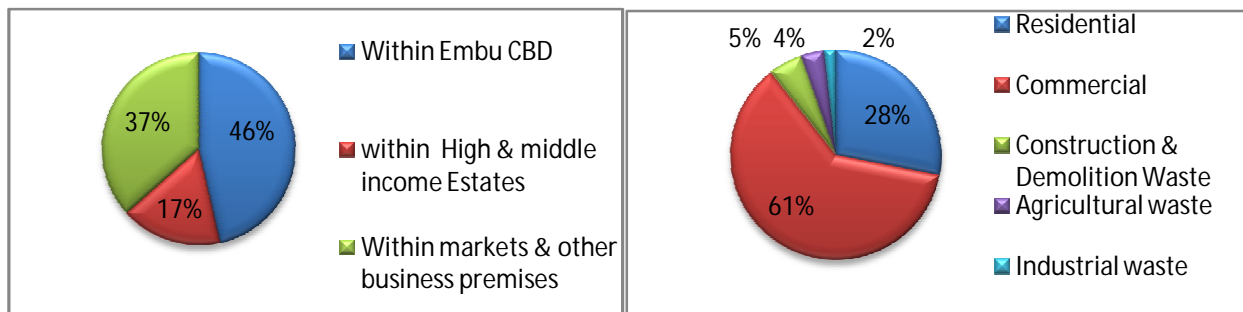
Figure 4.4: Areas served by the council

Figure 4.5: Sources of waste

4.6.5: Quantities of Waste generated within areas served by the Council

Table 4.2: Quantities of waste generated within the council area of jurisdiction

		Frequency	Percent		
				Valid Percent	**Cumulative Percent**
Valid	More than 100 tonnes per week	4	11.43	100.00	100.00
Not Valid	Not sure/Don't know	23	65.71	-	-
	Others	8	22.86	-	-

4.6.6: Classification of areas served by the Council

The results show that most of the respondents acknowledge that the council has not classified the areas under its jurisdiction (91%) into various zones according to the sources of waste. 9% of the responses (others) were not valid for this study.

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4.6.7: Waste handlers and their services within MCE
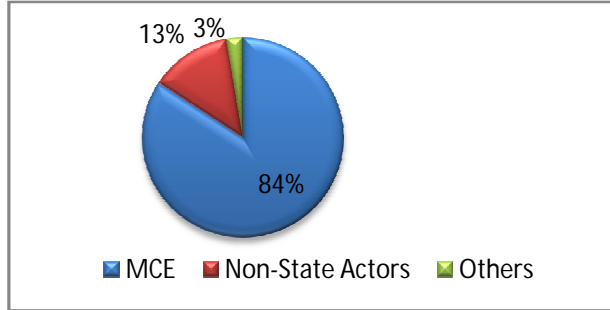
Figure 4.6: Waste handlers within Council's area of jurisdiction
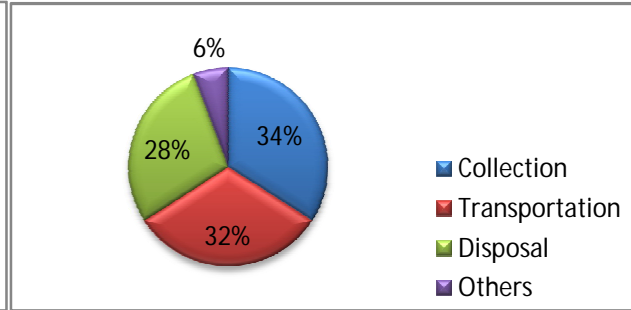
Figure 4.7: Services provided by waste handlers within MCE

4.6.8: Kinds and ownership of Equipment used by MCE for SWM
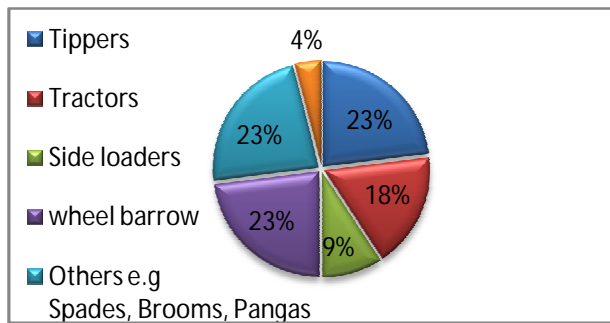
Figure 4.8: Equipments used by MCE
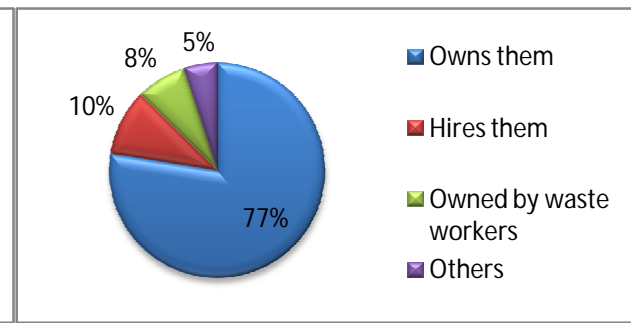
Figure 4.9: Details of equipment ownership

4.6.9: The community members' contribution to the SWM activities by MCE

The study depicts that most of the respondents believed that they contributed towards the council's adopted solid waste management through prioritization and identification of solid waste management needs (73%), providing equipment and labour (9%) and as a source of revenue to the council by paying promptly for the services offered (11%). 7% of the responses (others) were not valid for this study.

4.6.10: Linkage between SWM activities and community needs

Most of the respondents advocated that the waste activities provided are linked to the Community needs (60%) while some felt that MCE does not link the provided waste activities to their needs (31%). 9% of the responses (others) were not valid for this study.

4.6.11: Other Organizations offering solid management within Embu and the sources of resources for the operation and management of waste
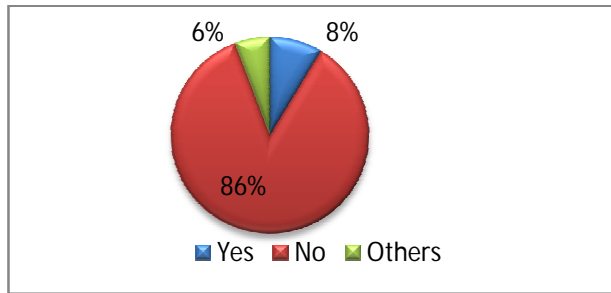
Figure 4.10: Other organizations offering solid waste management services
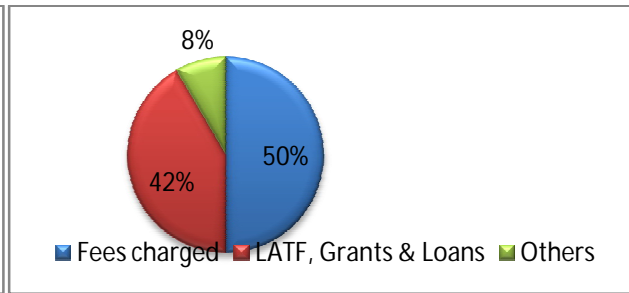
Figure 4.11: Sources of resources for operation and management of waste

4.6.12: Does the council offer solid waste management services at a fee?

Table 4.3: Are solid waste management offered at a fee?

		Frequency	Percent		
				Valid Percent	Cumulative Percent
Valid	No	0	0.00	0.00	0.00
	Yes	32	91.43	100.00	100.00
Not Valid	Others	3	8.57	-	-

4.6.13: Are the community members willing to pay the fees charged?

Table 4.4: Community willingness to pay solid waste management charges

		Frequency	Percent		
				Valid Percent	Cumulative Percent
Valid	No	19	54.29	61.29	61.29
	Yes	12	34.29	38.71	100.00
Not Valid	Others	4	11.43	-	-

4.6.14: Resources sufficiency and the Challenges faced by MCE when offering SWM services
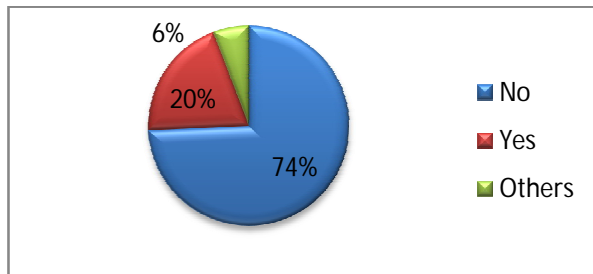
Figure 4.12: Sufficiency of the council's resources
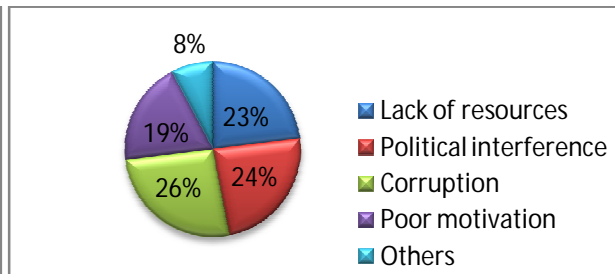
Figure 4.13: Challenges faced by the council

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4.6.15: Does the council offer services to all residents in the area that they are serving and are the hired workers trained?

Figure 4.14: Does all the residents receive solid waste management services?

Figure 4.15: The training background of hired waste workers

4.6.16: Work timings of the waste workers

Table 4.5: Work timings of the waste workers

		Frequency	Percent		
				Valid Percent	Cumulative Percent
Valid	8am-6pm	30	81.08	85.71	85.71
	Past 6pm	5	13.51	14.29	100.00
Not Valid	Others	2	5.41	-	-

4.6.17: Protective clothing provided by MCE

Table 4.6: Protective clothing used by waste workers

		Frequency	Percent		
				Valid Percent	Cumulative Percent
Valid	Glooves	25	27.17	28.41	28.41
	Overall & Aprons	27	29.35	30.68	59.09
	Gum Boots	21	22.83	23.86	82.95
	Dust Musks	15	16.30	17.05	100.00
Not Valid	Others	4	4.35	-	-

4.6.18: Frequency of payment to the waste workers and households' awareness and willingness to participate in waste reduction, reuse and recycling.
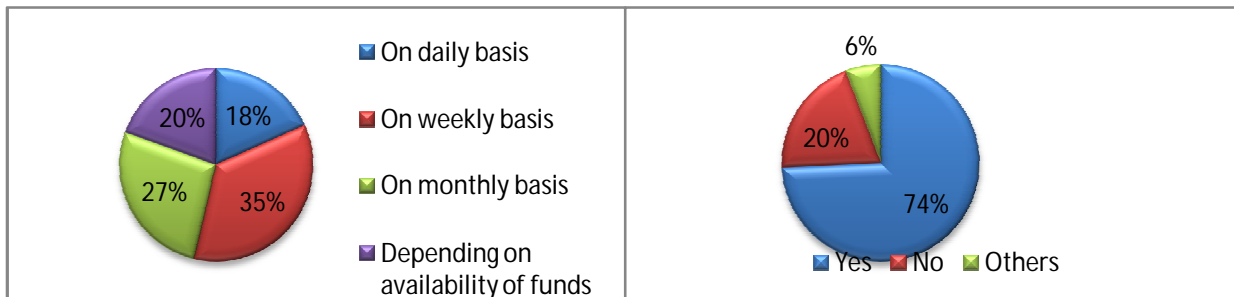
Figure 4.16: Frequency of payment to the waste workers by MCE

Figure 4.17: Awareness and willingness to participate in 3Rs

4.6.19: Frequency of solid waste collection services by MCE

The respondents considered that the council offers solid waste collection services on a daily basis (10%), weekly basis (49%), and on monthly basis (28%). 10% of the responses (others) were not valid for this study.

4.6.20: Materials salvaged from waste

The respondents considered bottles and glasses (30%), cardboards and cartons (24%), plastics (19%), metals and aluminium (27%) as some of the material salvaged from waste collected for recycling and re using.

4.6.21: Treatment of the collected non-organic materials and bio-degradable materials
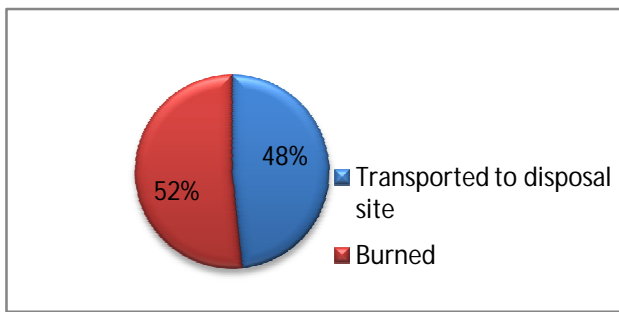
Figure 4.18: Treatment of non-organic materials
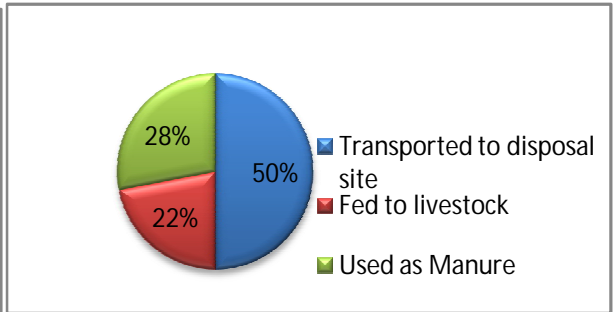
Figure 4.19: Treatment of bio-degradable materials

4.6.22: Decision making and management within MCE and the mandate of the council leaders and workers
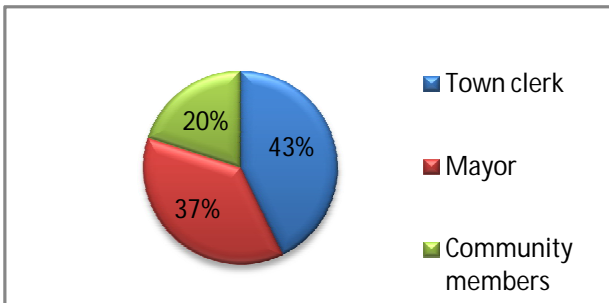
Figure 4.20: People involved in decision making and management within the council
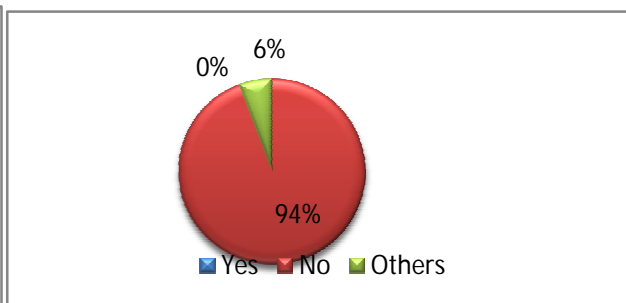
Figure 4.21: Workers and leaders within the council have a clear mandate

4.6.23: Stimulation of non-members participation by MCE

The results shows environmental clean ups (44%), LASDAP meetings (25%) and workshops (14%) as some of the ways used by the council to stimulate participation of non-members. 17% of the responses (others) were not valid for this study.

4.6.24: Special skills required to operate waste management activities by MCE

The study reveals that most of the respondents believe the waste handlers require special skills to operate the council's waste management activities (80%) while a few feel that handling of waste does not need any special skill as it can be done by any person (20%).

4.6.25: Are waste workers trained on SWM and does the Council encourage households to participate in 3Rs
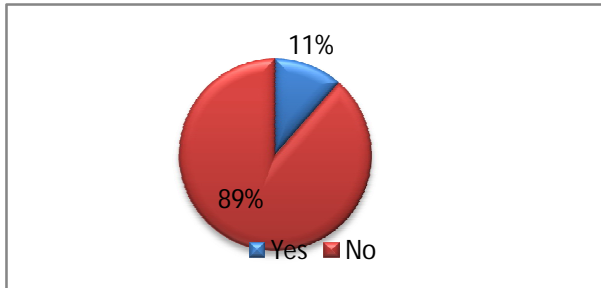
Figure 4.22: Waste workers within MCE are trained
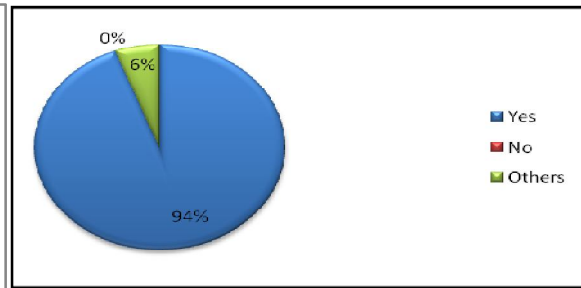
Figure 4.23: Awareness and willingness to participate in 3Rs

4.6.26: Organization of community meetings by MCE

The study reveals that majority of the respondents consider that the council organized and conducted community meeting on annual basis, for the purpose of solid waste needs identification and prioritization (94%), and on quarterly basis to follow up on the progress of implementation of already identified projects. 6% of the responses (others) were not valid for this study.

4.7 Solid Waste Actors

There were several actors in the Solid Waste Management (SWM) process who are directly and indirectly involved in the waste recovery activities in the municipality. At the lowest level of the waste recycling hierarchy, were the waste pickers, at the middle we had the waste dealers and finally, at the top, the Jua-Kali recycling industry. These different groups of people or entrepreneurs engaged in waste recycling and reuse have a hierarchical network. They also had different roles to play in the informal recycling sector.

