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MUNICIPAL COUNCIL OF HOMA BAY

HOMA BAY TOWN INTEGRATED SOLID WASTE MANAGEMENTBASELINE SURVEY

Consultant

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Homa Bay Town in Brief

Location: On the shore of Lake Victoria, Nyanza Province, western Kenya. It lies on longitude 34.30 E and latitude 0.30 S of the equator.

Notable natural feature: Lake Victoria, the second largest freshwater lake in the world, with a surface area of 69,000 km^2, of which 4,113 km^2 belongs to Kenya and the rest roughly equally to Tanzania and Uganda.

Climate: Inland equatorial, 17.5° Celsius to 34.8° Celsius round the year and two rain seasons of between 250-700 mm.

Population: 76,773 (1999 census) with current estimate being 90,000.

Religion: Mainly Christian, with a significant Muslim minority.

Languages: English, Kiswahili and Dholuo. The main ethnic group in the area is Luo.

Economic activity: Fishery, agriculture, some tourism, employment, and a large informal economy.

EXECUTIVE SUMMARY

Solid Waste Characteristics

The rate at which 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, commercial sector, institutions, markets and construction sites was estimated through the application of field observations and direct measurements at their sources. Composition analysis was undertaken to establish the percentage of organic wastes, metals, plastic/rubber, glass/bottles, waste papers and other forms of mixed wastes. The survey showed that the percentage composition of organic wastes was 91%, plastic and rubber 6%, waste papers 1% while others had 2% in domestic/ residential areas. Glass/bottles and scrap metals were notably absent from the household wastes. The density of household wastes was found to be 56.4 Kgs/M^3. Industrial wastes mainly originated from the Capital Fish (K) LTD, medical wastes from the Homa Bay District Hospital, commercial wastes from markets, hotels & restaurants, supermarkets, tailoring shops, butcheries and the bus park.

Solid Waste Management systems

Solid waste management (SWM) systems involve storage, collection, transport and disposal procedures.

Storage and collection Systems

Homa Bay Town residents use both standard containers and unstandardized containers in storage of waste. Standard containers are used for secondary (or communal) storage of the domestic waste and are supplied by the MCH or CBOs. Standard containers used in the town are plastic and galvanized dustbins, plastic bags and a few bulk containers. Unstandardized containers used included old basins, carton-boxes, sacks and plastic bags.

Communal collection; Door-to-door or House-to-house collection or `no collection' were the main collection methods used in MCH. Communal Collection/Use of Transfer Stations involved residents discharging their wastes at predetermined locations containing secondary storage facilities. Almost everywhere, the containers at communal collection points were sometimes overfilled and refuse was thrown around them; were exposed to all types of scavengers as well as bad odour. In Door-to-Door collection, the collection vessels were placed as close as possible to the entrance of the house, and the individual household containers were picked by a collector and emptied into the vessel. Similarly ‘no Collection' was a common system used in a some low-density and in all high-density residential areas.

Transportation of waste

The common modes of transportation used were: motor vehicles and human transport. Refuse-vehicle types under operation in Boma Bay town include the Ndume Little Pick-ups (Dumpers), High Tipping Container Pick up Trailers (Tractors) and an ordinary farm tractor. Human transport involved use of wheelbarrows to transport wastes to the transfer stations which were located strategically at various points within the municipality. This was done by either the municipal workers as well as staff of CBOs dealing with SWM. One financial institution reported

that it transported its waste paper to the head office in Nairobi by E.M.S speed post for shredding.

Waste Disposal Methods

Approximately 75% of wastes from MCH were disposed through open dumping at the disposal site. MCH has only one area set aside for the disposal of all types of solid wastes. The site has a fence but no gate and its proximity to residential areas allows easy access to people and animals, which might lead to transmission of diseases. The dump site is already full hence its life span has expired. Most of the hospital waste in the town is incinerated at Homabay District Hospital and at St.Paul's Mission Health Centre. Open burning is used by low and high income residents and some learning institutions. Similarly, there were placenta pits at the two hospitals surveyed in the MCH for disposal of placentas.

Solid Waste Recovery and recycling Practices

Three types of actors are involved in solid waste recovery activities in MCH, namely, the waste pickers, dealers and the *Jua-Kali* (informal) recyclers. Waste pickers operate in the commercial, residential and industrial zones obtaining all kinds of waste materials from open spaces, roadsides, communal dumps, dustbins, skips and other waste receptacles. Waste dealers are mostly interested in plastic & scrap metal items and act as brokers i.e. a linkage between the waste pickers and Jua-kali artisans and other Waste Recycling Industries (WRI's) in Nairobi and other market outlets.

There is no formal WRI in the town except the *Jua-Kali* workshops operating on a small scale basis and manufacturing a wide range of consumer end-products from the different waste materials. At the municipal slaughter house, the animal manure waste is recycled into biogas and compost. There was also organic recycling of fish bones and fish skin from the Capital Fish (K) LTD processing plant at the *Mgongo Waz*i open market. It was observed that there were many opportunities of setting-up WRIs in MCH which could benefit from the varied types and quantities of waste generated and the availability of cheap labour within the municipality's informal sector.

Municipal Council of Homa Bay SWM Arrangements and Legal framework

There are three forms of SWM service arrangements in MCH. First, the MCH provides SWM services directly using its employees. Secondly, the private arrangement which was independent of the municipal arrangement since the service recipients paid their collectors (CBOs) directly. Finally, the third service arrangement revolved around the services of waste dealers and recyclers.

MCH's service delivery is affected by the Central Government legislations beyond its control e.g. the Local Government Act, the Public Health Act, NEMA regulations etc. This situation denies MCH the liberty to choose its SWM programs. A good example is the 1984 Local Government Act which makes it difficult for the MCH to hire and fire its own employees. Similarly, there are no by-laws to facilitate solid waste recovery enterprises in the town. These limitations for the MCH have led to understaffing problems with incompetent and unskilled staff thereby affecting service delivery.

Under such conditions, non compliance has been common due to lack of awareness and 'I don't care' attitude. The situation is poor due to limited human and financial capacity to enforce

legislation and an uncoordinated enforcement by NEMA and the Council without clear defined roles and responsibilities.

Role of Community Based Organizations (CBOs) in Provision of Solid Waste Management Services

There were about ten (10) CBOs in the MCH but there were only five (5) active in SWM activities. The five active CBOs that were operational during the survey period included: *Asedhwa* Women Group, Environmental Watch Programme, WOKAN Women Group, Homa Bay *Jua kali* Women Association and Town Hawkers. These CBOs supplied dust bins to only clients who agreed to pay a negotiated fee which ranged between Kshs 150-300 per month.

The CBOs utilized the door-to-door collection systems and used wheel barrows in transportation of wastes from their clients to the transfer stations, skips or open spaces (for crude dumping). None of sampled CBOs transferred waste directly to the dumping site due to their low capacity. CBOs provide employment to some youths and women; for example, WOKAN Women Group has 13 permanent and 2 casual employees. Most CBOs were faced with technical problems like, lack of finance for expansion of services and limited occupational protective facilities dust coats, gloves, gum boots and nose masks. Generally, CBOs provided better services than the MCH because they are directly answerable to their clients. Proper partnership between CBOs and MCH can increase the efficiency of solid waste management services in the town.