4.7.1 The Street Waste Pickers

There were only two categories of pickers at the lowest level of the hierarchical network involved in waste recovery. These included the street waste pickers and the itinerant waste

buyers. The street waste pickers operated in the commercial and residential zones. They obtained all kinds of waste materials from; open spaces, roadsides, communal dumps, dustbins and other waste receptacles. The four (4) waste pickers interviewed revealed that they faced harassment and suspicion from the residents, the police and the municipal council who consider their activities undesirable. The waste pickers are normally perceived as street urchins "chokoraa", thieves or generally criminals. There is a negative attitude of the community towards taking care of their own solid waste (Municipal council CDS document, 2006-2010).

4.7.2 Itinerant Waste Buyers

The itinerant waste buyers work comparatively in cleaner environments, because they are interested in a limited number of items which have been sorted out and undergone some cleaning or other forms of upgrading. The study revealed that there were only two itinerant waste buyers in the municipality. The two were plastics waste buyers and they obtained their materials from the waste pickers, hotels and social events. The plastic materials they dealt in comprised; water bottles, acid containers, 5 litre and 20 litre containers. The plastic materials were first washed and later sold to the residents and shop owners for re-use in the storage of paraffin and water.

4.8 Exploring the sustainability of waste management activities adopted by MCE

In this section, findings from the field work are presented and discussed under specific headings. The field work findings based on interviews with MCE staff, households in Embu and government officials are presented and discussed against indicators developed for each sustainability aspect (refer to chapter 2).

4.8.1 Legal/Institutional Aspects

Owing to its cross-sectoral nature, waste management is fragmented into several pieces of legislation (UNEP/NEMA, 2005). The major concerned laws are tabulated in table 4.7:

Table 4.7 Laws relating to solid waste management in Kenya

	Law or regulation	Issuing Institution	Objective
1.	**Local Government Act (1963) Cap 265**	Ministry of Local Government	The Act mandates local authorities to establish and maintain sanitary services for the removal and destruction of waste and effluent in their area of jurisdiction.
2.	**Public Health Act Cap 242**	Ministry of health	The Act through specific sections mandates local authorities to secure and maintain public and Environment health. One way cited for achieving this, is proper solid waste management services
3.	**Environmental Management Co-ordination Act(1999)**	Ministry of Environment and Natural Resources, National Environment Management Authority	To safeguard the environment.
4.	**Waste management regulations (2006)**	Ministry of Environment and Natural Resources, National Environment Management Authority	Regulations on handling, packaging, treatment, condition, storage and disposal of all categories of waste, for waste generators and collectors.

Source: Author own construction based on (JICA, 2002, Karanja, 2005, NEMA, 2006)

4.8.1.1 Authorized by Local Government Act and Public Health Act for involvement in SWM

At the local level, the Municipal Council of Embu is in charge of both the operational as well as regulatory responsibilities for SWM. These roles are facilitated through two major legislative instruments namely Local Government Act, Cap 265, and the Public Health Act, Cap 242 (National Council for Law Reporting, 2004-2008).

The Municipal council of Embu has the primary duty of care for the provision and regulation of SWM services to the town of Embu. MCE major objectives are to improve public health and environment and to maintain public cleanliness in order to keep public places aesthetically acceptable by ensuring proper storage, collection, transportation and disposal of solid waste.

4.8.1.2 MCE SWM Institutional Arrangement

The Embu town is managed by the Municipal Council of Embu. The overall decision making organ concerning the town is the council which is composed of both elected and nominated councillors.

The council represents the legislative arm of MCE, and is concerned with policy formulation. Councillors are elected at the ward level which corresponds to the administrative sub-locations. They elect a mayor to the council every two years, who is the head of the policy arm, thus constituting the full council.

Special purposes committees include the Finance, Municipal planning, Education, Social services, Children and housing committees, Public health and environmental committees. These committees deliberate on matters within their concern and advise the council accordingly. The full council then ratifies decisions and endorses their implementation.

The other arm of MCE is the executive, comprising of the administrative and professional staff and is charged with the responsibility of policy implementation. The chief officer of the executive is the Town clerk, who acts as a bridge between the two arms. The Town Clerk has the main task of advising the council on policy implementation.

MCE is charged with the responsibility of provision of urban services and infrastructure such as water supply and sewerage, refuse and garbage collection, access roads, drainage, health and educational services. These functions are explicitly outlined in the Local Government Act Cap 265 (Republic of Kenya, 2004).

Within the executive arm of MCE, is the Engineer's department charged with the responsibility of cleanliness of the town including enforcement of all laws and regulations relating to Solid Waste Management (SWM).

Policies relating to SWM are formulated by an Environmental Committee in the legislative arm of the MCE. Endorsement of these policies by the MoLG is mandatory before implementation by the engineer's department. In addition, there are by-laws formulated by MCE for the enforcement of these laws.

The by-laws formulated by the MCE under the provisions of the Local Government Act (1963), focus on either prohibition of illegal disposal of waste, responsibilities of waste generators on

aspects such as storage of waste awaiting collection. Including responsibility of MCE to provide refuse receptacles, or rights of MCE on imposition of charges for waste collection and fines in the event of violation of rules or defaulters

4.8.1.3 MCE team has clearly defined responsibilities

MCE main responsibilities towards SWM are to; formulate and implement SWM policies, provide services for the collection, transportation, treatment and disposal of solid waste, regulate and monitor the activities of all generators of solid waste, formulate and enforce by-laws and regulations relating to SWM and, coordinate with other departments within MCE, donor Agencies, and other government organizations involved in SWM.

MCE delivers its SWM services through the Engineer's department, which is solely responsible for the delivery of SWM services with the detailed functions of: Waste collection and transportation, street cleansing, cleaning and recovery of solid waste from road gulleys, roadside and estate drain cleaning, dead animal collection, refuse disposal, supplying households with refuse receptacles/litter bins and grass cutting along road sides.

Engineer's department does not carry monitoring of SWM activities on waste generators other than some inspection of its own collection and disposal activities services.

4.8.1.4 Community members participate in decision making

Community members participate in the management affairs of the council through attending annual Local Authority Service Delivery Action Plan (LASDAP) meetings held at their respective wards where they prioritize SWM needs. They then appoint two representatives who present and defend their needs to the district consensus committee meeting. Upon convincing the committee members, the needs are included in the annual local authority budget for minister's approval. The municipal engineer remarks:

> *"At the district consensus meeting level, the prioritized SWM needs compete with other identified projects such as provision of water, health and education facilities etc. SWM is not given the weight that it deserves and as a result most of the SWM needs are not properly addressed"* (Personal communication with a respondent, July 2011)

4.8.2 Technical/operational aspect

4.8.2.2 Waste system able to remove all waste from the community neighbourhood

Waste system gives the SWM handling procedures from storage, collection, transportation and disposal of solid wastes from various waste generators within the municipality.

Storage Methods

For purposes of evaluation, the study categorized the storage facilities used by the residents as: standard containers and unstandardized containers.

a) Standard containers: These were used for secondary (or communal) storage of the domestic waste. They were observed to be used in various places. In most cases, they are supplied by the MCE. There were different types of standard containers:

Dustbins: Dustbins are the only standardized primary (or individual) storage facilities that were commonly used in high and medium income areas of the municipality as observed in the field study. They were also found in offices. They were mostly plastic in nature although some were metallic. The dustbins had openings or holes on the sides and were not susceptible to theft because they were stored indoors. Plastic dustbins were not subjected to damage due to absence of corrosion experienced with metallic ones. Most of these dustbins were emptied once in a day when full. This was common in high and middle income households where the rate of waste generation was high. Low income households would even empty it quarter-way. In offices however, the dustbins could be emptied half-way or when three-quarter.

Plastic and galvanized bins: These waste receptacles varied between 17-250litres. They were mostly plastic in nature apart from the galvanized ones found in construction sites. This was due to the fact that wastes from construction sites like sand, stones and cement were too heavy and could break a plastic bin. These plastic bins were purchased by MCE then placed strategically at different places within the municipality. MCE gave priority to the CBD in distribution of purchased bins.

b) Unstandardized Containers: Some of the unstandardized containers (that is, not provided by MCE) observed included old basins, carton-boxes, sacks and plastic bags. These were mainly used because of insufficiency/obsolescence of containers caused by the MCE which had the obligation of providing refuse receptacles to householders. Most of these containers (especially

oil-drums) were observed to be unhygienic due to lack of lids and were heavy to handle. According to respondents in Majengo, MCE never distributed any receptacles to them and this made them improvise receptacles in which they would store in their household wastes then later dispose them to open spaces close to their houses.

The criteria used by MCE in the distribution of refuse receptacles to its residents were based on the level of waste generated in a given area and the accessibility to that area. But, it was reported that whenever new dustbins were purchased, the high and medium-income areas received the first priority because of their political and economic influence. Low income householders were given the lowest priority because they are unable to pay for these services. Nevertheless, no receptacles were provided to high density areas like "Majengo" because such areas were conceived as illegal. In terms of location of communal containers, the only criterion used was the availability of space. The convenience of such receptacles to the householders was not taken into consideration at all. Such planning shortfalls in the distribution and location of storage facilities encouraged illegal dumping of household waste in most residential areas.

Waste Collection Systems

The refuse collection methods used included: Communal collection, or `no collection'. Details of each of these methods are as follows:

a) Communal Collection/Use of Transfer Stations

Under this system, the residents were observed to discharge their wastes at predetermined locations containing secondary storage facilities described earlier and refuse collection vehicles visited those sites at infrequent intervals. This kind of collection system was common in different areas of the municipality where the bulk containers were placed. Transfer stations were also observed at strategic points within the commercial zone. At Embu municipal market for instance, there was a transfer station where all wastes produced in the market were disposed off. In other places like Majengo, wastes were collected in open spaces which were once pits but later filled up. The wastes were then burnt later. It was also observed that the willingness of householders to co-operate in the collection process diminished rapidly as the distance increased from the communal collection points. The case in point is Majengo which is a low-income Estate. There were no defined waste collection points in this area hence residents dumped their wastes at their convenience. Almost everywhere, communal collection points exhibited several environmental

problems: the containers were sometimes overfilled and refuse was thrown around them; were exposed to all types of scavengers (birds, goats, cattle, dogs, as well as human beings who searched for both saleable materials and food remains). Such sites were also a nuisance to the waste-generators themselves because of the odour and smoke from the burning.

b) No Collection

'No Collection' was a common system used in a few some low-density and in all high-density residential areas. This system was being used where householders never received any service. Blue Valley Estate is one of the low-density areas which used this kind of system. Such high-income householders used the 'no-collection' method because they had large back yards where they disposed-off their wastes traditionally like in any rural areas of Kenya. They would then burn up the wastes after the pits were almost filled up to give room for more wastes.

In the informal settlements like Majengo, the system was only used because the MCE found it hard dealing with wastes in such areas. The population density was too high hence congestion of houses and people. The accessibility was poor and the residents were also hostile. According to the MCE, the residents were also not willing to pay for the services offered. According to observations, most of these disposal points were left unattended to. The pits were almost inexistent and they left open spaces in the fields or the backyards due to the fact that residents preferred burning to collection.

This method of collection was also practiced in health care facilities. There existed a placenta pit in Embu Provincial hospital where placentas were dumped and left to undergo decomposition. The other special waste from hospitals e.g. sharps and other wastes were incinerated and the residual ash disposed into a special pit constructed at Embu Provincial hospital. All schools visited in the Municipality were also observed to be practicing this method of collection whereby they could dump their wastes in rubbish pits then burn up the wastes when full.

Every refuse collection vehicle from the MCE was accompanied by 1 driver, 1 supervisor and 4 loaders. This gave a maximum crew size of 6 workers per vehicle. However, the crew size is supposed to depend on the types of vehicles used, distance between collection-points and the types and/or amount of waste to be collected from any given point each working day. It was observed that none of these factors was taken into consideration into the decision-making process. According to one of the Supervisor's, there were times when the roles were not defined

due to under-staffing. For instance, supervisors also act as waste collectors and loaders.

Frequency of Collection

The MCE's collection frequency had no basis. According to respondents residing closer to most collection points (transfer stations), there was laxity of the MCE in collecting wastes on a daily basis to the dumping site. The receptacles were not emptied on a daily basis hence this posed a great health risk to the nearby residents. The socio-political factors (for example, economic influence of householders) and the availability of refuse collection equipment played a role in the frequency of collection. Because of the political and economic powers of the high-income areas, they received a more frequent and efficient service than the low-income areas. Informal settlement received no service at all because of their illegitimate status and they never paid for the service. Such areas also lacked broad-streets for the easy passage of refuse collection vehicles. The waste pickers also revealed that they did not like servicing the low-income areas because they had little or no saleable materials which could be a good source of income.

Effect of environmental factors on amount of waste collected

The respondents interviewed reported that during the rainy season, they rarely went out to collect household waste because they lacked protective clothing like gloves, raincoats, caps, head dresses, nose masks and gumboots. The rain mostly interrupted the collection frequency in all areas of the municipality. During the dry months, the amount of solid waste collected was generally higher than that of wet months. This was attributed to the fact that the wastes are lighter and therefore a waste collector can be able to carry a lot of wastes per surface area. On the other hand, wastes collected during the rainy season are too heavy to carry due to accumulation of rain water in different wastes. This leads to low density of waste collected per surface area. According to a waste collector from MCE, during hot hours, the wastes smell too bad. This is due to the high rate of decomposition at such times. The waste collectors therefore reported for work from 6am to 10am during which the sun was not too hot.

Health Hazards among Refuse Collectors

The health hazards experienced among refuse collectors as revealed by the study included:
- Sprained muscles particularly the back muscles and chest problems due to improper lifting and overexertion especially in loading.

- Skin injuries i.e. abrasions and lacerations from sharp jugged objects, burns from hazardous household wastes, dog bites and other attacks from pests.

- Injuries from mechanized refuse collection vehicles.

- Exposure to dust (during the dry season), malodorous decomposing organic waste and smoke (from burning wastes) caused chest problems to most workers.

Transportation of waste

The different sectors sampled within MCE used different modes of transportation for the wastes generated depending on the scale of operation as well as the type/category of wastes generated. The most common were: vehicles, wheel barrows and manual transport.

Service Operations and equipment Requirements

Though there were specific routes assigned to the waste collection vehicles during collection and transportation of wastes, these routes were not followed and waste collection and transportation was based on the need at a given receptacle. There was an average of two refuse collection vehicles in the field per day. Each refuse collection vehicle made 4 trips per day. These shifts lasted from 8.00 a.m to 5.00 pm. The refuse collection vehicles transported wastes from the receptacles at the transfer stations from Monday to Saturday. There was no garage or workshop to park the vehicles hence they were always parked outside the municipality building. Wheel barrows from the MCE were not assigned specific routes by either the municipal council. They therefore collected and transported wastes to the receptacles based on the need.

Repair and Maintenance of Refuse Transportation Equipment Vehicles

Since refuse transportation vehicles had to work under strenuous conditions, it was desirable that a specific schedule of preventive maintenance be followed with proper garaging facilities. Besides the preventive maintenance programme, the vehicles needed frequent repairs. The major challenge however stemmed from the fact that there was an incomplete tool box as well as no workshop for maintenance and repair of broken-down vehicles. The study revealed that MCE utilized both preventive and breakdown maintenance for their vehicles. Minor problems were sorted out by the council mechanic while major breakdowns were taken to the "Juakali" mechanics at the garages since they were more qualified and experienced. The MCE used both preventive and breakdown maintenance for their wheel barrows.

Environmental Aspects of Refuse Transportation

There were a few shortfalls in the transportation system which had environmental implications. First, there was the issue of uncovered waste while being transported from collection points to disposal sites. While covering of refuse does not involve heavy expenditure, its absence created nuisance through the bad smell that emanated from uncovered vehicles and refuse that fell on the streets and roads on the way. Both vehicles and wheel barrows were not covered during transportation of wastes. Secondly, operational refuse vehicles were not washed after the service. The study revealed that the vehicles were cleaned on a weekly basis. Apart from reducing the lifespan of vehicles, it was also unhealthy for workers to use such dirty vehicles during the collection process. Wheel barrows were however washed on a daily basis immediately after service.

4.8.2.3 Waste Quantification and Characterization surveys within MCE

Waste characterization surveys were carried out at designated MCE communal waste collection points, and at immediate source (waste taken directly from households and various business, commerce and institutional premises) respectively, to determine the current character of MCE's waste. For solid waste data, the confidence level (C.L) is set at 80% or 90% (Cacadia 2003). In accordance with table 4.8the sample numbers taken and used for the characterizations achieved theoretical 95% Confidence levels for residential/domestic and non-domestic waste characterization at immediate source, and 90% and 90% Confidence levels respectively for domestic and non-domestic waste characterization at communal waste collection points. The results of the characterizations are summarized in the following sections.

Table 4.8: Number of Samples for Waste Composition

Materials	C.L 95%		C.L 90%		C.L 80%	
	Residential	Commercial	Residential	Commercial	Residential	Commercial
Newsprint	224-2397	698-3563	58-600	170-991	16-150	48-223
Cardboard	899-1955	533-997	225-499	134-250	58-123	35-64
Aluminium	275-1437	754-4399	70-350	191-1100	19-92	60-275
Ferrous	194-554	552-3411	50-139	138-953	14-37	36-214
Glass	145-619	596-2002	39-155	149-501	19-61	39-126
Plastic	261-1100	422-783	67-275	107-195	18-70	28-61
Organic	12-47	26-92	5-14	8-25	3-5	4-8

Source: Recycle Worlds 1994.