Conclusion and Recommendations

Municipal solid waste issues represented major problems to the MCH. 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. It was evident from the survey that the MCH 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 organisations and actors concerned. It is only through this that optimal efficiency and effectiveness in SWM can be achieved in the municipality. There is an urgent need for the enhancement of community initiatives and partnerships by the MCH to increase awareness of the importance of solid waste management and its contribution to a healthy living environment. The Council should stimulate public awareness and encourage waste producers to take more responsibility for treatment and disposal of their wastes. This study recommends for the formulation of an efficient urban solid waste management with participation from the public, private and the community through an integrated SWM system.

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ACRONYMS

AWEMAC- Africa Waste and Environmental Management Consultancy
BCs- Bulk Containers
CBD- Central Business District
CBO- Community Based Organizations
CDS- City Development Strategy
C-MAD- Community Mobilization Against Desertification
E.W.P- Environmental Watch Programme
GIS- Geographic Information System
ILO- International Labour Organization
ISWM- Integrated Solid Waste Management
KII- Key Informant Interviews
LVRLAC- Lake Victoria Regional Local Authorities Commission
LATF- Local Authorities Transfer Fund
MCH- Municipal Council of Homa Bay
MCK- Municipal Council of Kisumu
MDGs- Millennium Development Goals
MOH- Ministry Of Health
MSW- Municipal Solid Waste
NEMA- National Environmental Management Authority
NGOs - Non-Governmental Organizations
PPPs- Public Private Partnerships
SEUCO-South Eastern University College
SMEs- Small Micro-Enterprises
SWM- Solid Waste Management
UNDP - United Nations Development Programme
UNEP- United Nations Environmental Programme
UNIDO- United Nations Industrial Development Organization
WBCs- The Waste Buying Centres
WHO- World Health Organization
WOKAN- Women of Kanyada
WTP- Willingness to Pay

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CHAPTER 1: INTRODUCTION

1.1 Background of the Municipal Council

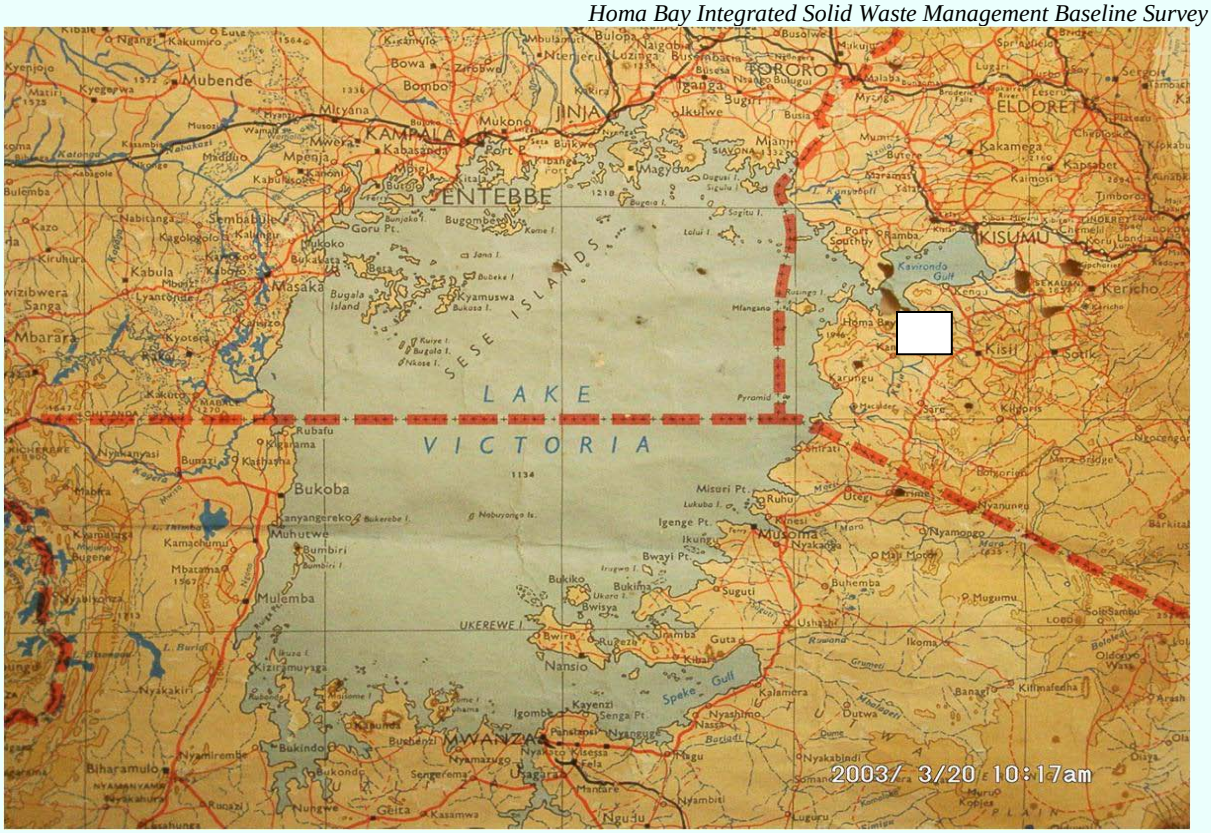
Municipal Council of Homa Bay is one of the urban settlements in the Lake Victoria basin, home to over 25 million people. It is experiencing rapid urbanization due to high birth rate, urban immigration and geographic expansion of the town. This has increased the demand for services and infrastructure in the town that lacks the capacity for resource management and has weak governance structures. The Municipality covers an area of 102.71 km^2 of land mass and 94.29 km^2 under the Lake. The population of the municipality has rapidly been increasing, and is currently estimated at 90,000 people. However, the infrastructural services have not been developed in pace with the rapid expansion of the population. This may be due to the fact that of the people moving to the town, the majority are likely to be poor migrants from rural areas in search of employment, and unable to contribute significantly to the revenues of the municipality. They concentrate in the poorer, more densely settled areas and thereby exacerbate the health and sanitation problems posed by these unplanned communities.

Homa Bay has suffered an economic decline since the advent of multi-party democracy in Kenya in 1992. This is because there has been a decline in industry and other economic activities, and more people depend on the small-scale informal sector. Major factories in the town have closed down, for example, the cotton ginnery, the milling industry and also reduced fish catch from the Lake. As a result, the town experiences above average urban poverty levels manifested in low income relative to the cost of living, poor housing and in some cases proliferation of slums, lack of security of tenure, vulnerability to crime, water borne and other infectious diseases including HIV/AIDS. Appropriate urban management systems need to be established to mitigate these problems and make urban settlement in Homa Bay town livable.

According to the Municipal Council of Homa Bay CDS Document 2006-2010, unemployment levels stand at 40%, with the majority of the inhabitants working in the informal sector, commonly known as *Jua Kali* and street trading as a coping strategy. The informal sector is therefore the most important source of income to most households: hence the town can safely be referred to as an "informal economy". The document further states that the per capita income stands at Kshs. 18,250 against the national income of Kshs 25,550 per annum. This indicates the poverty level in the area being less than 1$ per capita daily which is below the poverty line as stated by the World Bank standards. This leaves the majority with very little disposable income thus affecting the town's service provision in many ways.