Characteristics and quantification of household/Residential waste

The rate at which household waste is generated and its composition, are the principal parameters which are essential for the planning of any refuse management service. The quantity of any refuse produced by households was estimated through the application of field observations and direct measurements at domestic sources. The results indicated that the average daily production amounted to approximately 2.1, 1.7 and 1.4 Kg/household/day for Blue Valley, Dallas and Majengo respectively. On average, the rate of waste generated was found to be 1.7 Kg/household/day. Using an average household size of 3 persons (refer Kenya population census of 2009), the generation rates were estimated to be 0.70 Kg/person/day, 0.56Kg/person/day and 0.46 Kg/person/day in Majengo, Dallas and Blue Valley, respectively. On average, solid waste generation rate was 0.57 Kg/person/day.

Using a mean waste generation rate of 0.57 kg/person/day as calculated above, the total house hold waste generated was calculated and the results tabulated as shown in tables 4.9, 4.10, and 4.11.

Currently, MCE with a projected population of 44,907 generates about 25.6 tonnes per day or 9,344 tonnes per year. These results indicate that the socio-economic status of the people influenced the generation rates and even waste characteristics.

Table 4.9: Current population as per 2009 National Housing census Within MCE

Ward/Sub-Location	Population As Per (2009 Census)			House Holds	Area (Km^2)	Density
	Male	Female	Total			
Dallas/Stadium	9,168	9,599	18,767	6,901	3	5,520
Kamiu	7,524	7,496	15,020	4,810	7	2,311
Njukiri	2,196	2,419	4,615	1,373	9	519
Nthambo	1,925	2,365	4,290	901	5	933
Total:	20,813	21,879	42,692	13,985	24	

Source: KNBS-2009 Housing

Table 4.10: Projected Population within the MCE

Ward/Sub-Location		Projected Population			
	2009 Census	2010	2012	2015	2020
Dallas/Stadium	18,767	19,086	19,740	20,764	22,590
Kamiu	15,020	15,275	15,799	16,619	18,080
Njukiri	4,615	4,693	4,854	5,106	5,555
Nthambo	4,290	4,363	4,513	4,747	5,164
Total:	42,692	43,418	44,907	47,236	51,389

Table 4.11: Waste Generated Within MCE

Ward	2009 Census	Projected Waste Generated(Tonnes/Day)			
		2010	2012	2015	2020
Dallas/Stadium	18,767	10,879	11,252	11,835	12,876
Kamiu	15,020	8,707	9,005	9,473	10,306
Njukiri	4,615	2,675	2,767	2,910	3,166
Nthambo	4,290	2,487	2,572	2,706	2,943
Total:	42,692	24,748	25,597	26,925	29,292

From the analysis of the solid waste data provided by the MCE for waste collection for a period of six month, summary table 4.13 shows that approximately 1,358 tonnes of residential waste are collected and transported to the dump site annually and this translates to about 15%.

Table 4.12: Lists of the Primary Waste Collection and Final Disposal Facilities

Ward/Sub-Location	Location	Zoning	Primary Waste Collection Facility	Unique Code	Final Disposal Facility	Unique Code
Dallas/ Stadium	Woods Lodge	Commercial	Waste Receptacle	1C	-	0
	Stadium	Commercial	Waste Receptacle	2C	-	0
	Liberty	Commercial	Waste Receptacle	3C	-	0
	Prior	Commercial	Waste Receptacle	4C	-	0
	Highway	Commercial	Waste Receptacle	5C	-	0
	Upper Bus Park	Commercial	Waste Receptacle	6C	-	0
	Lower Bus Park	Commercial	Waste Receptacle	7C	-	0
	Kubukubu	Commercial	Waste Receptacle	8C	-	0
	Dallas	Residential	Waste Receptacle	9R	-	0
	Embu Market	Commercial	Waste Receptacle	10C	-	0
Kamiu	Blue Valley	Residential	Waste Receptacle	11R		0
	Majimbo	Residential	Waste Receptacle	12R		0
	Airstrip	-				13D
Njukiri		Residential	-	-		
Nthambo		Residential	-	-		

Table 4.13: Analysis of waste collected by MCE

Summary Table For Monthly & Annual Waste Collection{Tonnes}							
Jan-11	Feb	Mar	Apr	May	Jun	Total	
476	399	539	756	763	707	3,640	Waste Collected within Six Months
						606.7	Mean Monthly Collection Rate
						1,358	Total Residential (Per Annum)
						5,922	Total Commercial (Per Annum)

The physical composition of domestic waste was estimated by using both primary and secondary data available. A total of 315 representative samples spread over a week were taken directly from house holds in three zones from residential areas for waste characterization at immediate source while a total of 105 communal waste collection points located in residential areas spread across Embu municipality were sampled for waste characterization at collection points. The study was

carried out on the wastes collected from the low income area of Majengo, middle income areas of Dallas and Majimbo estates and the wastes from the high-income Blue Valley estate. These samples underwent a manual physical analysis for every component. The components were then put into plastic bags and weighed. Several analyses were made to obtain a reliable definition of the average composition of the town's solid waste.

The results of the residential /domestic waste characterisations carried out at immediate source and at communal waste collection points are summarised in figure 4.24below.
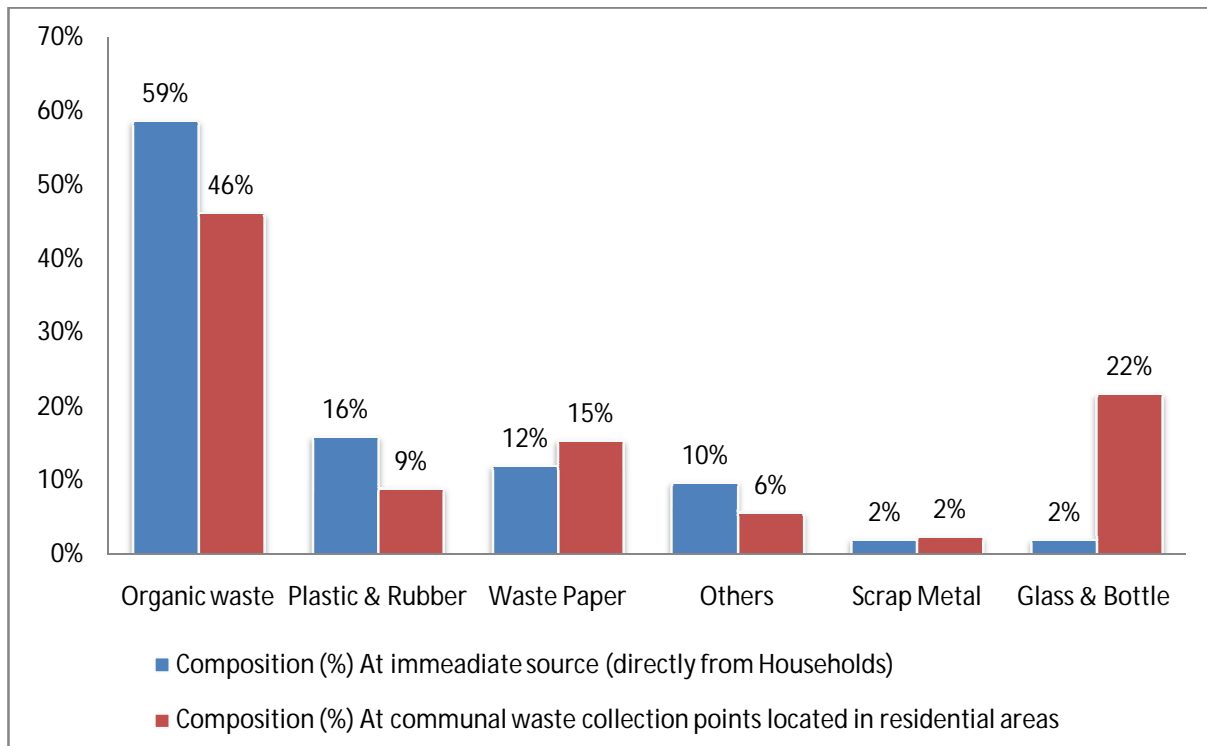
Figure 4.24: Waste characterization at immediate source and at communal collection points for Residential generators

Characteristics and quantification of Non-Residential Waste – Business, Commerce, Institutions, Markets

A total of 84 samples spread over one week were taken directly from retail supermarkets and various shops; offices and workplaces; institutions - including primary and secondary schools, religious venues and non-hazardous waste from health care units and hospitals; and at catering venues in two zones namely; Dallas and the CBD for Non-domestic waste characterizations at immediate source.

83 samples taken from communal waste collection points located in general business and commercial areas spread across Embu CBD and Dallas Zones, and 14 from collection points located adjacent to fruit and vegetable general markets, were used for the characterization of business, commercial and market waste at communal waste collection points.

The non-domestic waste characterizations determined at immediate source and at waste collection points are summarized in Table4.15 below;

Table 4.14: Waste characterization at immediate source and at communal waste collection points for Business, Commercial & Institutional generators

Waste Type	Composition (%)					
	At immediate source (directly from Premises)				At communal waste collection points located in general Business &Commercial Areas	At communal waste collection points located adjacent to markets
	Retail shops	offices & Workplaces	Institutions-Religious, Education & Non-Hazardous healthcare	Catering-Restaurants, Hotels & Eating places		
Organic waste	44%	26%	49%	69%	36%	51%
Plastic & Rubber	20%	17%	11%	9%	14%	14%
Waste Paper	22%	42%	20%	10%	19%	11%
Others	10%	14%	14%	9%	22%	18%
Scrap Metal	2%	1%	3%	2%	3%	2%
Glass & Bottle	2%	0%	4%	1%	6%	3%

The quantity of any refuse produced by non-domestic waste generators was estimated through the application of field observations and direct measurements. A total of nine communal waste collection points for business, commercial & institutional generators within the CBD were sampled and measurement of waste discharged measured directly for a period of 4 weeks.The results indicated that the average weekly production amounted to approximately 19.8 tonnes/communal waste collection point/week. On average, the rate of non-domestic waste generated within MCE was found to be 178.2 tonnes per week, which translates to 9,266 tonnes per annum.

From the analysis of the solid waste data provided by the MCE for waste collection for a period of six month, summary table 4.13 shows that approximately 5,922 tonnes of non-domestic waste

are collected and transported to the dump site annually and this translates to about 64%.

4.8.2.4 The MCE waste disposal site

Waste Disposal Methods and their Environmental Aspects

Due to the heterogeneity of the waste no one method of disposal can serve the purpose adequately and satisfactorily. Several methods were widely used in various establishments within the municipality. The most common were: Dumping, Incineration, open burning, Composting and other minor ones. Of those, the MCE, which had the obligation of disposing wastes, was entirely using open dumping or unsanitary land filling.

a) Open or Crude dumping

During the study period, the municipality had only one area set aside for the disposal of all types of solid wastes. The final disposal site of waste is approximately 1.5 hectares and is located 7km away from the CBD of Embu town and just 0.5 km from the Embu air strip. This land doubles as a public cemetery on one side and as a waste dumpsite on the other side with no distinct boundaries separating the two.

The dumpsite is not fenced, hence grazing animals such as cattle, goats, and stray dogs have easy access. Also noted at the disposal site were numerous flies, rats, smoke, fire and people scavenging for recyclable materials such as cartons, wires, bottles and plastics. At the site, there is no weighing, separation or treatment of the solid waste.

As evidenced from the site Plate 4.1, some of the MCE staff use parts of the disposal site for farming activities.

Plate 4.1: Disposal site used for farming activities

The dump site is already full hence its life span has expired. The municipality collected wastes from the receptacles and transported them to the disposal point. These wastes were mainly

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generated from the commercial zone, offices, markets, financial institutions, construction sites and the middle income residential areas of MCE. Similarly open dumping of household wastes in open spaces within the compounds was practiced in high income residential areas. The MCE openly disposes all its solid wastes at the dumping site posing serious environmental issues. There is no sanitary land filling and of concern is that the cleansing officer even revealed that he did not know anything about sanitary land filling. In sanitary land filling, waste is supposed to be spread in thin layers, compacted and covered with fresh layer of soil each day to minimize pest, aesthetic, disease, air and water pollution problems. Since none of these environmental considerations had been incorporated into the siting, operation and planning process of this dumping site, the site's conditions were observed to be rather pathetic and unsatisfactory as can be outlined here;

- The waste was not covered with any layer of soil since there was no bull-dozer to compact and cover the waste with a fresh layer of soil.
- There was no litter and dust control. The site was generally untidy and dusty.
- Human settlement was very close to the dumping site.
- Due to lack of proper screening, papers and plastics were blown away by wind from the dumping site towards the residential quarters with the possibility of spreading diseases and other environmental hazards.
- The dump was also a health menace to the surrounding residential areas because it was a source of objectionable smoke and odor.
- There were dogs inhabiting the dumping site which could attack and injure someone.
- The road to the dumping site was not tarmarked and accessibility was a problem for the vehicles transporting waste.
- The area had no gate and was accessible to human beings and animals like dogs. There were cases of a people growing crops at the dumping site.
- There were no pest control measures. Hence the dumping site served as a breeding ground for flies, mosquitoes; and other types of insects. There was no application of insecticides because of MCE'S financial constraints.
- There was ground water pollution at the disposal site in cases where it rained due to leach ate generation.

- There was no control of gas-movements and fire on the site. Such gases could cause explosions outbreaks of fires in the dumping site.

- There were no municipal council employees at the disposal site therefore there was no one to ensure security and record-keeping on waste deliveries.

- The site had no essential amenities like water, fire fighting points, and communication facilities (e.g. telephone).

In conclusion, it should be observed that no environmental and socio-economic aspects were taken into consideration in the siting, operation and planning of the MCE disposal site.

b) Incineration

Incineration is the process of thermally reducing the volume of solid wastes while producing offensive gases and sterilized residue by the application of the combustion process (NCRR, 1974). Incineration is basically used for the treatment and disposal of hazardous waste and at the municipality, it was being used for treatment and disposal of wastes generated from health care facilities. There is only one incinerator in the municipality at Embu Provincial Hospital. Health care facilities in the municipality incinerated their sharps, infectious, highly infectious, chemical and radioactive wastes .Private clinics sampled revealed that due to their small scale levels of operation, it was not feasible to construct incinerators. They however incinerated their medical wastes at Embu Provincial Hospital. At all the health care facilities studied, the residue ash resulting from incineration was taken to the receptacles for final disposal by the municipality at the municipal dumping site

c) Open burning

This method of waste disposal was mainly used by low and high income residential areas and learning institutions .All the learning institutions studied revealed that they openly burnt the wastes they generated. Open burning of wastes led to air pollution due to emission of smoke and dust particles from the burning wastes. The study revealed that 82.5% and 77.5% of households in high and low income residential areas openly burnt their wastes.

d) Other Solid Waste Disposal Methods

- There were placenta pits at the two hospitals studied in the municipality for disposal of placentas.

- The study revealed that one financial institution transported its wastes to the headquarters in Nairobi where they were shredded. This was occasioned by the sensitive nature and confidentiality of the information on the waste papers.

Factors Hindering the Operation, Siting and Planning of Sanitary Landfills

Sanitary land filling is the most recommendable method for disposal of solid waste in developing countries because it has the lowest cost. MCE did not incorporate environmental considerations into the current operations due to the following reasons;

- An inadequate finance to construct and operate a sanitary landfill was the major reason given for crude dumping of wastes.
- Crude dumping was cheap for the MCE and needed no planning.
- Lack of equipment. There was neither a bulldozer nor a compactor at the municipality for spreading the waste into thin layers, compacting and covering with fresh layer of soil.
- Open dumping was simple, reliable and adaptable.
- Open dumping handled all types of wastes without any prior treatment.
- Open dumping did not require any complex mechanical installations and skilled labor.

The study further revealed that the selection of sites in the past was merely based on the availability of quarries rather than on Environmental Impact Assessments (EIAs). The environmental implications that arose from such planning shortfall have already been outlined in the foregoing Section. Location of landfills using the site availability criteria alone had also led to heavy travel and high transportation costs. The constraints identified for not incorporating environmental issues in the selection of landfill sites were a general lack of political will of awareness of the need for environmental impact assessment, insufficient public participation, lack of an adequate legislative framework, lack of institutional base, insufficient skilled manpower, lack of scientific data and information, and insufficient financial resources. Sanitary landfill planning is supposed to involve three major actors: land use planners of the town, the water authority and the SWM authority (Flintoff, 1984).The decision-making process on site selection is also supposed to be done in collaboration with the Ministries of Lands (Department of Physical Planning) and Water, but what was lacking was co-ordination among all these parties .This can be attributed to jurisdictional fragmentation and overlaps in the Kenyan legislative policies related to SWM.

4.8.2.5 Waste system operations are based on, and adapted to local user needs

Currently MCE is able to provide tailor made storage containers for its service users such as litter bins, refuse receptacles, compost pit or open drums

Equipments used during quarterly environmental clean ups are locally manufactured and easy to operate. These include brooms, rakes, wheelbarrows and shovels.

Plate 4.2: Embu environmental clean-up day

4.8.2.6 Waste management equipments manufactured and can be maintained locally at a low cost

Currently, MCE has four farm tractors (with tipping trailers), one side loader and a tipper lorry which have been manufactured and assembled in the country. When there's any need for repairs, the council hires the services of a local mechanic who is a resident of Embu.