The MCH offers various kinds of services. However, these fall short of meeting the needs of the citizens. The level of service delivery varies with the location of any settlement from the town centre. This is basically due to planning inadequacy. The Central Business District of Homa Bay Town is rather small and relatively well planned, with government buildings, commercial centre and some residential areas. However, most of the low income areas are unplanned, densely populated and with the low income communities living in sub standard environmental health conditions.

Figure 1: Location of Homa Bay town, near Lake Victoria



The vision of Homa Bay Town Development Strategy is to be "a working and developing city." The CDS highlights development challenges as identified and prioritized by the citizens of Homa Bay, harmonized from a broad spectrum of stakeholder views and interests. Poor urban planning ranks high on the list of challenges and was closely associated with the unchecked sprawl of densely populated informal settlements characterized by lack of basic service provision and limited accessibility.

Despite sitting on one of the largest fresh water Lakes in the world, Homa Bay Town citizens continue to experience severe water shortages, with supply mainly confined to the core urban centre. This accompanied by the low sewerage coverage provides justification for the high ranking of water and sanitation as a key challenge. The municipal water supply system produces 2,000m^3 per day to about 41% of the population. The total demand for treated water for the urban population is 3,100 m^3 per day and for the whole service to cover the municipal boundary is 5,100m^3 per day indicating that water supply demand is 1100 m^3 and 3100 m^3 for urban and rural areas respectively. The peri-urban areas have been left with no water supply hence rely on water vendors, rivers, the Lake and shallow wells. Currently, the urban area is experiencing an acute water shortage because of numerous bursts of pipes and frequent pumps breakdown due to fluctuating power supply. The 750 m^3 sewerage system capacity serves less than 20% of the population. The majority of residents (about 80%) use septic tanks, pit latrines and bushes. However, this is set to improve upon completion of the legal and institutional reforms under the water supply and sanitation board called South Nyanza Water and Sanitation Company and eventual privatization of Homa Bay Town water supply, (MCH, CDS Document 2006-2010).

Poor environmental management closely associated with solid waste collection and treatment inefficiencies, discharge of inadequately treated waste water, blocked drains often associated with flash floods, and direct pollution of water bodies through informal practices such as car-washing, also rank highly in the list of challenges. Urban agriculture and livestock keeping widely practiced as a livelihood means, particularly in the peri-urban fringes continue to suffer under repressive and archaic laws that provide limited legal space, posing a direct challenge to this poverty reduction opportunity. Other highly ranked challenges include the inadequacy of decent and affordable shelter, high prevalence of HIV/Aids, malaria and infectious diseases, poor access to health services, and unexploited transport and communication potential.

Key priority areas identified for strategy development were improved urban environment and solid waste management systems. The International Labour Organization(ILO) has proved that engagement of Public Private Partnerships (PPPs) approach can lead to both the generation of decent jobs and improved service delivery under the right conditions particularly when these partnerships are pro-poor through the involvement of local communities and enterprises (the informal economy). However, enabling environment such as political willingness and support, community participation and effective monitoring and evaluation system are crucial for successful PPP, therefore improved service delivery and employment creation that can lead to reduced poverty.

SWM is a major concern in Homa Bay Town, a Lake Victoria CDS town. The amount and types of solid waste generated in the MCH 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
- Lack of political and institutional support (weak by-laws)
- The absence of a systematic approach
- Poor community attitudes towards environmental cleanliness
- over-reliance on imported and inappropriate technology and equipments
- Inequality in service provision.

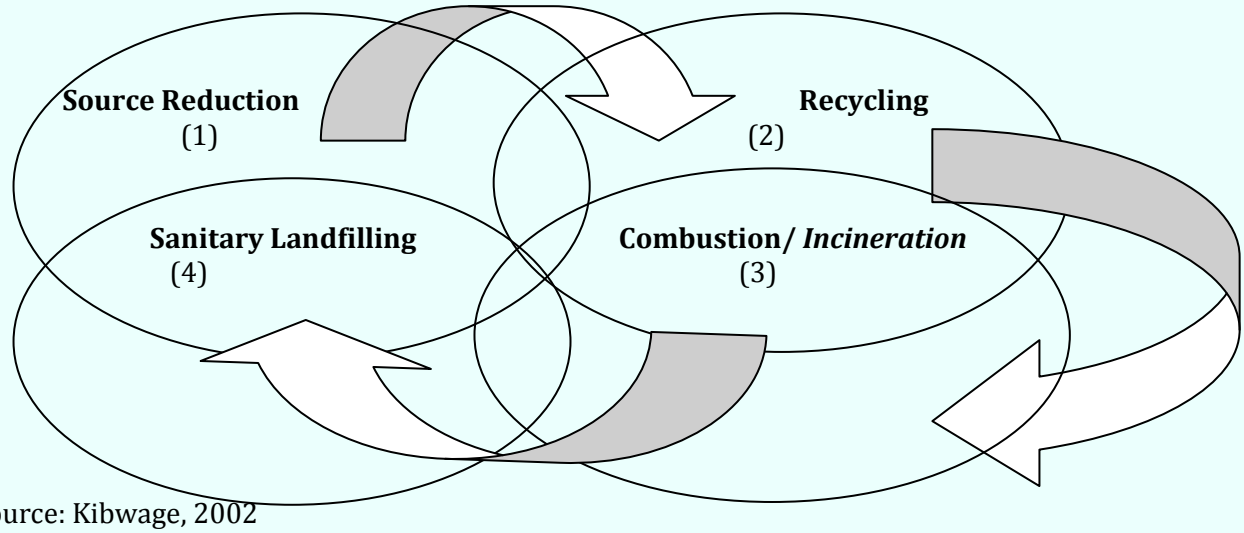
Having no alternatives, the residents often dumped their refuse on roadsides and open drains which were washed by run-off into Lake Victoria thus contributing to poor environmental health, and low quality of aquatic life. UN-Habitat offered to support the Municipal Council of Homa Bay through the UN-Habitat Lake Victoria CDS and water and Sanitation initiatives by developing a pro-poor Integrated Sustainable Waste Management Strategy. Both the CDS and WATSAN are under implementation in Homa Bay, and the strategy will serve as a Demonstration Project to illustrate the interagency collaboration through the established Multi-Stakeholder Forum working group.

1.2 Integrated Solid Waste Management

An ISWM approach has been recommended by a variety of authors. Integrated systems involve the use of a combination of techniques and programmes to manage the municipal waste stream. Within the range of management options, a hierarchy for SWM planners to consider when planning and implementing integrated waste management programmes has been suggested (refer to Figure 2). Briefly, the first level of the management hierarchy is ***source reduction***, which is the reducing of the amount and/or the toxicity of waste we generate at source. The

second level is ***recycling***, which is the 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/incineration*** should be considered next because this method reduces the bulk of municipal waste and can provide the added benefit of energy production. A final level is landfilling, which is at the bottom of the hierarchy and is necessary to manage non-recyclable and non-combustible wastes (refer to Figure 2). These priority areas were strongly supported during the 1992 Earth Summit on Environment and Development under Agenda 21 (UNCED, 1992).

Figure 2: An integrated solid waste management approach



Source: Kibwage, 2002

1.3 Terms of Reference

The project had two major components, a rapid Baseline Survey of the Homa Bay Integrated Solid Waste Management System and Development of a 5-year Pro-poor Sustainable Waste Management Strategy for the period 2010-2015.

a) A rapid Baseline Survey of the Homa Bay Integrated Solid Waste Management System

The baseline information gathering for the ISWM was guided by the broad goals of the Homa Bay CDS. The data collected in the baseline study reflected the ability to build indices based on key indicators derived from guiding principles of sustainability and integration. These indicators acted as a measure of the project gains depending on how they score against sustainability and integration components of the project. The baseline information was collected based on SWM technical, environmental, financial-economic, socio-cultural, institutional/organizational, policy/legal/political, HIV/AIDS, Gender, and Climate Change issues. To achieve this, the whole SWM system and existing private-public partnerships were examined based on the above principles.

b) Development of a Pro-poor Sustainable Waste Management Strategy.

To undertake this component, participatory techniques were used. This included basic presentations, discussions and practical exercises though field work. This led to the development of a five year integrated Solid Waste Management Strategic Plan for MCH. This has been published as a separate document from this report.

CHAPTER 2: STUDY METHODOLOGY

2.1 Introduction

This baseline survey was carried in July 2010. Keeping in view the nature and scope of the study, the consultant adopted various methodological procedures and techniques in data collection, processing and presentation.

2.2 Study Population, Data Sources and Data collection methods

Both primary and secondary data was collected in order to gain understanding of the following aspects:

- The current quantities of solid wastes generated, collected, recycled, treated and disposed
- The environmental considerations currently employed in ISWM
- Financial and economic principles in solid waste management
- Socio-cultural principles of MCH
- The existing organizational structure in solid waste management in Homa Bay municipality
- The relevant policies and legislation and their requirements in ISWM

To obtain the information listed above, the survey targeted the following sources: the municipal council staff, private waste collection companies (CBOs), 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.

2.3 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.

MCH has 5 major residential estates. A representative residential estate was selected based on its socio-economic status. Table 1 below provides the distribution of the resultant sample size from the residential estates.

Table 1: Sampled Residential Areas

SN	Sampled Residential Estates/ Income Level	Frequencies
1	Milimani(High income)	40
2	Makongeni (Middle income unplanned)	20
3	Site and Service (Middle income planned)	20
4	Shauri Yako (Low income)	40
	Total sample	**120**

2.4 Industrial and Institution Waste Survey

Industries and major institutions (including hospitals, offices) within the town were surveyed to determine waste generation and management in such locations. Institutions and businesses were sampled based on the same principles as residential neighborhoods. The various sectors were grouped together and samples taken for the various wards within the town. Table 2 below provides the distribution of the resultant sample size from the operation areas

Table 2**:** Sampled Waste Generators

Commercial zones	Hotels, restaurants and food kiosks	Learning and financial institutions
▪ Suba Butchery ▪ Rosemi Shop ▪ Babo Printers ▪ Shivling Supermarket ▪ Grabophin Computers (cyber cafe) ▪ Joylab Tailoring Shop ▪ Emirates Butchery ▪ RA Anyango Coca-Cola Depot ▪ Videya Discount Supermarket ▪ Total Petrol Station	▪ Ruma Hotel ▪ Twin Towers Hotel ▪ Mini Caro Kiosk ▪ Mary Kiosk ▪ Jully Restaurant ▪ Tawakal Cafe ▪ Main Market kiosk ▪ Bunde Kon'goro kiosk ▪ Kabissa Hotel ▪ Travellers Hotel ▪ Homa Bay Tourist Hotel ▪ Bay Annex Hotel ▪ Eureka Restaurant ▪ Kavirondo Hotel	▪ Homa Bay High School ▪ Homa Bay Primary School ▪ Homa Bay Children's Home ▪ Homa Bay Youth Polytechnic ▪ Post Bank ▪ Equity Bank ▪ Homa Bay Catholic Diocese Development
Juakali garages	**Offices**	**Waste recycling industries and jua-kali workshops**
▪ Komalo Garage ▪ Ndugu and Brother Motor Garage ▪ Gamba Garage ▪ Osumba Garage ▪ Japolo Workshop Garage ▪ Wan'g neno Garage ▪ Odhiambo Safaris Garage ▪ Sofia Garage	▪ Community Mobilization Against Desertification (NGO) ▪ Soyanco Plaza(Personal office) ▪ Mocedins San	▪ Ober Workshop ▪ Pongezi Workshop ▪ Odumo Technical Tours ▪ Geoffrey Odhiambo Workshop ▪ Seline Migono ▪ Benard Ouma Workshop ▪ Omosh Art And Design

▪ Peter Garage ▪ Bombolulu Garage	Frontiers (NGO) ▪ Kimira Oluoch Small Scale Irrigation project (personal office) ▪ District Forest Offices (Government office)	Workshop ▪ Paul Otieno Workshop ▪ Rumo kitam Workshop ▪ Kwa Mungai Workshop ▪ Simba Tinsmith ▪ Nyowesi Workshop ▪ Milando Workshop ▪ Oli Arts and Design
Markets	**Construction sites**	**Health institutions**
▪ Municipal Market ▪ Shauri yako Market	▪ Twin Towers Construction Site ▪ Central S.D.A Construction Site ▪ Priscot Enterprises Construction Sites ▪ Flats Area Construction Site	▪ Homabay District Hospital ▪ St. Paul's Mission (Health Centre) ▪ Atlas Clinic And Laboratory(Clinic) ▪ Homa Medical (Clinic)

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

2.5 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. Sets of questionnaires were developed for Key Informant Interviews. The targeted sources of information were divided into the following categories:

Table 3: A summary of key informants

S/no	Category	No. of respondents
1.	CBOs providing SWM services namely Women of Kanyada (WOKAN), ASEDHWA, Town hawkers, Jua-kali women Association and Environmental Watch Programme (E.W.P)	5
2.	Street waste pickers	3
3.	Waste dealers and wholesalers	3
4.	MCH staff i.e. Drivers, Supervisors and Refuse Collectors	9
5.	MCH Management staff (Town engineer; Cleansing superintendent; Municipal works officer; Accountant)	4

2.6 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.

2.7 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 MCH formed an important ingredient in the whole study. The relevant photographs have been pasted in various sections of the report.

2.8 Secondary Sources of Data

Secondary data was generated by making a critical review of relevant literature in various libraries, institutions/organizations like Africa Waste and Environment Centre (AWEMAC), United Nations Environment Programme (UNEP), World Health Organization (WHO), United Nations Development Programme (UNDP), United Nations Centre for Human Settlements (UN-Habitat), Central Bureau of Standards (CBS), and the MCH Planning and Environment 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 theses.