4.8.2.7 Waste system operations are based on physical characteristics of the serviced areas

MCE started off collection of garbage using handcarts which were manually operated and could easily be manoeuvred within the footpaths and roads of Embu.

The council has since acquired 2 trucks and 4 tractors through various grants from development partners, Funding from Central government through LATF or donor agencies and also from its own revenue generated locally. The trucks have facilitated the ability of MCE to increase coverage area for service to affluent areas of which are endowed with all weather roads. The other characteristic of these affluent areas or institutions includes planned housing and roads, thus providing easy access from one street to another by trucks. However, most low class settlements in Embu are characterized by weathered, narrow roads, footpaths and unplanned housing, thereby making access of streets by trucks difficult. As a consequence MCE waste workers have to collect garbage from plots on foot, and bring the garbage to a truck parked in a main street that is easily accessible.

4.8.2.8 Waste system not able to facilitate waste recovery, reuse and recycling

Waste that is collected is mixed. It is neither sorted by the service users or MCE waste workers. Scavengers sort and salvage valuable waste before transportation at the transfer stations and at the designated dumping site.

It is undisputable that source separation of waste, would ensure that salvaged valuables are clean, thereby saving time and other resources like water which are required for cleaning. Furthermore, clean valuable waste fetches a higher market price, and ensures that recycled products are of better quality. It can be said that the middlemen who purchase the salvaged materials from the scavengers understands the financial consequences of trading clean salvaged waste hence they ensure that the salvaged waste is cleaned before it is traded or recycled.

4.8.3 Financial/economic aspects

4.8.3.1 MCE Sources of SWM resources

The major sources of revenue for the MCE include Local Authority Transfer Fund, Contribution in Lieu of Rates, Road Maintenance Levy Fund, Business Permits, Slaughter Slab, Rent, Market fees, Vehicle parking fees and Cess. There was no major source that goes direct to SWM since all the money went to the same pool. Therefore, meeting the financial demands of SWM was a major problem in MCE. The council was not able to estimate the true costs of their entire SWM operations. This was because SWM expenditures were simply rolled into the conservancy section. Similarly, all the capital expenditures of the Municipal council were lumped up into the engineering department.

The MCE economic environment is characterized by high poverty levels, poor infrastructure, poor agricultural market, low industrialization, poor planning and development control, and un-employment. In addition, the council faces constrained revenue resources hence posing a major challenge to service delivery.

4.8.3.2 The Waste system is not able to sustain itself e.g. through service charge

MCE provides service to different income groups as well as different generators of waste such as households in the informal settlements and affluent residential areas, restaurants, institutions. These different service users are charged similar rates per month that is Ksh 25 for every connected meter by EWASCO (Embu Water & Sewerage Company).

EWASCO collects approximately Ksh 128,700 per month from 5,148 meters and remits the same on quarterly basis to MCE for SWM services provided. The funds are for payment of salaries and operation costs. Operational costs include maintenance of trucks, fuel costs and other equipments. However, there is lack of surplus that could be used for other projects like acquisition of land for waste disposal.

4.8.3.3 Service users willingness and ability to make timely payment for the service

As aforementioned, Collection of fees is carried out by the Embu water and sewerage company (EWASCO) through water bills. This company is entrusted with the provision of water and sewerage services to the residents of Embu with the Municipal council of Embu (MCE) being a major share holder. To ensure efficiency in the collection of the fees charged, EWASCO has ensured that most of the water connections are metered. The consumers are supposed to pay their water bills on monthly basis failure to which water supply to their premises is disconnected. Once disconnected the consumers are supposed to pay reconnection fee, which is purposively set at a relatively higher price of ksh.500 to deter defaulters. To ensure that their operation and maintenance cost are met, EWASCO charges a minimum of ksh. 275 per month to every metered connection.

However, the issue of defaulters or absent service users in Embu compromises timely payments of services offered by MCE. In addition, not all residential areas within Embu municipality are provided with metered water connection (legal connection) by EWASCO, but are provided with SWM services by MCE.

MCE spends an average of approximately ksh. 3,714,478 per annum on SWM as per the approved 2011/2012 financial year budget (MCE, 2011).

4.8.4 Social/cultural aspects

4.8.4.1 Workers handling waste provided with proper working equipment and protective gear (working conditions)

MCE provides gloves to waste workers in addition to overalls and gumboots. Gloves mainly require regular replacement as compared to other protective gear. Timely replacement of worn out protective gear is often a challenge to MCE as everything has to be budgeted for, beforehand. According to the interviewed waste workers there are delays in replacement. The same applies to

equipments.

Often waste workers serving on temporary basis have no access to protective gear as the MCE cannot afford the luxury of purchasing these in surplus. An interesting twist to provision of protective gear is whether the waste workers in general, are willing to use them. From the interviews conducted with waste workers, there was an indication that gloves and gumboots are a nuisance during hot days because of the resulting discomfort.

MCE Waste workers have to manually load collected waste from storage containers. The whole series of actions is very labour intensive including lifting of heavy waste containers, making it unattractive for involvement of women. MCE does not provide Medical insurance cover to the waste workers.

4.8.4.2 Workers are paid a regular salary

Waste workers in MCE start work from 8am to 5pm from Monday to Saturday, with one hour lunch break, but the working hours could extend beyond 5pm depending on the traffic condition. The permanent waste workers are entitled to a small allowance for the afternoon meal when out for duty. The workers who are employed on a permanent basis by MCE are paid on a monthly basis while temporary staff receive a daily wage for the days worked. (Personal communication with MCE Cleansing Superintendent, July 2011).

4.8.4.3 Activities / campaigns create awareness among service users on waste behaviour, waste reduction, reuse and recycling

Environmental cleanups are some of the activities used by MCE's members to reach out to Embu members for their support. For environmental cleanup exercises, the local chief, NEMA District Environmental Officer, churches and schools are involved in the cleanups. Furthermore, the local chief's office, churches and schools are avenues used by MCE to pass on information, on upcoming environmental cleanups or campaigns to the community. These activities held every quarter of the year, also serve as avenues for campaigns on environmental issues, proper sanitation behaviours and seek to recruit additional service users.

The measure of success of these avenues in promoting proper sanitation behaviours is not clear, but service users from Embu who were interviewed are aware of and some practice reuse and recycling (mainly composting) as part of solid waste management.

4.8.4.4 Capacity building for waste workers and other MCE staff facilitated

MCE is privileged to partner with NEMA and NGOs such as Practical Action. These NGOs give technical support through tailored trainings offered to the waste workers and other MCE staff. Some of the trainings offered focus on environmental issues in relation to solid waste and proper waste handling. Training programmes and regular monthly payment for waste workers act as incentives and motivation to ensure commitment to efficient provision of services.

Trainings for staff are held on ad hoc basis especially when funds are available or if there are new emerging issues on managing solid waste. The trainings mainly focus on waste separation at source, recycling and use of simple, local equipments.

4.8.5 Environmental/Public health aspects

4.8.5.1 Waste system not able to safely remove all waste from the community neighbourhood

As previously mentioned, not all households in Embu are provided with garbage collection. This creates a scenario of both serviced and unserviced pockets within the same community necessitating regular environmental cleanup campaigns. Informal settlement areas such as Majengo are characterized by high mobility of households and a high number of tenants, possibly making establishment and maintenance of cooperation difficult.

In addition, the scavengers are involved in waste recovery, reuse and recycling mainly for economic benefits. However, the resulting positive environmental impacts, for instance reduction on exploitation of virgin resources, cannot be overlooked. Provision of tailor made waste containers and transportation of waste to the disposal site, can be said to promote safe waste removal from the source of its generation. However, some of the storage containers for example the open drum expose stored waste which becomes conducive ground for breeding of flies, in addition it's a source of obnoxious smell. Use of gunny bags face the danger of liquids seeping through. There is also the challenge of stray dogs tearing up garbage bags, and the unserviced households in Embu depict a scenario of inability to remove all waste from the neighbourhood. There are reports by MCE of continued indiscriminate dumping in the area.

4.8.5.2 Practice of waste recovery, reuse and recycling by the MCE and its members

Unfortunately, separation of waste at source and recycling (mainly composting) has not quite taken root within Embu municipality. Waste separation within the informal settlement is for example inhibited by the nature of housing plan within a plot, which takes up virtually every available space. Involvement in waste recovery is only carried out if there's a direct benefit accrued to the service user. For instance, some households interviewed in Embu practice organic waste recovery for compost making for their food garden. One respondent representing a plot in Blue Valley estate in Embu with 3 semi-permanent houses remarks:

> *"My wife selects potato peelings, remains from vegetable, fruits and puts them away at the corner of the compound. I mix these with ash from the charcoal cooker and leave it there for a few weeks, before using it in the garden as manure, for our own food."* (Personal communication with a respondent, July 2011)

Plate 4.3: Blue valley (1/4 acre) in Embu showing composting and practice of subsistence farming

CHAPTER FIVE

5.0 MCE SOLID WASTE MANAGEMENT ACTION PLAN

5.1 Introduction

Waste management is widely recognized as a major concern in MCE and for sustainable development. Most of the solid wastes in the MCE remain uncollected. Resultant effects include spread of infectious diseases, blocked sewers and litter in the streets through crude dumping. With both direct and indirect linkages to economic development, waste materials represent wasted money, in terms of the original cost of the materials, the disposal and in its potential value as a recyclable and reusable resource.

It is widely recognized that the concept of ISWM is an approach to reach better, more sustainable solutions to these problems (Ogawa, H., 1997). The concept not only takes technical or financial-economic sustainability into account as in conventionally done, but it also includes socio-cultural, environmental, institutional and political aspects that influence overall sustainability of waste management.

ISWM involves four levels.

- **Source Reduction**, which is the reducing of the amount and/or the toxicity of waste we generate at source.
- **Recycling,** this involves collecting, reprocessing, marketing and using materials that were once considered waste. This is commonly being referred as 5 Rs approach, i.e. Reduce, Recycle, and Re-Use, Re-Think and Re-sale.
- **Waste Combustion** -this method reduces the bulk of municipal waste and can provide the added benefit of energy production.
- A final level is **sanitary land filling**, which is at the bottom of the hierarchy necessary to manage non-recyclable and non-combustible wastes

This document presents a strategic and integrated five year approach that aims to provide the MCE with practical ways, detailed intervention plans and financial requirements for addressing SWM in the town.

5.2 Strategic Areas

Strategy is based around the following 12 major strategies:

Recycling and composting programmes, Storage facilities, Collection Systems, Transportation of waste from Collection to Disposal Points, Waste disposal, Handling of special/hazardous waste, Environmental educational awareness, Capacity building of stakeholders, Private Public Partnerships (PPP),Legislative Framework on SWM, Resource Mobilization, and MCE organizational set-up

5.3 Key Objectives

The key relevant objectives for the implementation of the strategies above are:

- To establish recycling and recovery programs
- To ensure adequate provision of storage facilities
- To establish efficient waste collection systems
- To ensure efficient transportation of wastes from collection to disposal points
- To ensure proper disposal of wastes
- To ensure proper handling and disposal of special/hazardous waste
- To ensure education and awareness on SWM issues
- To promote capacity building of stakeholders
- To encourage Public Private Partnerships/Privatization
- To ensure enforcement and compliance with the legislative framework on SWM
- To mobilize resources for SWM
- To change the SWM organizational set-up

5.4 The Strategy for MCE

5.4.1 Vision

The vision of the ISWM strategy for MCE is to have an economically and environmentally sustainable Embu town with a cost effective and self-sustaining Pro-poor Integrated Solid Waste Management (ISWM) system.

5.4.2 Overall Goal

The overall goal for the Solid Waste Management Strategy, 2012-2017 is that: MCE will adopt cost-effective and self-sustaining Solid Waste Management systems to protect the environment, public health and ensure sustainable urban economic growth.

5.4.3 Specific Goals

The specific goals of this strategy are to:-

- Adopt an integrated approach which includes strategies for avoiding and reducing waste generation, waste reuse, recycling, composting, disposal, and waste collection;
- Adopt appropriate legislation which are practical, effective, and culturally-sensitive;
- Develop communication strategies that are culturally-sensitive to support SWM activities;
- Enhance the capacity of the people and institutions to manage solid waste;
- Establish policy, planning and monitoring systems that will ensure the development, implementation, and monitoring of solid waste management policies and strategies;
- Develop environmental monitoring programs to protect the environment;
- Adopt strategies for effective and compliant management of hazardous and special waste;
- Adopt measures to support financially sustainable SWM programmes.

5.4.4 Mission and Core Values of MCE

The core values of the MCE are; good leadership, capacity building of our people and stakeholders, diversity is our strength, integrity in our operations and service delivery, recognition and appreciation, and communication

The vision, mission and core values of the MCE helped design its objectives and strategies. The same will be used in the implementation of this ISWM strategy. This will be through provision of a quality SWM service while promoting local economic developments, which support growth, equity and security.

5.4.5 Guiding Principles

Implementation of the ISWM strategy will be guided by the following principles and approaches:

- Active involvement, education, and communication with all stakeholders through a comprehensive, consultative and participatory approach to influence behavior change
- Personal and corporate responsibility, including the user/polluter pays approach, the extended producer responsibility principle and appropriate economic incentives
- Sustainable approach to integrated solid waste management
- Holistic and precautionary approach, mindful of future demographic trends and technological advances

5.4.6 Strategy Approach

Key findings indicate that conventional methods have been the dominant models of solid waste collection and disposal Within Embu Municipality. However, there is a shift in SWM from the Council led to multiple provision stakeholders. There is also a shift in the Local Authority from that of a sole implementer to a more facilitating role, which provides room for active involvement at grassroots in provision of services.

Consequently, this strategy presents a new provisioning termed Public Private Partnership (PPP) approach which will:-

- Allow multiple service providers operating at different zones and levels of SWM
- Facilitate use of different technologies for different SWM hierarchy
- Different SWM service charges and modes of payment and financing for zone and level
- Resource minimization technologies to employment modern small-medium scale technologies and by both private and SMEs
- Development of intermediate collection and transportation points to reduce distance and cut transportation costs on private companies.

Based on the above information, the following chapter presents the key interventions of the 5-year ISWM Strategy for MCE.

5.5 Situational Analysis

5.5.1 Introduction

SWM is a major concern in Embu town. This is characterized by heaps of solid waste in both the residential and commercial areas. The amount and types of solid waste generated in the MCE varies greatly. Adequate storage, collection, transportation, disposal and recovery activities and services are beyond the resources of the local authority. The authority generally lacks the means to manage the rapidly growing amounts of solid waste. The following factors were responsible for the poor SWM service:

- Insufficient financial resources within municipal authority and poor mobilization of resources.
- There are no viable economic incentives to encourage waste recycling, waste reduction and investments in safe disposal

- Lack of political and institutional support (weak by-laws) and low enforcement of the existing laws and regulations.

- The absence of a systematic approach on SWM to regulate both the generation points, facilitation of waste characterization, encouraging of economic and sustainable management options (segregation, recycling/reusing) and lack of provision on ultimate disposal.

- Poor community attitudes towards environmental cleanliness shifting responsibility to the municipal authorities

- Lack of general awareness among the communities on sustainable SWM

- Inadequate SWM mechanisms at generation points including collection, storage and transfer logistics

- over-reliance on imported and inappropriate technology and equipments

- Inequality in service provision.

Solid waste generation is highest in the markets and commercial zones of the CBD. The Municipal Council provides transfer stations for storage of this waste. The MCE owns four (4) tractors, one side loader and a tipper for transporting this waste to the dumping site located 7 km away from the CBD. The site has an overall size of 1.5 hectares. This area has not been designed and the present dump therefore occupies 0.5 hectares. Its proximity to residential areas allows easy access to people and animals which may be a health hazard. Individual households undertake most of their collection which is often disposed off in open spaces by hand e.g. by roadsides, alleys and undeveloped plots. This is because the municipality is unable to reach these areas.

5.5.2 Institutional Framework for SWM in MCE

5.5.2.1 Regulation and Policy Environment

SWM problems in the municipality are largely as a result of a lack waste management policy and framework that would aim at improving the standards, efficiency and coverage of waste from ''Cradle-to-Grave''. Before the enactment of Environmental Management and Coordination Act (EMCA) 1999, Local Authorities (LAs) had monopoly control over sanitation and SWM services under the Local Government Act (CAP 265) and Public Health Act (CAP 242). The former empowered LAs to establish and maintain Municipal Solid Waste (MSW) management services while the latter required them to provide the services. The Acts however neither set standards for the service nor require waste reduction or

recycling. Similarly, the Acts do not classify waste into municipal, industrial or hazardous types or allocate responsibility over each type.

Considerable effort has been made with respect to policy and legal/regulatory framework for SWM since EMCA 1999 allocates considerable property rights as far as various aspects of environmental management are concerned. The most important of this is the right to clean environment allocated to the citizens. The citizens can now compel polluters, including indiscriminate waste dumpers, to pay for the damage or nuisance caused. In reality however, the cost of litigation (both in terms of finance and time) makes it difficult for most of the citizens to exercise this right. Other important rights are those allocated to NEMA, e.g. with respect to licensing of waste disposal facilities. Institutional weaknesses in NEMA and other lead agencies also affect the effectiveness with which this right can be exercised.

The MCE and communities operating in the town play only a small role in SWM because they are not integrated into the formal system. Policies on community based SWM service are lacking and there is need to emphasize development of environmental partnerships with stakeholders.