2.9 Study Limitations

There were two major limitations during the study period. Lack of updated records at the MCH and Community Based Organizations (CBOs) tasked with collecting wastes within the town was also a major challenge to the study team. Similarly some of the key informants particularly the Capital Fish (K) LTD processing plant was very uncooperative and was not willing to divulge any information. The consultant was therefore not able to get some of this information from the primary sources and had to rely on secondary data and other sources.

CHAPTER THREE: SOLID WASTE CHARACTERISTICS

3.1 Introduction

This Chapter contains the analysis and discussions on household waste, industrial waste, hotel & restaurant wastes, institutional wastes, construction wastes, hospital waste characteristics and factors responsible for poor SWM services in the Municipality.

3.2 Characteristics of household 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 of these investigations indicated that the average daily production amounted to approximately 1.1, 0.9 and 0.7 Kg/household/day for Milimani, Makongeni and Shauri Yako respectively. On average, the rate of waste generated was found to be 0.9 Kg/household/day. Using an average household size of 6 persons (refer Kenya population census of 1999), the generation rates were estimated to be 0.10 Kg/person/day, 0.12Kg/person/day and 0.16 Kg/person/day in Shauri Yako, Makongeni and Milimani, respectively. On average, solid waste generation rate was 0.13 Kg/person/day. MCH with a population of about 90,000 (Kenya National Bureau of Statistics, Homa Bay, 2008), generates about 11.7 tonnes per day or 4,270.5 tonnes per year. These results indicate that the socio-economic status of the people influenced the generation rates and even waste characteristics (read more in Box 1).

The physical composition of domestic waste was estimated by using both primary and secondary data available. Representative samples were taken from residential areas to obtain the average household solid waste composition for MCH.The study was carried out on the wastes collected from the low income area of Shauri Yako, middle income areas of Makongeni and Site & Services estates and the wastes from the high-income Milimani 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. Organic wastes comprised of 91%, plastic and 6% rubber, 1%waste papers while others had 2%. Glass/bottles and scrap metals were notably absent from the household wastes.

Table 4: Household waste generation rates

SAMPLING AREA	WASTE GENERATION PER HOUSEHOLD PER WEEK (Kgs)	WASTE GENERATION PER PERSON PER DAY (Kgs)
MILIMANI (High-income)	6.69	0.16
MAKONGENI and SITE & SERVICES ESTATES (Medium-income)	5.21	0.12
SHAURIYAKO (Low-income)	4.03	0.10
AVERAGE	5.31	0.13
Note: Average Household size used = 6 persons Week = 7 days		

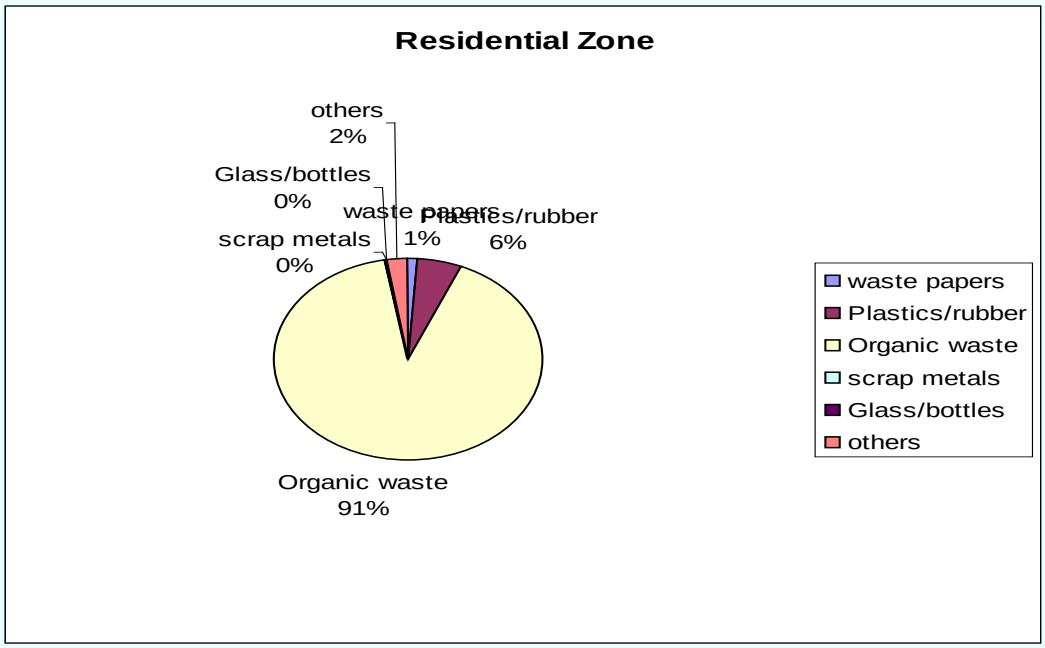
Box 1: Socio-economic status and household wastes characteristics

My name is Linet Adhiambo from Makongeni. I am aged 24 years and married with two children. I dropped out of school in class seven (7) and moved to live with my husband who is a class eight drop out. My husband is self employed and works at a welding workshop in town earning an average of Kshs 5,000 per month. This money is what we use to pay rent, buy food and all the necessities of the family. The wastes we produce are often approximately less than one (1) kilogram per day and are disposed in the open pit in front of the house. The wastes normally do not contain bones since the last time we bought meat was December 2009!

The waste paper is also re-used as tissue papers and in lighting fire in the house. The food wastes are rare since we eat the food remains from the previous meals before cooking other foods. If a private waste collector decides to collect wastes from our house, we will not be willing to pay since the money can be used to purchase other basic needs like food and clothing. I don't have any suggestions on how to reduce problems associated with waste management.

Plate 1: Typical household waste showing its components

Figure 3: Chart showing various components of household wastes



The densities of the household wastes were also estimated by taking five (5) representative samples and averaging the results to obtain the desired results as shown in the table below. The average density was found to be 56.4 (Kgs/M3).

Table 5: Density analysis of household waste

SAMPLE NO	DENSITY (KGS/M3)
1	50
2	44
3	70
4	42
5	76
MEAN	56.4

3.3 Characteristics of industrial waste

A small number of industries exist in Homa Bay Town. The main industries include the Capital Fish Kenya Limited, the Cotton Ginnery and *Jua Kali* industry among others. Information collected revealed that the cotton ginnery stopped its operations three (3) years ago and thus do not currently generate any solid wastes. It was also established that Kenya Industrial Research Development Institute (KIRDI) is undertaking a pilot project to test the viability of establishing a pineapple industry within Municipal Council of Homa Bay. Once the industry is established, it is expected to generate a recommendable volume of solid waste.

However during the study period, it was established that only the Capital Fish Kenya Limited is currently operational and is a major source of industrial waste in the town. During our baseline study, attempts to obtain the current statistics on solid waste from the industry's management were unsuccessful. However, information from *Shauri Yako* fishmongers, *Kandiege* fish processors and *Lela* B fish processors made it possible to obtain the approximate generation rates of solid waste as captured in the table below.

Table 6: Capital Fish (K) Ltd waste generation rates

Type of waste	Average weight (KG) per day	How it is disposed
Fish bones	6300	Re-sold to consumers
Skin wastes	300	Used for poultry feed
Fats	203	Used for cooking fish
Fish flesh (chips)	100	Re-sold to consumers
Eggs	36	Re-sold to consumers
Fillet rejects	210	Re-sold to consumers
Fish intestines	12	Buried
TOTAL	7161	

From the table above, it can be deduced that the solid wastes generated from the industry is composed of fish bones (6300Kg/Day), skin wastes (300 Kg/Day), fats (203Kg/Day), fish flesh/chips (100 Kg/Day), eggs (36 Kg/Day), fillet rejects (210 Kg/Day) and fish intestines (12

Kg/Day). The wastes were separated and sold differently at the *Mgongo Wazi* and *Kabunde* retail markets. It was also established that the Capital Fish Limited also operates a dumpsite at *Rodi Kopany* where the solid wastes which are not resold to the *Mgongo Wazi and Kabunde* Markets are disposed.

Plate 2: Capital Fish (K) Ltd by-products being recovered at the *Mgongo Wazi* Market

3.4 Characteristics of institutional wastes

3.4.1Heath institutions

There was substantive generation of waste in the hospitals within the Municipality. In all the categories, it was established that most of the wastes generated were handled from within the hospital. There was little metallic waste generated in health facilities with almost all being injection needles. Scrap metal from obsolete equipment was difficult to quantify since these were disposed-off regularly. At the Homa Bay District Hospital, the convoluted disposal procedures results in a lot of waste being kept in storage without being identified as waste. The generation rates of different categories of solid wastes at the Homa Bay District Hospital were as follows:

Table 7: The various categories of wastes and their volume by mass

Type of wastes	Mode of treatment and disposal
Incinerated ash	Taken to Municipal council dumpsite
Highly infectious	Incinerated
Radioactive waste	Incinerated
Chemical	Incinerated
Non infectious	Taken to the refuse disposal pit and burnt
Placentas	Placenta pits

The categories of hospital waste identified included non-infectious wastes (paper, packaging materials, plastic bottles, food and cartons), infectious (gloves, dressings, blood, body fluids and used specimens), highly infectious (anatomical waste, pathological waste), chemical (formaldehyde, batteries, photographic chemicals, solvents, organic chemicals, inorganic chemicals), radioactive (any solid, liquid or pathological waste contaminated with radioactive isotopes of any kind) and placentas.

Plate 3: Various categories of hospital waste being incinerated

3.4.2 Learning institutions

There were a total of 44 public primary schools and 13 private primary schools, one children's home, one youth polytechnic (Homa Bay youth polytechnic) and 21 secondary schools within MCH during the study period. These learning institutions generated a lot of wastes ranging from waste papers, organic wastes, old clothing, polythene bags, plastic bottles and carton boxes with waste papers carrying 60% of the wastes by volume. To obtain the generation rates of the learning institutions was challenging since the wastes were inadequately quantified.

3.4.3 Financial institutions

There were a total of five financial institutions at MCH namely Equity bank, Cooperative Bank (Kenya) Limited, Post Bank, Kenya Commercial Bank and the Barclays Bank of Kenya. These institutions generate highly classified wastes which are shredded within the banks and often collected by the CBOs for disposal at the municipal council dumpsite at the foot of *Asego* hill. The generation rates were estimated at 20 kilograms per month (Environmental Watch Programme) for each of the banks except for Post Bank which sends their wastes periodically to Nairobi for shredding. The other wastes generated in small quantities include organic wastes, plastic water bottles and polythene bags. The Kenya Women Finance Trust (KWFT) was also found to generate the same composition of wastes.

3.5 Characteristics of solid waste in the commercial sector

3.5.1Hotels, restaurants and food kiosks

Hotels, restaurants and food kiosks were found to be notable contributors of solid waste within the Municipality. The Municipality has a total of twelve (12) hotels, ten (10) restaurants and 59 food kiosks according to the Municipal Council records. During the baseline survey, 5 hotels, 5 restaurants and 8 food kiosks were sampled for the study. The study revealed that the generation of waste in hotels and markets tends to preclude metals although there were also special wastes like the construction material in a number of hotels that are undergoing expansion e.g. the Twin Towers Hotel. Other special wastes included bottles most of which were not separated from the general organic waste.

Organic waste was the predominant waste in this sector. This included food left-overs and the garbage created during preparation of the food. The paper and plastic wastes arose mainly from the material in which the foodstuff is packed. A large indeterminate proportion of the organic waste is sold to residents as animal feed and hence is not included as waste in these computations. Other wastes generated by the hotels, restaurants and food kiosks included waste papers, used soap remains, plastics, glass and bottles.

The survey conducted revealed that solid waste from the hotels, restaurants and food kiosks did not differ extensively in their composition. Waste from the hotels were composed of used bathroom soaps, organic wastes from food remains and kitchen wastes, plastic bottles, waste papers and polythene bags. Wastes from the restaurants included waste papers, plastic bottles, food remains and other decomposables. Most food kiosks generated minimal quantities of food remains and waste papers with no plastic containers.

Plate 4: Hotel wastes

3.5.2 Bus Park

The main bus terminus in the Municipality is an important entity in solid waste study survey. The information obtained from the bus park attendant/superintendent indicated that the bus park generates an average of sixty (60) kilograms of solid waste per day which is composed of waste papers, plastic bottles, polythene papers, cartons and organic wastes.

3.5.3 Tailoring shops

According to the municipality records, a total number of 21 large and small tailoring shops exist within the municipality and contributes a notable volume of textile waste. From the interviewed tailoring shops, it was found that they generated an average of 5 kilograms of textile wastes per day which are stored in the 90 kilogram sacks and resold to the carpentry workshops to be used in making sofa sets. Other types of wastes generated by the tailoring shops include polythene bags, broken needles and papers though in negligible quantities.

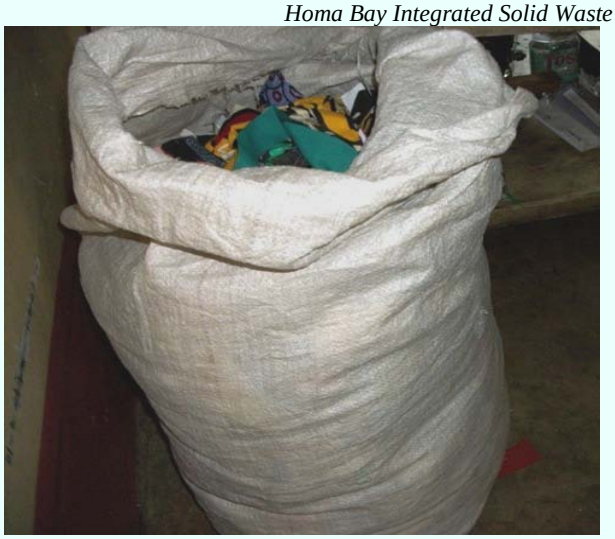


Plate 5: A sack containing tailoring shop's wastes

3.5.4 Butcheries

Butcheries sampled during the survey contributed an average of 5 kilograms of solid waste per day with a greater composition being the organic wastes. The main components were the bones and other decomposables together with minimal quantities of waste paper and old newspapers. The butcheries which sell vegetables also generated smaller quantities of vegetable wastes.