As would be expected of any legislation, there are several shortfalls in the Kenyan legislation on SWM. This survey does not intend to give a detailed analysis of the current solid waste legislation but to pin-point the major shortfalls that need attention by environmental policy makers. Most of the shortfalls in the Local Government Act 1984 are administrative or political in nature and affect the SWM less indirectly than directly. Restructuring of the Local Government Act of 1963 in 1984, gave the Minister for Local Government immense powers in the control of local authorities in Kenya. The current Act therefore denies local authorities autonomy in decision-making and management of their affairs. Municipalities and thus MCE should have the liberty to choose waste management programs, limit waste disposal, impose generation and disposal levies, or do whatever it is that best fits their needs and/or abilities. Currently, the council does not have this freedom. The 1984 Act also makes it difficult for the MCE to hire and fire its own employees. These kinds of limitations for the MCE have led to institutionalization of bad practices of SWM in the council. Such legal shortfalls have also led to understaffing problems in most of the Municipality's Departments with incompetent and unskilled staff thereby affecting service delivery. It is essential to increase the revenue base of the Council. However, under Section 148 of the Local Government Act, the local authorities and thus MCE have no powers to effect any fees or charges or make any expenditure on any service without the approval of the Ministry of Local Authorities. All

financial estimates/budgets must be approved by the Minister of Local Government before expenditure takes place. Under such loopholes in revenue collection, there are more beneficiaries than contributors in the provision of basic services. The MCE therefore lacks regulation for collection, storage, transportation and disposal of solid waste. There are no by-laws to facilitate solid waste recycling enterprises in the town. The MCE, as a local authority, is under obligation under the provisions of the Public Health Act to take all lawful, necessary and reasonably, practicable measures for the maintenance of its areas at all times in clean sanitary conditions, and for the prevention of the occurrence thereof, or for the remedying or causing to be remedied, any nuisance or condition liable to be injurious or dangerous to health, and to take proceedings at law against any person causing or responsible for the continuance of such nuisance or condition (Republic of Kenya, Public Health Act). Section 118 gives a list of what shall be deemed to be nuisance for purposes of the Act. Among these are two situations that are within the scope of this study. The first is any garbage receptacle, dustbin, dung pit, refuse-pit, ash-pit or manure heap so foul or in such a state so situated or constructed as in the opinion of the MOH be offensive or to injurious or dangerous to health. The second is any accumulation or deposit of refuse, offal, manure or other matter whatsoever which is offensive or which is injurious or dangerous to health.

In both of these situations, the MOH must serve a notice on the author of the nuisance or, in his absence, on the occupier or owner of the premises on which the nuisance arises, requiring him to remove it within such time as specified in the notice, and to execute such work as may be necessary to prevent a recurrence of the nuisance. Where the author of the nuisance cannot be found and it is clear that the nuisance does not arise or continue by the act or default or sufferance of the occupier or owner of the premises, then the MOH must remove the same and do what is necessary to prevent the recurrence thereof. In the two situations described above, the author of the nuisance is the MCE due to its failure to carry out the duty of cleaning the town. Where the Council cannot remove its own nuisance, the residents are left to help themselves because they cannot be able to take the MCE to court. Hence, the burning of garbage causing environmental pollution among other poor disposal methods are the only options available to waste producers in the municipality. Apparently, the Public Health Act superficially treats all wastes equally without due weight on the toxicity and the consequent pollution and health hazards on the individual waste category. This is simply due to lack of environmental health standards as pertains to waste management in Kenya. This has led to a situation where there is no waste segregation at source in the MCE. The Act gives power to

the MCE or any other local authority to make By-Laws in respect to all such matters as are necessary or desirable for the maintenance of the health, safety and well-being of the inhabitants of its area or any part thereof. The provision is repeated in the Local Government Act, Section 201. The irony with such provision is that, the same author of the nuisance is expected to make by-laws against himself. (Municipal Council of Embu Solid Waste Management By-laws 2009).

However prioritizing cleaning in the budget was not given special considerations in the by-laws. There was no money charged for garbage generation or dumping although there used to be a fee levied against dumping in the Embu earlier in the 1990s. This was not effective and was stopped (service charges were also scrapped) with the entry of the single business permit. EMCA 1999 and the 2007 NEMA Waste Management Regulations as stipulated in the Kenya Gazette supplement No 69 of 29thSeptember, 2006 under Legislative supplement No. 37 and Legal Notice No. 121, Environmental Management And Co-ordination (Waste Management), Regulations 2006 outlines details on:-

- Definition of waste
- Responsibility of waste generators
- Segregation of waste by generators
- Cleaner production methods
- Licensing for transportation of waste
- Modes of Transporting waste
- Licensing of disposal facilities
- Waste treatment by operators of disposal sites
- Requirement for Environmental Impact Assessment of SWM facilities
- Requirement for Environmental Audit of SWM facilities
- Operations of Re-use and recycling plants
- Handling, storing and transporting of hazardous waste
- Classification, registration, labeling, packaging, advertising, import, export, distribution, storage, transportation, handling and disposal of pesticides.
- Management of biomedical wastes
- Management of radioactive substances

The above comprehensive regulations use an integrated approach in SWM. The operationalization is on-going and they tend to address most of the gaps reviewed above. These regulations are superior to any other existing regulation as per EMCA, 1999.

5.5.3 Internal and external analysis

One of the most critical activities in strategic planning is to analyze the environment within which an institution operates. One popular way of doing this is to understand the Strengths, Weaknesses, Opportunities, and Threats that the institution has. It defines the relationship between internal and external appraisals. The external appraisals (Opportunities and Threats) are those conditions that have a broad rather than direct impact on an organization. The internal appraisal (Strengths and Weaknesses) focus on human resources, technology, structure, culture or traditions, processes, physical facilities, policies and other internal conditions that directly affect an organization. For this analysis, SWOT analysis method was used.

Table 5.1: SWOT Analysis

Strengths	Weaknesses
- Empowered citizens with knowledge on SWM - The municipality councilors have excellent organizational skills through which a vibrant campaigns can be initiated to mobilize and sensitize residents on SWM issues - The council has a fair image from the public when it comes to support - Physical assets, infrastructure and equipments e.g. Tractors, existing transfer stations, and various types of receptacles and Viability of good road network - Existence of drafted SWM By-laws, & relevant Acts e.g. the NEMA Act, Public Health Act, and Local Government Acts to ensure proper SWM - Availability of municipal enforcement *askaris* and other regulation and enforcement agencies - Institutional framework; There is the District Environment Committee to guide in implementation of SWM issues; There is technical support from various institutions and the government - The MCE owns the current dumping site.	- Lack of Public-Private Partnerships - Limited funding opportunities - Inadequate SWM tools and equipments - Impassive supervision of SWM staff - Lack of enforcement and implementation of existing by-laws and other regulations - Weak MCE administrative structure, personnel roles are not very clear - SWM budgeting is not being emphasized - Inadequate training of personnel in SWM - Lack of staff capacity in the social welfare department to undertake social action programs promoting ISWM systems - Embargo on new staff employment and inadequate number of employees - Poor frequency in garbage collection - Low Attitude of residents towards SWM issue - Roaming animals, in most cases, animal bodies are littered all over the town - Dumping site not managed well, not fenced or protected - Relevant government departments work in isolation and the council is perceived as being 'thoracic' when administering

Land can be sold and proceeds used to purchase a new site • Good will of the people • Government institutions and other institutional frameworks e.g. DEC, and various tools e.g. Solid Waste Management Regulations 2006 offer technical support on SWM issues	enforcements
Opportunities • The Ministry of Public Works has equipments and machinery which can be effectively utilized in SWM services • Different types & quantities of waste which can be reused and/or recycled • Good will and willingness of people to separate waste at source • Good security situation in Embu • Presence of international and local investors, financial and business institutions • current dumpsite can be reclaimed • Presence of Government Departmental offices e.g. NEMA • Cultivated donor confidence • Supportive political leadership with a development agenda and strong community cohesiveness • Interest in environmental issues in the mount Kenya region by development partners • Various environmental funds e.g. devolved government funding like CDF, LATF • Local initiatives e.g. Kazi kwa vijana project • The Multi-Stakeholders Forum (MSF) is already established on the ground • Adequate and cheap manpower high number of institutions of learning in the region, availability of human capital Region endowed with a pool of professionals and young graduates • Central government and its agencies like NEMA and the municipality already have policies and regulations on SWM • The town is located in a strategic area • The town is growing very fast & with the passage of the new constitution, it going to be the headquarters of Embu County • Periodical investment opportunity reports by the District Development Office have identified potential investment	**Threats** • With the passage of the new constitution, the Council can be dissolved. • Residents have a negative attitude towards SWM and rate payment. • Natural calamities e.g., drought, climate change etc • Poor planning and lack of a focused development agenda denying locals an opportunity to invest in SWM • Lack of capacity and technological development to handle waste • Inadequate dumping space in comparison with waste generated • Lack of finances and other resources for efficient SWM provision • With the passage of the new constitution, all public land will be under the commission of land. This will create new issues within the council on land related matters • Population increase is fast compared with the capacity for service provision • Impunity e.g. resistance towards improved waste generation and disposal mechanisms from entrenched vested interests • Prevalent perception of NGOs as being rivals to the Government and the local authority in competing for donor funded resources • Land tenure practices encouraging sub-division without planning may lead to conflicting land policies • Shortfalls of SWM legislations, • Instability of the coalition government, bureaucracy in decision making process, corruption and poor record keeping • Unrealistic demands by donor agencies leading to conflicting local interests • Ignorance on environmental issues • High levels of unemployment and poverty • Undeveloped infrastructure

opportunities in SWM • Government policies e.g. vision 2030, national development policy, national environment policy	• Slow pace of political reform, likelihood of political interference and meddling by powerful local forces, corruption in national and local governments.

5.5.4 Stakeholders Involved in SWM in Embu

In Embu, there exists a wide range of individuals, groups and organizations currently faced with the challenge of SWM. These stakeholders include the Central Government, the MCE, informal groups, Community Based Organizations (CBOs) and individuals.

5.5.4.1 Central Government

The Central Government is responsible for establishing the institutional and legal framework for SWM. The Ministry of Local Government has high power of MCE, which limits the council's ability to make independent decisions with regard to spending priorities and policies. In addition the National Environmental Council (NEC) formulates national environmental policies and priorities while the National Environmental Management Authority (NEMA) is the government implementing agency with a coordinating, guiding and outreach role. The Government is also unable to adequately fund the council's programmes. However, there are opportunities like linkage to partners, provision of political goodwill, and the holder of the current policy on environment and food policy.

5.5.4.2 The Municipal Council of Embu (MCE)

The MCE is generally responsible for the provision of solid waste collection and disposal services. It is the legal owner of waste once it is collected or put out for collection. Besides SWM, the municipal council is also responsible for the provision of the entire range of infrastructure and social services. The vital Department of Environment is yet to be established to take up the responsibilities of SWM from the Engineer's Department. The present organizational structure therefore gives little leverage to undertake effective SWM in the municipality as a result of weak planning and development control framework and inadequate capacity to enforce environmental regulations. Institutional norms are weak and unsupportive of environmental planning and sanitation. As a result, the authority generally lacks the means to manage the rapidly growing amounts of solid waste.

5.5.4.3 The Informal Sector

The informal private sector carried out unregulated waste activities. These included small scale entrepreneurs and waste salvagers. These groups undertake waste collection and small

scale recycling as a source of income and a strategy to improve their surrounding environmental health situation. The street waste salvagers operate in the commercial and residential zones, obtaining waste material from open spaces, communal dumps, dustbins and other waste receptacles. Waste dealers also acted as brokers and thus linkages between the waste pickers and SMEs within the town and beyond and also Waste Recycling Industries in Nairobi. Therefore, waste can be a source of livelihood to a large number of people.

5.5.4.4 Individual Households

Individual households are interested in receiving effective and dependable waste collection services at reasonably low price. However, in low income a residential area like Majengo, there is no collection leading to a situation where solid waste is commonly dumped onto nearby open spaces, along roads and pathways, into drains or dug holes within their compounds. Individuals have a negative attitude towards SWM, with a perception that it is the Municipality's duty to deal with solid waste.

5.5.4.5 Local Community

The local community has high interests in SWM in that they want to live in a clean environment. They however have little power in policy formulation and strategy direction. The local community poses a number of threats which include potential for local politics to negatively affect service provision, perceived expectations, realized benefits and direct competition.

5.5.4.6 Donors and Financiers

Potential donors and other financiers are expected to have high interests in SWM of the Municipality. They have high powers because of their ability to provide funding and influence policies. The opportunities they provide include their ability to provide resources, ability to influence thinking and policies, potential to optimize utilization of local natural resources and ability to promote a good image. The threats emanating from this category of stakeholders include tarnishing of the Council's name especially after bad experiences, ability to cripple projects by withholding funding and potential over-dependency of funding.

5.6 Strategic Issues, Strategic Objectives and Key Actions

Strategic issues are key challenges facing an organization derived from environmental appraisal. This section discusses the overall aim and strategic objectives of the strategy as well as a 5-year intervention action plan to improve existing waste collection, transportation

and disposal systems. This strategic plan gives the ways these objectives will be accomplished. It makes use of the PPP to enhance the technical, institutional, social and financial issues related to SWM.

The overall aim of the SWM strategy for MCE is to provide an efficient and sustainable solid waste management system through the creation of an enabling environment for multi-stakeholder participation and adoption of an ISWM strategy for the town. In pursuit of this, the key strategic issues are outlined below;

5.6.1 Recycling programmes

Recovery and re-use of solid wastes is a major step in reducing quantities of waste ending up in the landfill (Lund 1984; UNCHS, 1994). The predominant waste type in Embu is organic waste with significant portions of paper and plastic waste. The large amounts of organic waste indicate the necessity of frequent collection and immediate composting. The significant amount of paper and cellulose material, plastics and rubber, and metals indicate that the waste can be recycled or reused.

Key strategic objective 1: To establish recycling and recovery programmes

The key actions to help realize this objective are;

- Establishment of recycling micro-industries/ enterprises on: Plastics (to make plastics poles, blocks, household items, shredding, etc), organic materials, bones/ horns, scrap metals, glass/ bottles and waste papers

- Training of youth on recycling technologies

- Separation of waste at source to reduce the amount disposed at the dumpsite/ to encourage recycling in the town.

5.6.2 Storage facilities

Storage of solid waste is a major challenge in Embu town. Storage facilities are mainly provided by MCE. However due to financial constraints and political issues, there have been inadequacies in the supply of storage facilities. There is need for provision of adequate storage material by replacing those destroyed not only in the CBD area but also in the estates. The bins should also be compatible with planned recycling systems.

Key strategic objective 2: To ensure adequate provision of storage facilities

The key actions to help realize this objective are;

- Replacement and repair of storage containers that are currently provided by MCE

- Adding of more standard storage containers because the town is growing

5.6.3 Collection Systems

The proportion of solid waste generated to that collected is very low in the MCE. This leads to indiscriminate dumping on either private property or public open spaces. There is also inequality in service delivery where the high and middle income areas of the town are well serviced by MCE, while low income households are not serviced. The collection efficiency is also hampered by the inappropriate waste container design. Households dispose their waste without plastic bags slowing down the collection process. There is non-uniform and biased distribution of collection containers.

Key strategic objective 3: To establish efficient waste collection systems

The key actions to help realize this objective are;

- Establish more and well planned transfer stations

- Increase the capacity of the receptacles

- Improve on management of transfer stations

- Redesigning of the waste collection sites i.e. the transfer stations to be user friendly.

- Research on the reasons for failure of some constructed transfer stations.

- Repossessed plots by MCE can be used as transfer stations

- There should be a weekly schedule for collection of wastes from the receptacles

5.6.4 Transportation of waste from Collection to Disposal Points

Transportation of wastes is a strategic area to be addressed because of poor road network and infrastructure in the town. Accessibility to the dumping site is a major challenge especially during rainy season due to lack of an all weather road. The vehicles currently in operation are underutilized. Poor planning of the town also hampers accessibility especially in informal settlements hence non-accessibility of these areas by the transportation vehicles leaving wastes un-collected.

Key strategic objective 4: To ensure efficient transportation of wastes from collection to disposal points

The key actions to help realize this objective are;

- Improve road networks for easy waste collection and disposal

- Repair of the existing transport facilities through a good repair and servicing system.

- Acquire new transport and disposal equipment, e.g. Compactor vehicles, etc.

- In the long term (2017) there should be compulsory acquisition of land in the informal settlements in order to develop access roads

- Town planning department to immediately do the Planning to make residents aware

5.6.5 Waste disposal

The most common methods of waste disposal in Embu are: open dumping, open burning and incineration of medical waste. Open dumping/unsanitary land filling is the most preferred method. There is no control on dumping at the site and composite mixture of solid wastes (including garbage, commercial wastes and ashes) are dumped haphazardly within the site and outside the boundaries without due regard to surface water flow, wind transport of particulate matter and pollution potential to sources of water. Due to dismal separation of waste at source and communal collection points, the area around the site is littered with all types of waste, ranging from hazardous medical waste to an assortment of paper, plastic, metal and biodegradable materials. The site is not fenced and therefore not protected from intrusion by people and animals. The site is already full.