3.5.5 Supermarkets and wholesale shops

Supermarkets generated different types of wastes. These wastes are composed mainly of waste papers and polythene bags with the later contributing 75% by volume of the total. The shops in the municipality generated an average of 17 Kilograms of solid wastes per day. These wastes were composed of waste papers, plastics, polythene papers, organic wastes and used straws with plastic bags and polythene bags taking 60% of the total waste.

Plate 6: Wastes from Supermarkets

3.6 Characteristics of construction wastes

Homa Bay is a growing town and is characterized by a large number of construction sites which contribute notable quantities of solid wastes for disposal. The average mass of solid waste generated from the construction sites is 50kg per day. These wastes include broken glass, used cement bags, broken bricks, scrap metals, used nails, plastic containers, stones and ballast, waste papers, polythene papers and organic wastes. Enormous percentage of construction wastes was being re-used.

3.7 Characteristics of wastes from automobile garages

There are approximately 50 motor vehicle garages in the municipality. The wastes generated from the automobile garages were of the same composition and consisted of engine oil plastic containers, used oil, carton boxes, broken glass scrap metal (large quantities), used tyres and rubber tubes.

Plate 7: Solid waste at automobile garages

3.8 Characteristics of wastes from petrol stations

During the survey, it was found out that there are a three (3) major petrol station in the municipality. However other small scale filling stations exist within the CBD and outside. The wastes generated by these petrol stations included engine oil plastic containers, carton boxes, scrap metal (large quantities), used tyres and rubber tubes.

3.8 Characteristics of wastes from markets

There are four major markets in Homa Bay Town which include the *Shauri Yako/Soko Mjinga* market, the Homa Bay Municipal council market, the *Mgongo Wazi* market and the *Kabunde*. The *Shauri Yako/Soko Mjinga* market and the Homa Bay Municipal market generate all kinds of solid wastes from plastic bottles, waste papers, vegetable wastes, broken glass, waste papers, stones, soil, batteries, carton boxes and other forms of organics. The survey revealed that each of these

markets generated an average solid waste mass of one (1) tonne per day with the mass collected tripling every Thursdays due to the fact that Wednesday is a market day.

The *Mgongo Wazi* market and the *Kabunde* Market are special types of markets dealing with the recovery of the solid wastes (fish remains) from the Capital Fish processing company. Moreover, fish packaging materials form a very important component of the solid wastes generated from the markets.

Plate 8: Vegetable wastes at the Shauri Yako market

CHAPTER 4: THE INSTITUTIONAL/ORGANIZATIONAL AND MANAGEMENT FRAMEWORK

Municipal solid waste issues represent a major problem to the MCH. As the town grows and develops, there is need for improvements in infrastructure and technology to help overcome barriers to the safe disposal of the generated solid waste. Therefore, the management of solid waste is one of the challenges facing MCH. Solid waste management practices in the municipality have largely concentrated on collection and disposal to the dumping site. The collection, transfer and disposal of these wastes have been generally assumed by the municipal council.

Before one can analyze factors responsible for the poor solid waste management in the municipality, it is important to understand the political and economic framework of the council in regard to service provision. Therefore, this chapter examines the different players in solid waste management to enable us appreciate their capacities and baseline status with regard to their activities. The field survey revealed that three major actors were involved directly or indirectly in SWM activities. This included the MCH, CBOs and the informal sector agents (small scale waste dealers and recyclers).This Chapter's main focus is on the analysis of factors responsible for poor SWM services in the municipality, with special attention given to the municipality's role in SWM and its operational constraints. It also examines the existing institutional and organizational set-up and its implications to the SWM services in the Municipality.

4.1 SWM Service Arrangements

During the survey period, there were three forms of SWM service arrangements. First the MCH was providing SWM services directly using its own employees. A second arrangement was-*private arrangement* - which was largely independent of the municipal arrangement. This was where the service recipients themselves arranged for the collection, transportation and disposal of their own waste without involving the MCH. In this case recipients paid their collectors (CBOs) directly. There was a third service arrangement that revolved around waste dealers and recyclers. Details of the latter two service arrangements will be outlined in later chapters. This chapter will focus on the role and operational constraints of the major actor, that is, the MCH.

The traditional approach of collection and disposal used by MCH is inefficient and financially unsustainable. This is because SWM is not prioritized in the budget. Therefore with the growing waste management problem in the Municipality, privatization of SWM was increasingly considered more effective in the affluent areas of the municipality. However illegal dumping was very common as was witnessed in roadsides and other open spaces in the low income areas of the town e.g. *Shauri Yako*.

Residential areas were not prioritized by the MCH for household waste collection. The constraints sited included; lack of staff, short working hours (08.00 a.m -12.00 noon), the Cleansing Section was overwhelmed by the work within the CBD alone and therefore making it difficult to cover the entire municipality, lack of staff motivation and failure of the council to prioritize SWM practices. It was assumed that the residential areas in high and middle income estates like Milimani and Makongeni respectively were covered by private collectors thus indirectly delegating MCH's mandate. In these areas, collection was regular because the residents paid for the services and roads were accessible. However, in the low income areas, there was no collection because roads were impassable and residents didn't pay for the services. Since there was no collection services in the low income residential areas, reduced capacity of the MCH did not affect them because they did not depend on its services at all. As a consequence, poor urban areas will continue to

suffer unless different models of refuse collection and disposal are formulated and implemented.

The five CBOs in the private waste collection business did not contact the municipality for contractual agreement with their customers. They fixed their rates on a willing buyer willing seller basis and customers paid an agreed amount of money per month for collection and disposal of solid waste from the residential areas and any willing customers from the CBD.

All the solid wastes collected were being disposed-off at the dumping site within the town residential area, adjacent to the cemetery. The land belonged to the MCH. The dumping site which was not fenced was already filled up and had no attendant. There was another dumping site owned by Capital Fish (K) LTD where they dumped their wastes generated from processing of fish.

The general belief that the private sector can do a better job than the MCH was true considering the Council's poor service record. The failure of the council to service all the areas of the town had repercussions on SWM. Residents at the middle income residential areas, institutions and a wide range of business entrepreneurs had privately contracted any of the five CBOs to collect their solid wastes at an agreed fee paid directly to the CBOs over regular intervals of time. The five CBOs in operation in the town were: ASEDHWA Women Group, EWP, WOKAN (Women of Kanyada) Women Group, Homa Bay *Jua Kali* Women Association and Town Hawkers group. The CBOs indicated that their long-term plans were to start recycling projects to supplement their income sources; however, none had taken any tangible initiative to achieve that. Lack of capital was stated as the major limiting factor.

Most of the solid waste generated within the CBD is collected with a collection efficiency estimated at 70-80%. The collection that took place was shared between the MCH and the CBO collectors mainly concentrated in the high income areas leaving the poor surrounding neighborhoods largely unattended.