Key strategic objective 5: To ensure proper disposal of wastes

The key actions to help realize this objective are;

- Establishment of a new dumping site/ relocation of the current dumpsite

- Compact the existing waste at the dumpsite in the short term

- Re-filling of quarries from the current road projects

- MCE should start identifying new sites for the dumping site and start negotiations with the contractors and owners of the quarries to reserve the quarries for disposal

- Proper disposal of construction waste which at the moment is haphazard

- MCE to establish a commercial incinerator at the dumping site to handle hazardous waste and serve the Municipality.

5.6.6 Handling of special/hazardous waste

Handling of special/hazardous waste is a strategic issue because of the incapacity and lack of Knowledge of generators of this category of wastes to properly handle their wastes. Hazardous waste such as medical waste, batteries, used oil; dry cells among others are increasingly becoming a big Challenge with the growth and development of Embu town. There is only one standard incinerator at Embu provincial hospital serving the entire hospital.

Key strategic objective 6: To ensure proper handling and disposal of special/hazardous waste

The key actions to help realize this objective are;

- Proper handling and disposal of various categories of hazardous/special waste, for example, dead animals, e-waste recovery plant in the town, oil from Jua kali garages, hospital wastes, unclaimed bodies and body parts among others

- Regular monitoring by the public health department

5.6.7 Environmental educational awareness

The lack of training, education and awareness coupled with the negative attitude and lack of Cooperation from the community on SWM is a major constraint towards achieving sustainable SWM. Therefore, awareness and sensitization program is imperative for sustainable SWM service provision. Such a program should focus on a number of areas including: incorporation of environmental education in the school curriculum; waste separation at source, neighborhood clean ups, demonstration and/or pilot SWM projects, community participation in SWM initiatives.

Key strategic objective 7: To ensure education and awareness on SWM issues

The key actions to help realize this objective are;

- Through the school system from early childhood

- Use all local communication systems / media to sensitize the public on good practices on waste disposal e.g. using even funeral meetings, church sessions, radio stations e.g. wimwaro fm, kameme fm and inooro fm etc

- Chief barazas; Door to door campaigns to create awareness and education on SWM

- Collective responsibility on environmental awareness by all stakeholders

- Youth groups to act plays on sensitization on SWM

- Sensitization of women on the need for proper disposal of sanitary towels; Households and schools to be targeted in sensitization condoms ;parents at the household level need to sensitize

5.6.8 Capacity building of stakeholders

The lack of training and sensitization on SWM by major stakeholders in Embu is a major Constraint. There is need to build capacities of CBOs, MCE, the informal sector and the local community on environmental management especially SWM; Public awareness education on SWM issues such as by-laws and community involvement

Key strategic objective 8: To promote capacity building of stakeholders

The key actions to help realize this objective are;

- Conduct Trainings on new SWM technologies

- Conduct workshops for stakeholders

5.6.9 Private Public Partnerships (PPP)

ISWM necessitates the need to involve all the relevant stakeholders in SWM. The MCE should join hands with other stakeholders in collection and disposal of solid wastes. This can be achieved through financial and technical support to the private waste collectors.

The key actions to help realize this objective are;

- Joint meetings with private sector to have presentations on solid wastes

- There is need for budgeting to strengthen PPP

- Identify more funding sources to facilitate PPP

- Support private entities in SWM

- Develop a PPP policy to define dealings with different stakeholders e.g. youth

5.6.10 Legislative Framework on SWM

There is a general lack of enforcement and compliance with the legal framework on SWM. Environmental Management and Co-ordination (waste management) regulations 2006 gives provisions for proper SWM, however, improper SWM is rampant right from generation to final disposal. There is therefore a need to come up with structures to ensure enforcement and

compliance with these regulations. Similarly there is need for the municipality to enact by-laws discouraging the use of certain categories of waste such as plastic waste.

Key strategic objective10: To ensure enforcement and compliance with the legislative framework on SWM

The key actions to help realize this objective are;

- Enforce SWM by-laws

- Enact by-laws to discourage the use of plastic bags

- Categorize the waste producers (carpenters, cereal sellers, etc) rather than operating without control

- Discipline and change of attitude

- Look at the current by-laws and fill in the gaps

- Various lead agencies and relevant stakeholders to be made aware on SWM regulations

- MCE to work together with the Public Health office in licensing of traders to ensure Public Health regulations are followed

- Harmonization of all activities involving laws on SWM at the local level

- Joint monitoring committees drawn from different stakeholders

- MCE should have a Public Health department; Department of environment to monitor on issues of compliance with legislation

5.6.11 Resource Mobilization

Resource mobilization is important to facilitate the implementation of this strategic plan. A strategic approach to resource mobilization entails moving from short term, reactive resource mobilization to long term mobilization of five years. It also means planning operational strategy based on the income streams that the council has. A Resource Mobilization Strategy (RMS) tandem with the overall Strategic Plan will be developed in order to attract more income, reduce dependency on traditional sources, reduce future donor dependence and develop a roadmap to self financing, diversify the funding base, increase unrestricted funds, ensure sustainability of the council, employ and retain quality and experienced staff and acquire more physical assets. The fundraising strategy needs will be based on the vision,

mission, core values, strategic objectives and targets. All stakeholders are expected to participate in mobilizing resources required to achieve the objective targets.

Key strategic objective 11: To mobilize resources for SWM

The key actions to help realize this objective are;

- Devolved funds from the government e.g. CDF

- Networking with international communities (UN HABITAT,SIDA,USAID)

- Fundraising through harambees

- Stakeholders to put some of the activities in their budgetary allocations

- Environmental funds and other bi-lateral funding in programmes within the municipality.

- MCE to have a budget line for SWM

- MCE to start charging fees for garbage collection

- Develop income generating projects that are self-sustainable and aimed at raising revenue.

- Technical waste committee comprising of financial institutions, investors

- Bodies which can give ideas to be incorporated

- Local investors with businesses in town to be brought in through corporate social responsibility

- MCE to charge the individuals dumping at the receptacles at the transfer stations to cover for transportation costs to the dumping site

- MCE to Sell of recyclable materials especially organic wastes

- Brand the council to be attractive to donors

- Borrowing from financial institutions.

- Privatization of SWM services to Private Enterprises

5.6.12 MCE organizational set-up

The reasons for poor SWM service provision in the MCE can be attributed to lack of proper planning and systematic approach by the Engineer's Department and lack of political and

institutional support. Consequently, SWM issues are not prioritized by the council in the allocation of funds for purchase of facilities, equipments and for operational costs. There is therefore a need to establish the Department of Environment which will be responsible for the provision of SWM services.

Key strategic objective 12: To change the SWM organizational set-up

The key actions to help realize this objective are;

- Establish the Department of Environment and recruit the technical staff e.g. the Director of Environment
- Capacity building of new staff
- Net working with other councils

5.7 Implementation Matrix

This section outlines the action plan matrix for the specific strategic objectives in this strategic plan for the period 2012-2017. Under each strategic objective, prioritized activities have been listed with their performance indicators and measurable targets. The matrix apportions responsibility to key stakeholders within a given time frame. The general assumption is that the Kenyan Government, development partners, and residents will be key players of the implementation process of the strategy to realize its vision. This vision is mainstreamed with the Kenyan Government vision 2030.

Objective/ Priority area	Key Actions	Responsibilities	Time Frame	Indicative Budget (Kshs Millions)				
				2012/13	2013/14	2014/15	2015/16	2016/17
1.Establishment of recycling programs	-Establishment of recycling plants/ micro-industries • Plastics (plastics poles, blocks, etc) • Organic Materials • Bones/ horns • Scrap metals • Glass/ bottles • Waste papers -Training of youths on recycling technologies -Separation of waste at source to reduce the amount disposed at the dumpsite/ to encourage recycling in the town	-MCE in partnership with various stakeholders; Town Engineer -Proposed Director of Environment	-Long term	1	2.5	5.0	7.5	10.0
2. Improve storage facilities	-Replacement and repair of damaged storage containers -Adding of more storage containers because the town is developing	- Waste generators - MCE-cleansing section in conjunction with various stakeholders	-Mid-term (2 years)	1.0	1.5	0.5	0.5	0.5
3.Improve waste collection systems	-Establish well planned more transfer stations -Increase the capacity and number of the skips -Improve on management of transfer stations -Redesigning of the waste collection sites i.e. the transfer stations to be user friendly - Research on the reasons for failure of the constructed transfer stations -Repossessed plots by MCE can be used as transfer stations -There should be a weekly schedule for collection of wastes from the skips	- MCE; Town planner, Cleansing department	-Mid-term (2 years)	1.0	1.0	0.5	0.5	0.5
4. Improve on waste transportation from collection to disposal points	-Improve road networks for easy waste collection and disposal -Repair of the existing transport facilities through a good repair and servicing system. -Acquire new transport and disposal equipment, e.g. Compactor vehicles, etc. -In the long term(2017) there should be compulsory acquisition of land in the informal settlements -Proper planning of the town by the Town planning department	-MCE; Town Engineer, Town planner - Kenya Rural Roads Authority (KURA)	-Long-term	1.0	2.0	3.0	4.0	8.0

Objective/ Priority area	Key Actions	Responsibilities	Time Frame	Indicative Budget (Kshs Millions)				
				2012/13	2013/14	2014/15	2015/16	2016/17
5. Improve waste disposal	-Establishment of a new dumping site/ relocation of the current dumpsite -Compact the existing waste at the dumpsite in the short term -Re-filling of quarries from the current road projects -MCE should start identifying new sites for the dumping site and start negotiations with the contractors and owners of the quarries to reserve the quarries for disposal -Proper disposal of construction waste which at the moment is haphazard -MCE to establish a commercial incinerator at the dumping site to handle hazardous waste.	-MCE;Town Planner	-Mid-term (2 years)	1.0	2.0	0.5	0.5	0.5
6. Proper disposal of special/ hazardous waste	-Proper handling and disposal of various categories of hazardous/special waste e.g. Dead animals, e-waste recovery plant in the town, Oil from Jua kali garages, ,Hospital wastes, Unclaimed bodies, Body parts e.t.c	-District Public Health Officer -NEMA -MCE	-Long-term	0.5	1.0	1.5	2.0	2.5
7.Environmental educational awareness	-Through the school system from early childhood -Use all local communication systems / media to sensitize the public on good practices on waste disposal e.g. using even funeral meetings, church sessions, radio stations etc -Chief *barazas*; Door to door campaigns to create awareness and education on SWM -Collective responsibility on environmental awareness by all stakeholders -Youth groups to act plays on sensitization on SWM -sensitization of women on the need for proper disposal of sanitary towels; Households and schools to be targeted in sensitization condoms ;parents at the household level need to sensitize	-Proposed Director of Environment -MSF -Public health department	-Immediate and continuous	0.5	1.0	1.5	2.0	2.5

Objective/ Priority area	Key Actions	Responsibilities	Time Frame	Indicative Budget (Kshs Millions)				
				2012/13	2013/14	2014/15	2015/16	2016/17
8. Capacity building of stakeholders	-Conduct Trainings on new SWM technologies -Conduct workshops for stakeholders	-MCE; Director of Social Welfare	-Immediate and continuous	0.5	0.5	0.5	0.75	1.0
9. Strengthen PPP/Privatization	-Joint meetings with private sector to have presentations on solid wastes -There is need for budgeting to strengthen PPP; identify funding sources -Support for private entities in SWM -Good structures in place where all the partners benefit -Develop a PPP policy to define dealings with different stakeholders e.g. youths	- MCE;Town clerk	- Immediate and continuous	0.5	1.0	1.5	1.75	2.0
10.Enforcement of laws and policies	-Enforce SWM by-laws -Enact by-laws to discourage the use of plastic bags -Categorize the waste producers (carpenters, cereal sellers, etc) rather than operating without Control -Discipline and change of attitude -Look at the current by-laws and fill in the gaps -Various lead agencies and relevant stakeholders to be made aware on SWM regulations -MCE to work together with the PH office in licensing of traders to ensure PH regulations are followed -Harmonization of all activities involving laws on SWM at the local level -Joint monitoring committees drawn from different stakeholders -MCE should have a PH department; Department of environment to monitor on issues of compliance with legislation	- MCE-Enforcement Officer - NEMA District Environment Officer - District Public Health Officer	-Immediate and continuous	0.5	0.5	0.5	0.75	1.0

Objective/ Priority area	Key Actions	Responsibilities	Time Frame	Indicative Budget (Kshs Millions)				
				2012/13	2013/14	2014/15	2015/16	2016/17
11. Resource mobilization	-Devolved funds from the government e.g. CDF -Networking with international communities (UN HABITAT,SIDA,USAID) -Fundraising through *harambees* -Stakeholders to put some of the activities in their budgetary allocations -Environmental funds and other bi-lateral funding programmes in this region -MCE to have a budget line for SWM -MCE to start charging fees for garbage collection -Technical waste committee comprising of financial institutions, investors -Bodies which can give ideas to be incorporated -Local investors with businesses in town to be brought in through corporate social responsibility -MCE to charge the individuals and CBOs dumping at the skips at the transfer stations to cover for transportation costs to the dumping site -MCE to Sell of recyclable materials especially organic wastes	- MCE;Mayor ; Town Clerk; Proposed Director of Environment	-Immediate and continuous	0.5	0.5	0.5	0.5	0.5
12. Change of SWM organizational set-up	-Establish the Department of Environment and recruit the technical staff e.g. the Director of Environment	- MCE;Town clerk ;Chairman of the finance and general purpose committee	- Mid-term	0.5	1.0	0.5	0.5	0.5

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5.8 Monitoring and Evaluation

Performance monitoring and evaluation shall be the responsibility of those who are most closely involved in the implementation of the annual plans. In this respect, the head of the relevant Municipality Departments will carry out continuous performance self assessment. They will be expected to have the capacity and will be given the responsibility to undertake performance measurement and reporting. MCE plans to put in place an effectual monitoring and evaluation system through a committee in order to ensure successful implementation of this strategic plan. The monitoring system will provide information on the progress of the implementation of the various activities that will form a basis for future improvements. The monitoring will improve service delivery and provide a basis for timely corrective interventions in case of failure. The objective will be to institutionalize an effective and participatory M&E system for the municipality. This will allow active participation of stakeholders and help build donor confidence.

It is envisioned that the municipality and its partners in the implementation of this ISWM strategic plan activities will agree on the indicators to be used and to provide feedback on progress. Reports will be key benchmarks on the progress on the implementation of ISWM activities in the MCE. The reports will enable the management and key stakeholders to track the implementation. Periodic reviews will be organized to determine status with intervention suggestions. The selection of indicators will take place at the design stage and will include indicators at all levels – objectives, inputs, activities, outcomes and impact. Outcome or impact indicators will measure the effect of activities in respect to the extent to which they meet the set objectives. On the other hand, process and output indicators at all levels will be important in monitoring and evaluation.

The methodology outlined below shall be used for performance monitoring and evaluation. At the beginning of the year, all sections dealing with SWM will set their performance targets as part of their annual work plans as derived from the strategic plan. In setting these targets, it is proposed that the performance framework shown in table 5.2 be used.

Table 5.2: Performance framework

Expected results	Performance indicators	Source of verification	Data collection methods	Data collection frequency	Responsibility	Assumption

Key reasons for monitoring are:

- It will establish if performance targets have been met and the explanations as necessary.

- It will act as an early warning system and detect potential difficulties and help to address them during implementation.

- It will provide feedback to the next phase of implementation, reduce the cost and /or increase the efficiency of post evaluation.

The various management organs will also monitor the progress of the implementation process through quarterly reports from the various sections tabled during their respective meetings and consolidated at the various levels until there will be a municipality-wide review report. Any activities that will require re-scheduling or targets that need revision shall be adjusted through a re-negotiation process. Strong Strategic Planning unit (Implementation committee) needs to be created during a Stakeholders Forum and will be charged with the coordination of performance monitoring and evaluation. This unit shall develop tools and procedures for on-going monitoring and evaluation .The evaluation of the annual plans is important to find out if the intended results have been realized. Performance evaluation will be carried out at agreed intervals and will be used as benchmarks for annual evaluation. The outcome of the annual evaluation will form a good basis for the plans for the next year.

5.9 Key Assumptions

The 5 year ISWM strategy was formulated based on the following key assumptions;

- That there will be adequate funding for all the activities to be undertaken.

- That all the stakeholders responsible for the strategy activities will be cooperative and undertake their responsibilities as laid out.

- The solid waste generation rates within MCE will remain constant within the 5 year implementation period of the ISWM strategy.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

This chapter provides answers to the research questions, and reflects on the key data findings against the reviewed literature. It also aims to reflect on the feasibility of employed research methodology. Finally, this chapter will try to come up with recommendations, for consideration for further research.

6.2 Overview of the employed research methodology

Collection of data as previously mentioned was facilitated through use of in-depth interviews and site visits. The collected data was relevant to the specific indicators that were assessed during the field work. There was also review of relevant secondary data based on the research study focus, including its geographical area. The interview questions (Appendix I) correspond to the 3 research questions posed, which eventually feed into the overall research objective.

6.3 Analysis of key findings against ISWM and theoretical frameworks

The conclusions and recommendations of this study are based on the overall research objective, to develop a strategy for solid waste management for the MCE and develop a solid waste management action plan.The approach taken for presentation is based on reflections of key data findings, against the three dimensions of ISWM developed by van de Klundert &Anschütz (2000), and Schübeler et al. (1996). As previously mentioned by these authors, ISWM refers to a waste management system that bests suits the society, economy and environment in a given location. It promotes stakeholder participation, advocating for waste prevention and resource recovery. In addition it encourages analysis of interactions with other urban systems, and promoting an integration of different habitat scales.

The three ISWM dimensions include:

- Actors

- Solid waste management system elements. This component also explores integration of SWM system with other urban systems.
- Sustainability aspects

6.3.1 Actors in MCE's solid waste management

Partnership or collaboration amongst SWM actors is advocated for, in an integrated sustainable waste management system (Schübeler et al., 1996, van de Klundert and Anschütz, 2000). Furthermore the actors listed below are identified by these authors as some of the key actors whose collaborative roles make important contributions into achieving a sustainable SWM system.

The data findings presented in chapter 5 establishes the following groups of actors contributing one way or another to MCE's solid waste management: Service users, NGOs, CBOs and Central government.

6.3.2 Solid waste management system elements adopted by MCE

Involvement in multi-activities

Through various actors as aforementioned, MCE has adopted various SWM activities such as garbage storage, collection, transportation, disposal, sorting and salvaging valuable recyclables, selling of recyclables such as paper, involved in recycling of salvaged solid waste such as glass bottles and plastics, and selling the end- or by-products directly to consumers or recycling industries.

Driving forces leading to adoption of specific waste management activities

It would be justifiable to some extent with reference to the presented field work findings, to describe MCE's motivation for involvement in varied solid waste management activities as economically, socially and finally environmentally driven. It is interesting to note that different experts from research on SWM have discovered similar driving forces including the scale of importance attached to them, which is unique to developing countries. Karanja (2005) describes the involvement of actors in SWM as so diverse, but common ones on a scale of decreasing importance include economic and social benefits (African Development Bank, 2002, Huysman et al., 2004, Karanja, 2005, Peters, 1998), and the reality of a clean neighborhood (Anschütz, 1996) just to mention a few.

In as much as environmental protection in developing countries is of least importance as a driving force for involvement in SWM (Huysman et al., 2004, Karanja, 2005), the fact that service users come together and collectively solve their SWM problems, still has the positive spillover effect towards contributing to environmental management. Anschütz (1996) and Huysman et al. (2004) attribute low priority being given to environment management in developing countries, more so in informal settlements, to the fact that SWM is a low ranking problem of a community which is largely low income.

SWM may be a low ranking problem but the need of a clean neighborhood is still a justifiable need. The reality of a clean Embu though given a low immediate priority compared to economic benefits and promising job opportunities, was one of the positive effects that households in Embu expressed as hoping to eventually achieve.

Links with other urban systems

The field work conducted established the practice of composting of organic waste by some households in Embu. The compost is mainly applied in their garden used for subsistence farming. This can be described as a form of urban agriculture.

In addition, salvaging of valuable waste, recycling and trading in waste makes a contribution to the reduction of pressure on use of raw materials (Beukering et al., 2005, Karanja, 2005). Extension of dump sites life is also prolonged through the practice of waste reduction, reuse and recycling, as less waste is eventually disposed off at the dumping fields (Baud et al., 2001).

6.3.3 Sustainability analysis of MCE's solid waste management activities

Key findings are selected from data presented in section 4.8 of chapter 4 *exploring the sustainability of waste management activities adopted by MCE,* and presented qualitatively below under the various sustainability aspects compiled by van de Klundert &Anschütz (2000), and Schübeler et al. (1996).

Legal/Institutional Aspects

The Municipal Council of Embu is in charge of both the operational as well as regulatory responsibilities for SWM. These roles are facilitated through two major legislative instruments namely Local Government Act, Cap 265, and the Public Health Act, Cap 242 (National Council for Law Reporting, 2004-2008).

The overall decision making organ within MCE is the council which represents the legislative arm of MCE, and is concerned with policy formulation. The other arm of MCE is the executive, comprising of the administrative and professional staff and is charged with the responsibility of policy implementation. Policies relating to SWM are formulated by an Environmental Committee in the legislative arm of the MCE. Endorsement of these policies by the MoLG is mandatory before implementation by the engineer's department. In addition, MCE formulates by-laws for solid waste management under the provisions of the Local Government Act (1963), which only focus on either prohibition of illegal disposal of waste, responsibilities of waste generators on aspects such as storage of waste awaiting collection, including responsibility of MCE to provide refuse receptacles, or rights of MCE on imposition of charges for waste collection and fines in the event of violation of rules or defaulters.

MCE main responsibilities towards SWM are to; formulate and implement SWM policies, provide services for the collection, transportation, treatment and disposal of solid waste, regulate and monitor the activities of all generators of solid waste, formulate and enforce by-laws and regulations relating to SWM and, coordinate with other departments within MCE, donor Agencies, and other government organizations involved in SWM. Community members participate in the management affairs of the council through attending annual Local Authority Service Delivery Action Plan (LASDAP) meetings held at their respective wards where they prioritize SWM needs.

Technical/operational aspect

MCE provides standard storage containers tailor made to suite different service users for secondary or communal storage of waste. Due to insufficiency/obsolescence of these containers, the house holds were observed to use non-standardized waste storage containers.The criteria used by MCE in distribution and location of storage containers in a given area were based on the level of waste generated, the accessibility, and the social political factors. The convenience of the waste storage containers to users was not taken into consideration hence encouraging illegal dumping of waste in most areas.

MCE practised either communal collection system where the residents were observed to discharge their wastes at predetermined locations containing secondary storage facilities where refuse collection vehicles visited those sites at infrequent intervals or 'No Collection' system in a

few some low-density and in all high-density residential areas where householders never received any service. The waste that is collected by MCE is mixed because there is no source separation and hence making the environment for sorting and salvaging of valuable waste non conducive.

The MCE's collection frequency had no basis. There was laxity of the MCE in collecting wastes on a daily basis to the dumping site hence this posed a great health risk to the nearby residents. The socio-political factors and the availability of refuse collection equipment played a role in the frequency of collection

The different sectors sampled within MCE used different modes of transportation for the wastes generated depending on the scale of operation as well as the type/category of wastes generated. The most common were: vehicles, wheel barrows and manual transport. All the equipments used were found to be locally assembled hence easier maintenance due to availability of spare parts.

Though there were specific routes assigned to the waste collection vehicles during collection and transportation of wastes, these routes were not followed and waste collection and transportation was based on the need at a given receptacle

The residential solid waste generation rate within Embu Municipality was found to be 0.57 Kg/person/day. Currently, MCE with a projected population of 44,907 generates about 9,344 tonnes per year. These results indicate that the socio-economic status of the people influenced the generation rates and even waste characteristics. MCE collects and transports 1, 358 tonnes of residential waste to the dump site annually and this translates to about 15%. The composition of residential waste was found to vary in composition depending on source of the sample. On average the composition of residential waste in Embu constituted 52.5% organic/biodegradable waste, 10.4% paper, 15.8% plastics, 3.4% glass, 2.2% metal and 15.7% others.

MCE was found to generate 9,266 tonnes of non-domestic solid waste per annum out of which 5,922 tonnes are collected and transported to the dump site annually and this translates to about 64%.The composition of the non-domestic was found to vary with the source of sampling and the type of generator as summarized by table 6.1.

Table 6.1: Waste characterization at immediate source and at communal waste collection points for Business, Commercial & Institutional generators

Waste Type	Composition (%)					
	At immediate source (directly from Premises)				At communal waste collection points located in general Business &Commercial Areas	At communal waste collection points located adjacent to markets
	Retail shops	offices & Workplaces	Institutions-Religious, Education & Non-Hazardous healthcare	Catering-Restaurants, Hotels & Eating places		
Organic waste	44%	26%	49%	69%	36%	51%
Plastic & Rubber	20%	17%	11%	9%	14%	14%
Waste Paper	22%	42%	20%	10%	19%	11%
Others	10%	14%	14%	9%	22%	18%
Scrap Metal	2%	1%	3%	2%	3%	2%
Glass & Bottle	2%	0%	4%	1%	6%	3%

For solid waste disposal, several methods were widely used in various establishments within the municipality. The most common were: Dumping, Incineration, open burning, Composting and other minor ones. Of those, the MCE, which had the obligation of disposing wastes, was entirely using open dumping or unsanitary land filling where no environmental and socio-economic aspects were taken into consideration in the siting, operation and planning of the disposal site.

Financial/economic aspects

The major sources of revenue for the MCE include Local Authority Transfer Fund, Contribution in Lieu of Rates, Road Maintenance Levy Fund, Business Permits, Slaughter Slab, Rent, Market fees, Vehicle parking fees and Cess. There was no major source that goes direct to SWM since all the money went to the same pool. Therefore, meeting the financial demands of SWM was a major problem in MCE. Different service users are charged similar rates per month by EWASCO (Embu Water & Sewerage Company), which collects approximately Ksh 128,700 per month and remits the same to MCE on quarterly basis. MCE spends approximately ksh. 3,714,478 per annum on SWM as per the approved 2011/2012 financial year budget (MCE, 2011).

Social/cultural aspects

MCE provides protective clothing to waste workers such as glooves, overalls and gumboots. Timely replacement of worn out protective gear is often a challenge to MCE due to financial

constraints. MCE doesn't provide medical cover to the workers and their families. MCE's waste workers work longer hours, do not work in shifts and may extend after working hours. MCE plans to change waste workers title to customer care staff with an aim of decreasing the impact of the low-status attributed to people associated with SWM.

Environmental cleanups campaigns held on quarterly basis are some of the activities used by MCE's members to reach out to Embu members for their support.

MCE is privileged to partner with NEMA and NGOs such as Practical Action. These NGOs give technical support through tailored trainings offered to the waste workers and other MCE staff focusing on environmental issues in relation to solid waste and proper waste handling. Trainings for staff are held on ad hoc basis especially when funds are available or if there are new emerging issues on managing solid waste. The trainings mainly focus on waste separation at source, recycling and use of simple, local equipments

Environmental/Public health aspects

MCE doesn't provide SWM services to all households in Embu hence creating a scenario of both serviced and unserviced pockets within the same community necessitating regular environmental cleanup campaigns.

The scavengers are involved in waste recovery, reuse and recycling mainly for economic benefits. However, the resulting positive environmental impacts, for instance reduction on exploitation of virgin resources, cannot be overlooked. Provision of tailor made waste containers and transportation of waste to the disposal site, can be said to promote safe waste removal from the source of its generation. However, some of the storage containers for example the open drum expose stored waste which becomes conducive ground for breeding of flies, in addition it's a source of obnoxious smell. Use of gunny bags face the danger of liquids seeping through. There is also the challenge of stray dogs tearing up garbage bags, and the unserviced households in Embu depict a scenario of inability to remove all waste from the neighbourhood.

Unfortunately, separation of waste at source and recycling (mainly composting) has not quite taken root within Embu municipality. Waste separation within the informal settlement is for example inhibited by the nature of housing plan within a plot, which takes up virtually every available space. Involvement in waste recovery is only carried out if there's a direct benefit

accrued to the service user.

6.4 Conclusion

Municipal solid waste issues represented major problems to the MCE. As the town grows and develops, improvements in infrastructure and technology should help to overcome barriers to the safe disposal of this solid urban waste. From the study, it was apparent that the MCE had the legal obligation to collect solid waste. However it was often unable to cope with the quantities of waste because of inadequate funds, lack of equipment and poorly trained management resources. The study also revealed that lack of proper institutional, organization and financial planning was another major factor responsible for poor SWM services**.** It was evident from the study that the MCE alone cannot work or function in isolation to solve the town's waste management problems. However, to improve the environmental sanitation, all available resources must be fully explored and exploited, including active participation of all formal and informal organizations and actors concerned. It is only through this that optimal efficiency and effectiveness in SWM can be achieved in the municipality. The purpose of this study was to explore the sustainability of adopted Local Authority based waste management interventions, within the MCE and to come up with an action plan that would be used as a basis for monitoring and evaluating the interventions to be implemented in the next five years, i.e. between 2012 and 2017.

6.5 Recommendations

- *Implementation of the MCE SWM action plan*

It is anticipated that following implementation of the action plan as presented in chapter 5, solid waste management standards will improve and there is likely to be an improvement of current waste collection rate, increase the amount of waste recycled, improve access to investments and employment opportunities in SWM, improved access to basic urban services, and well informed personnel/institutions to operate, maintain and manage solid waste sustainably. It will also improve the health and livelihoods of the local community.

- *Quantitative measure of sustainability of SWM systems*

Consideration should be given to establishing a general but standard quantitative measure for each sustainability aspect presented in the ISWM framework. This research analyses data qualitatively in attempting to determine how far are local authority based SWM systems

sustainable using the ISWM framework. These findings are still useful, but if probably used in *combination* with a quantitative measure, one would be able to determine conclusively in how far are these SWM systems sustainable. However, it is important to keep in mind that any scale of measurement assigned quantitatively has to be country, area, and priority specific, in addition to having a sound scientific basis.

- *Application of the 'carrot and stick' principles in promoting some of the sustainability principles*

It is without doubt that sustainability principles such as waste reduction, reuse and recycling bring about economic benefits supports livelihood, ensure clean neighborhoods, and reduce pressure on use of raw materials amongst other benefits. These sentiments are strongly expressed by (Baud et al., 2001, Beukering et al., 2005, Huysman et al., 2004, Karanja, 2005, Schübeler et al., 1996, van de Klundert and Anschütz, 2000), just to mention a few.

In Kenya for example, the waste management regulations by NEMA require that SWM service providers cover collected waste to prevent spread of obnoxious smells and scattering of garbage. This is one of the environmental/public health indicators applied in this research. Separation of domestic waste, recovery and recycle are concepts that are not yet supported by any national or city regulation in Kenya (Practical Action, 2004), and this possibly impacts on its practice by citizens. This is not to say that everything should be based on law. However, the importance of law in helping to change behaviors cannot be overlooked, especially where there are awards and consequently repercussions for going contrary to what is stipulated. Incentives to change waste behaviors and promote the practice of waste reduction, reuse and recycle could also be promoted from a legislative level. For instance literature (Mull, 2005), as well as field work findings, show the practice of waste reduction, reuse and recycle is promoted if there is a direct benefit. Mull (2005) further points out, that involvement of actors in recycling of waste relies on the *practice* of a given *household*, and *value* placed on the recyclable waste. Therefore, notable initiatives which advocates for waste minimization, separation of waste, reuse, and recycle should be promoted within Embu and its environs.

- *Address grey areas between NEMA and MCE*

There is an obvious duplication of effort on the requirements of the SWM permit and license as stipulated by NEMA and MCE. It is therefore important that the environmental regulator

(NEMA) and local authority (MCE) address some of these issues. More so if SWM service providers are to clearly understand what is required of them. This will also prevent unnecessary costs incurred by these non state waste actors, for two separate documents that address the same issue. In addition, grey areas such as which institution is responsible for enforcement or monitoring activities of non state service providers in SWM becomes clear.

Karanja (2005) specifically mentions that enforcement of SWM laws or regulations in Kenya is assigned simultaneously and contradictory to the different institutions and in the end is ineffective. There is also lack of clear demarcation of roles at the central government and local authority level between various national institutions concerned with SWM.

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APPENDICES

APPENDIX I: Interview questions for Local authority officials, households and other government officials

NB: The Information Provided Is For Academic Use

SECTION A: GENERAL INFORMATION

1. Title of the respondent:…………...……………..…...........…………….……………………….

2. Name of the institution :…………………...……………..………….......(If household, indicate so)

3. Location/ward of the respondent:…...….................……….............................

SECTION B: DOMESTIC SWM SYSTEMS WITHIN THE COUNCIL

1.   What   kind   of   waste   management   activities/services   does   the   Council provide?...
....

2. Give reasons for Council involvement in a particular type of waste management activity in (1) above.......................………………...……………………………………….............................……

3.   For how long has the Council been offering these services?..

4.   Who are the Councilcustomers/clients?..
....

5.   Where does theCouncil offer these services? (Exact area definition)…………………………………
…………………………………………………………………………………………..…….........

6. What are the sources of wastes in these areas?...

7.   How   much   waste   is   generated   within   these   areas?   Specify   method   of measurement..

8. Is there any classification of the various areas within the municipal council?

      [   ] Yes   [   ] No

      If yes; If yes specify criteria of classification

AREAS	CLASSIFICATION	CRITERIA

9.   Who   are   the   waste   handlers   within   the   Municipal   Council   area   of jurisdiction?...
....
....

10. Which services are provided by above handlers?

[ ] Collection only   [ ] Collection and transportation

[ ] Transportation only   [ ] other (specify)

SECTION C: SUSTAINABILITY OF THE DOMESTIC SWM SYSTEMS

A. Technical/Operational

1. What kind of equipments does the Municipal council use for their activities?...
....

2. From where does the Council get their equipments? Do they own the equipments? If no, do they hire them, from whom/where and at what cost?...
…………………………………………………………………………………………………..

3. What's the community members' contribution to the adopted waste management activities techniques and Equipments used?...
....

4. Are the provided waste activities linked to what the community members need?
    [ ] Yes   [ ] No

    Explain…………………………………………………………………………………………
    ……………………………………………………………………………………….........

5. Are there any other organizations within your area offering waste management services?
    [ ] Yes   [ ] No

    If yes;

    i) What services do they offer?....................................……………………………............……….

    ii) Does the Council link or coordinate their services together with those provided by other actors?...

    [For example linking primary collection by CBOs to secondary collection by local authority or contracted enterprise]

B. Financial/Economic

1. Where does the Council get its resources for operations and management of the domestic solid waste?...
2. Are the services offered at a fee?
    [ ] Yes   [ ] No

    If yes;

    i) How much and how often is the fee payment required?...
    ....

    ii) How did the Council arrive to the amount charged for service?..
    ....

    iii) *(If finances are from service charge)* Are the community members able and willing to pay

for the services provided?...

3. What actions does the Council take to manage households that don't make the required payments? (Exploring social control mechanism)………………………………………………………….……………
…………………………………………………………………………………………………..….........

4. (If payment is in-kind)Are the community members willing to give in-kind contributions to services provided?
[   ] Yes   [   ] No

If   yes,   what   kind   of   in-kind   contributions   does   the   community provide?...

5. I n your opinion, are the resources sufficient to keep the Council in operation
[   ] Yes   [   ] No

Give reasons?..

6. W h i c h challenges does the Council face and what steps has it planned to undertake in order to tackle these problems?..

C. Social/Cultural

1. Does the Council offer services to all residents in the area that they are serving?
[   ] Yes   [   ] No

2. Does the Council hire workers to provide service to residents?
[   ] Yes

If yes;

i) From where are the workers sourced from?...

ii) How many are the hired waste workers?..

iii) What is their education training background/are they trained, by whom and in what manner?...

iv) What are their work timings?..

3. Are the Council workers provided with protective clothing? (What kind e.g. gloves, overall etc)………………………………………………………………………………………..…………

4. Are the workers paid for their service?
[   ] Yes   [   ] No

If yes, what is the system for p a y m e n t ? (Daily, w e e k l y, m o n t h l y, i r r e g u l a r l y w h e n f u n d s are there etc)…………………………………………...…………

5. Are the households aware and willing to participate in waste reduction, reuse and recycling (3 Rs)?
[   ] Yes   [   ] No

Please explain…………………………………………….............……………….………………

6. Does the Council educate the community or specific target groups e.g. women or children on the 3Rs

mentioned above?

    [ ] Yes   [ ] No

If yes, in what manner?...………....

D. Environmental/Public Health

7. How often does the Council provide waste collection services?...

1. Do the workers pick out any valuable waste from what is collected?

    [ ] Yes   [ ] No

If yes, what is picked out (salvaged) and for what purposes?.................................………….……………………….…………………………………

2. What exactly happens with the collected non-organic materials?.........................………….……………...….…………………………………

3. What exactly happens with the collected biodegradable materials?.................…………...…………….
…………………………………………………………………………………………………..

4. Are the community members sensitized on collecting or picking out valuable waste for the above mentioned purposes (Also exploring separation of waste)

    [ ] Yes   [ ] No

E. Institutional/Legal

1. Is the Council authorized to be involved in municipal solid waste management?

    [ ] Yes   [ ] No

If yes, by who? Please explain………..…………………….……………………….…..............……

2. Who is Incharge of the management and decision making of the Council?....………………..…
…………………………………………………………………………………………………..

3. Do the Council leaders and workers have a clear mandate of what is expected from them?

    [ ] Yes   [ ] No

4. Do Community members participate in the management affairs of the Council?

    [ ] Yes   [ ] No

If yes, how?...

5. How does the Council stimulate participation of non members?..
…………………………………………………………………………………………………

6. Is there any special skill required to operate the Council's waste management activities?

    [ ] Yes   [ ] No

Explain…………………………..…..……………………….…………………….…..............……

7. Are the waste workers trained in these areas?

    [ ] Yes   [ ] No

If yes, by whom?...

8. Does the Council encourage households to participate in waste reduction, reuse and recycling?

[ ] Yes   [ ] No

If yes, how?..

9. Does the Council organize community meetings?
[ ] Yes   [ ] No

If yes;

i) How frequently? ……………………...................………………………………………………….

ii) What are the objectives or purpose for the meetings?...

iii) What are the outcomes?...

iv) What is being done with the outcomes?...

SECTION D: CONCLUSION

1. Kindly make any other comments or observation on challenges faced by Council in implementing its activities and steps it has taken or planning to take to tackle the challenges?................................
……………………………………………………………………..………...……………..…………
……………………………………………………………………………………………………

APPENDIX II – Zoning of the Municipal council of Embu
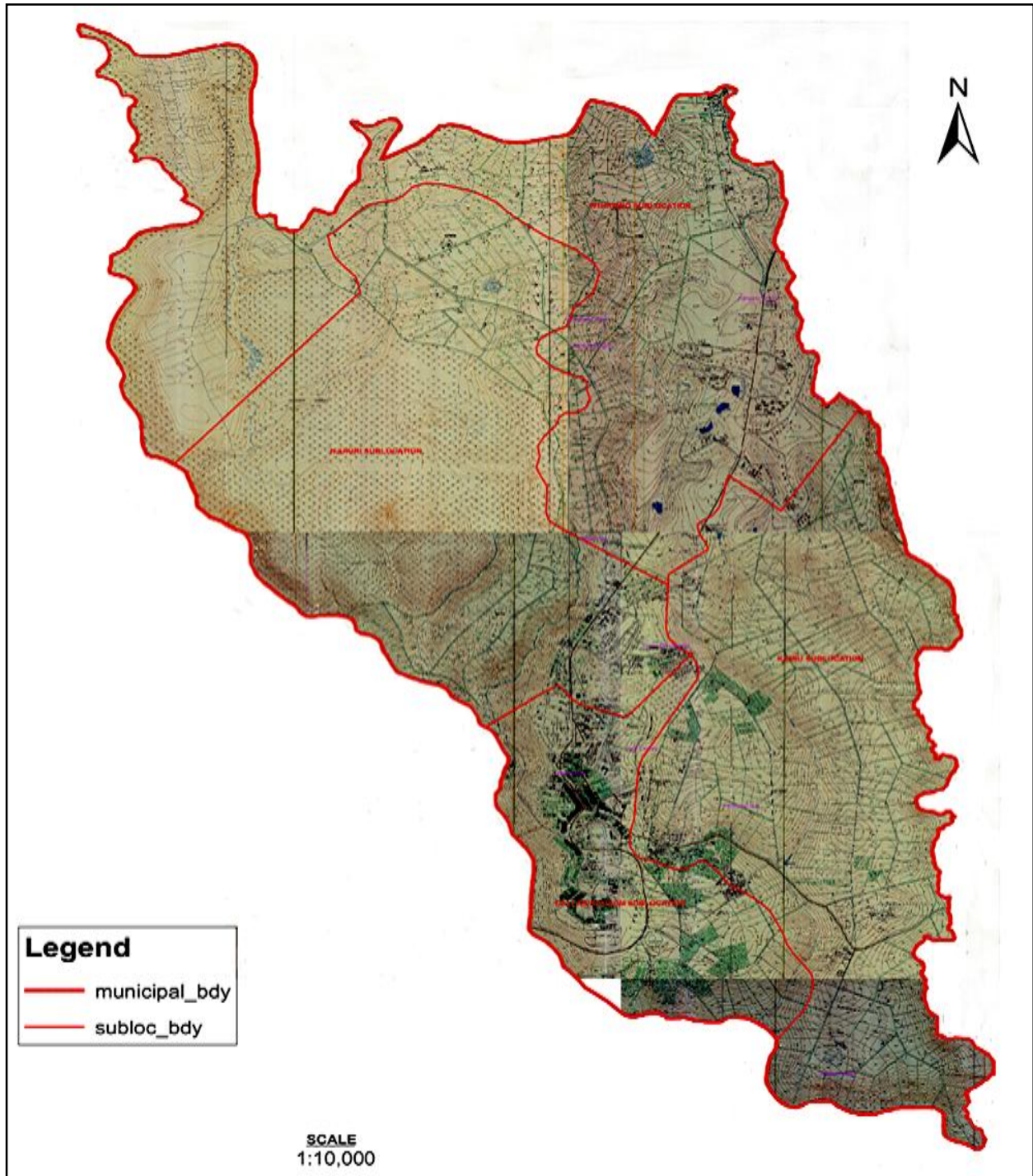
APPENDIX III: Analysis of waste collected by MCE

| Collection Days | Date | Source/Zone | No. Of Trips | | Waste Collected In Tonnes | | | | Collection Days | Date | Source/Zone | No. Of Trips | | Waste Collected In Tonnes | | |
			Tipper	Side Loader	Tipper	Side Loader	Total Waste					Tipper	Side Loader	Tipper	Side Loader	Total Waste (Tonnes)
1	2/1/11	1C	1	0	14	0	14		1	1/4/11	1C	2	0	28	0	28
2	4/1/11	4C	2	1	28	7	35		2	2/4/11	4C	0	2	0	14	14
3	5/1/11	4C	2	1	28	7	35		3	3/4/11	4C	0	2	0	14	14
4	6/1/11	2C	2	2	28	14	42		4	6/4/11	2C	1	2	14	14	28
5	7/1/11	6C	2	2	28	14	42		5	7/4/11	6C	2	2	28	14	42
6	8/1/11	6C	0	2	0	14	14		6	8/4/11	6C	1	2	14	14	28
7	11/1/11	7C	0	2	0	14	14		7	9/4/11	7C	1	2	14	14	28
8	12/1/11	8C	0	3	0	21	21		8	10/4/11	8C	0	2	0	14	14
9	13/1/11	8C	0	3	0	21	21		9	12/4/11	8C	2	2	28	14	42
10	16/1/11	10C	1	0	14	0	14		10	13/4/11	10C	2	2	28	14	42
11	18/1/11	10C	0	1	0	7	7		11	14/4/11	10C	2	2	28	14	42
12	19/1/11	10C	1	2	14	14	28		12	15/4/11	10C	1	2	14	14	28
13	20/1/11	10C	1	2	14	14	28		13	16/4/11	10C	2	2	28	14	42
14	21/1/11	3C	2	2	28	14	42		14	17/4/11	3C	0	1	0	7	7
15	22/1/11	3C	1	2	14	14	28		15	19/4/11	3C	0	2	0	14	14
16	25/1/11	5C	2	0	28	0	28		16	20/4/11	5C	2	3	28	21	49
17	27/1/11	5C	2	0	28	0	28		17	21/4/11	5C	2	2	28	14	42
18	28/1/11	4C	0	2	0	14	14		18	22/4/11	4C	2	2	28	14	42
19	29/1/11	4C	0	2	0	14	14		19	23/4/11	4C	2	1	28	7	35
20	30/1/11	2C	0	1	0	7	7		20	24/4/11	2C	1	2	14	14	28
									21	26/4/11	9R	1	2	14	14	28
									22	28/4/11	9R	2	2	28	14	42
									23	29/4/11	1R	1	3	14	21	35
									24	30/4/11	11R	2	2	28	14	42
TOTAL-JAN			**19**	**30**	**266**	**210**	**476**		**TOTAL-APR**			**31**	**46**	**434**	**322**	**756**
1	1/2/11	9R	0	2	0	14	14		1	3/5/11	4C	2	2	28	14	42
2	2/2/11	9R	0	2	0	14	14		2	4/5/11	4C	1	3	14	21	35
3	4/2/11	1R	0	3	0	21	21		3	5/5/11	2C	0	3	0	21	21
4	5/2/11	11R	0	2	0	14	14		4	6/5/11	6C	2	3	28	21	49
5	8/2/11	12R	0	3	0	21	21		5	7/5/11	6C	0	1	0	7	7
6	9/2/11	1C	2	2	28	14	42		6	8/5/11	7C	0	2	0	14	14
7	10/2/11	4C	1	1	14	7	21		7	10/5/11	8C	0	2	0	14	14
8	11/2/11	4C	1	2	14	14	28		8	11/5/11	8C	0	2	0	14	14
9	12/2/11	2C	2	0	28	0	28		9	12/5/11	10C	0	3	0	21	21
10	15/2/11	6C	2	3	28	21	49		10	13/5/11	10C	2	0	28	0	28
11	18/2/11	6C	0	2	0	14	14		11	14/5/11	10C	1	1	14	7	21
12	19/2/11	7C	1	2	14	14	28		12	17/5/11	10C	2	0	28	0	28
13	22/2/11	8C	0	1	0	7	7		13	18/5/11	3C	2	0	28	0	28
14	23/2/11	8C	0	3	0	21	21		14	19/5/11	3C	2	2	28	14	42
15	24/2/11	10C	0	2	0	14	14		15	20/5/11	5C	2	2	28	14	42
16	25/2/11	10C	0	3	0	21	21		16	21/5/11	5C	2	2	28	14	42
17	26/2/11	10C	2	2	28	14	42		17	22/5/11	4C	2	2	28	14	42
									18	24/5/11	4C	2	2	28	14	42
									19	25/5/11	2C	4	1	56	7	63
									20	26/5/11	1C	2	2	28	14	42

#	Date	Zone							#	Date	Zone					
									21	27/5/11	4C	2	0	28	0	28
									22	28/5/11	4C	2	0	28	0	28
									23	29/5/11	2C	2	0	28	0	28
									24	31/5/11	6C	2	2	28	14	42
TOTAL-FEB			**11**	**35**	**154**	**245**	**399**		**TOTAL-MAY**			**36**	**37**	**504**	**259**	**763**
1	1/3/11	1C	0	2	0	14	14		1	1/6/11	8C	2	2	28	14	42
2	2/3/11	11R	2	2	28	14	42		2	2/6/11	8C	2	2	28	14	42
3	3/3/11	11R	0	3	0	21	21		3	3/6/11	10C	2	2	28	14	42
4	4/3/11	2C	1	2	14	14	28		4	4/6/11	10C	2	2	28	14	42
5	5/3/11	6C	0	3	0	21	21		5	5/6/11	10C	1	1	14	7	21
6	6/3/11	6C	0	1	0	7	7		6	7/6/11	10C	2	2	28	14	42
7	8/3/11	7C	0	2	0	14	14		7	8/6/11	3C	2	2	28	14	42
8	9/3/11	8C	0	3	0	21	21		8	9/6/11	3C	0	2	0	14	14
9	10/3/11	8C	0	3	0	21	21		9	10/6/11	5C	2	1	28	7	35
10	11/3/11	10C	0	3	0	21	21		10	11/6/11	5C	2	0	28	0	28
11	12/3/11	10C	0	3	0	21	21		11	12/6/11	4C	1	1	14	7	21
12	13/3/11	10C	1	2	14	14	28		12	14/6/11	4C	2	2	28	14	42
13	15/3/11	10C	0	3	0	21	21		13	15/6/11	2C	0	2	0	14	14
14	17/3/11	3C	0	2	0	14	14		14	16/6/11	9R	0	1	0	7	7
15	18/3/11	12R	2	2	28	14	42		15	17/6/11	9R	2	1	28	7	35
16	19/3/11	5C	0	2	0	14	14		16	18/6/11	1R	2	1	28	7	35
17	22/3/11	5C	0	1	0	7	7		17	19/6/11	11R	0	1	0	7	7
18	23/3/11	4C	2	1	28	7	35		18	21/6/11	12R	1	1	14	7	21
19	24/3/11	4C	0	1	0	7	7		19	22/6/11	4C	1	1	14	7	21
20	25/3/11	2C	1	1	14	7	21		20	23/6/11	2C	1	1	14	7	21
21	26/3/11	9R	0	3	0	21	21		21	24/6/11	9R	1	1	14	7	21
22	27/3/11	9R	0	1	0	7	7		22	25/6/11	9R	2	2	28	14	42
23	28/3/11	11R	1	2	14	14	28		23	26/6/11	1R	1	1	14	7	21
24	30/3/11	11R	1	2	14	14	28		24	28/6/11	11R	0	1	0	7	7
25	31/3/11	12R	2	1	28	7	35		25	29/6/11	12R	2	0	28	0	28
									26	30/6/11	10C	1	0	14	0	14
TOTAL-MAR			**13**	**51**	**182**	**357**	**539**		**TOTAL-JUN**			**34**	**33**	**476**	**231**	**707**

SUMMARY TABLE FOR MONTHLY COLLLECTION & ANNUAL COLLECTION{TONNES}							
Jan-11	**Feb-11**	**Mar-11**	**Apr-11**	**May-11**	**Jun-11**	**Total**	
476	399	539	756	763	707	3,640	Waste Collected Per Month,{Tonnes}
						606.7	Mean Monthly Collection Rate,{Tonnes}
						7,280	Annual Collection,{Tonnes}
						1,358	Total Residential,{Tonnes}
						5,922	Total Commercial,{Tonnes}

APPENDIX IV: Solid Waste Management by MCE Photographs

Litter bins and refuse receptacles strategically positioned along the streets of Embu for waste collection (Provided by MCE).Note advertisement posters and ashes, an indication open burning of waste within the collection facilities.

Indiscriminate dumping of waste along the major streets of Embu and in the drainage channels. Note the Heaps of Garbage deposited on the entrance of the main Embu retail market awaiting collection (transfer station).

Loading of waste into the side loader and tipper truck. Note that MCE provides loaders with protective clothing

but they are not keen to wear them, the loader wears only gum boots and gloves but no aprons or masks.

Farm tractor and trailers used by MCE for collection and transportation of Solid waste to the disposal site .Wheelbarrow, brooms rakes and spades are some of the tools provided by MCE to the sweepers for collecting and transporting waste to the Transfer station.

Children playing on the un-fenced MCE dumping site oblivious of the dangers they are exposed to. Note the scavengers and the stray dogs at the disposal site

| Composition of a Typical Residential waste. | Composition of a Typical hotel waste. |