Waste collection and transportation to the dumpsite was inefficient with the waste not transported often burnt to reduce the waste volume. This poor management of solid waste resulted into blockage of sewers and drainage systems, leachate generation, unpleasant odours, smoke from private burning of waste as well as pollution of Lake Victoria through run-off. The dumping site was also filled up; its siting was not properly done (located next to the cemetery and residential area) and also served by poor road network. Thus a new parcel of land needs to be allocated for construction of a sanitary landfill.

Box 2 : Benefits of UN-Habitat equipments in SWM in the MCH

My name is Mr. Paul Ogwalo and I am the cleansing superintendent at the council. The main problem we've been experiencing here is that the Council's management does not see solid waste management issues as a basic service to be given a priority. This is because it is not an income generating activity. However with the emphasis that has been placed on the importance of this service by international bodies, notably the UN-Habitat, the Municipality management is slowly becoming aware of the need for proper SWM practices and is now cooperative in seeking more efficient options of dealing with SWM issues in the Municipality.

Before the donation of the tractors and skips by UN-Habitat, we only had one tractor at MCH. The tractor is now over 20 years old and often had mechanical problems, time which the collection of

solid waste was a major problem to the municipal operations. The introduction of transfer stations was a major step in the MCH solid waste management. Even though the transfer stations are not very efficient, they help a lot since waste can now be stored in one area for collection. However, this system has major disadvantages in that one has to climb up to dispose the waste leading to disposal outside the transfer stations by some individuals. Loading the garbage to the truck and spillages during transportation especially during the wet season also posed operational constraints.

The introduction of skips has brought a major overhaul in the solid waste management system in the Municipality. We are now able not only to store waste efficiently but it has also made it easier to transfer the collected waste to the dumping site. The tractors donated by UN-Habitat do not require pushing the waste to the tractor and hence a major step in the right direction. We are now able to make 4 trips per tractor in the field. Our request to the UN-Habitat and other international bodies is to provide us with more skips so that once the tractor lifts off the loaded skip; an empty one is replaced to facilitate waste collection. It will also enable us to place the skips in more area outside the areas currently served.

Despite the council receiving donation of equipments and technology from UN-Habitat, particularly for solid waste collection and disposal, problems still exist in SWM practices within the municipality (read more in Box 2). Although the donor-provided equipments and technology are appropriate to the nature of the waste, the collection vehicles were frequently ill-suited to extremes in climate and road conditions. Poor handling, poor vehicle routing, lack of maintenance and inadequacy of equipments (e.g. receptacles) was a major cause of poor service provision.

Minor repairs and maintenance of refuse collection and disposal vehicles was being done by a council mechanic who had an incomplete toolbox. This was done just outside the council offices since they had no workshop for council vehicles. Major mechanical problems were taken to various *Jua kali* mechanics since the council had no such contracted service provider.

4.2 Organizational Structure

In April 1974, Homa Bay obtained the status of an urban council, before moving a step higher to a town council in 1987. In 1991, the town was elevated to the status of a municipality. The Municipality is governed by the "Municipal Council of Homa Bay" incorporated by an Act of Parliament which came into effect on January 1st. 1964. The Council consists of 6 elected councilors, 2 nominated councilors including 1 appointed public officer.

The Mayor, who presides over all Council Meetings, is elected by members of the Council. The management of the municipal council of Homa Bay is structured into two wings. The first one is the civic wing comprising of the councilors and headed by His Worship the Mayor. This wing has four committees each headed by an elected councilor. The council runs its services through these committees which make decisions on key issues. The four committees are:

- Town planning and works
- Environment and public health
- Education, housing and social services

- Finance, staff and general purpose committee

All environment matters including SWM were handled by the Environment and Public Health Committee. There was a time when the Education, Housing and Social Services committee wanted to run environmental issues but it never worked. The second arm is the executive wing with five administrative departments headed by the Town Clerk who is the Chief Executive.

The current functional departments at MCH are;

- Clerks department
- Town Treasurers department
- Education and Social services department
- Engineering department
- Audit department which is a new department formerly under the town treasurer's department.

All matters on SWM were the responsibility of the Engineering department which was headed by the Assistant Town Engineer (see table 9). The service was being provided directly by the Cleansing Section which was headed by a superintendent.

The Cleansing Section officials recognize the need to reduce and separate waste at its source, to conduct mass media campaigns, and to develop clear and enforceable policies and by-laws promoting waste reduction, recycling, and community participation but there appears to be lack of political will to do so. If this section can be allocated its own department, it can reduce the workload in the engineering department.

Apart from the provision of SWM services, the Cleansing Section was also responsible for market cleaning, Bus Park cleaning, control of dumping, collection and disposal of slaughter waste, street sweepings, and bush clearing within the MCH's area of operations. Other responsibilities of the Section included special services such as collection and disposal of dead animals, storm water drain cleaning and general administration.

4.3 Manpower Resources and Capacity

In 1981, there were 10 persons in the cleansing section at all levels. In 1985 the number increased to 18 staff members and to 22 persons in 1989. However, the numbers continued to increase until 2006 when the number was 30. Since then there was no new employment. Some staff members have since retired and some died bringing the current number to 25 workers in the cleansing section.

Table 8: The current staff strength in the Engineering Department's cleansing section

Established Staff Rank	Strength/No.
Assistant Town Engineer	1
Works officer	1
Cleansing Superintendent	1
Clerical officer II	1
Senior Headman	1
Headman	1
Drivers	4
Loaders	4
Refuse collectors	1
Bush clearer& Labourers	12
Total	**27**

There are 27 permanent staff members including the Assistant town Engineer and Works Officer. The numbers of casuals vary depending on the external pressure exerted on the council by the politicians. The casuals are usually hired for a period and then laid off depending on availability of funds. The section indulged youth in the "*Kazi kwa Vijana"* initiative and it proved very effective.

There is only one Cleansing superintendent for the whole town. This makes him inefficient and overworked, furthermore there is no supervision vehicle for him to use. The number of drivers is equivalent to the number of vehicles. However at any one given day, only two vehicles go to the field meaning the services of the two remaining drivers are not used. The council has only one bush clearer meaning if he is ill or overworked, his services will be missed. Meanwhile according to the cleansing superintendent, most staff shared work since there was manpower shortages in the cleaning section e.g. a supervisor sometimes acted as a loader. All these are challenges facing staffing in the SWM sector due to lack of proper human resource planning. The cleansing staff members get a dirty allowance of 100 shillings a month which is insufficient. The quality of any staff depends on training and skills development. The interview with the Cleansing superintendent and other workers in the section revealed that there were external trainings and workshops for a few of the cleansing section staff.

Though one might sympathize with the present (2010) labour strength, the MCH had no plans to increase it. This is because the current staff is not only underutilized but there is an employment embargo. Shortage of waste collection and disposal equipment (receptacles) has led to a situation where some workers only report every morning and return to their homes at midday without providing any service to the Council and yet at the end of every month, they received all their financial benefits.

4.4 Shortfalls in the SWM Legislation

SWM is a complex matter. Although the technical aspects are of prime importance, there are also a number of non-technical questions that have to be addressed to give a complete picture of the issue. Due to the environmental risks connected with pollution caused by unsanitary dumping of

wastes in Homa Bay, the town's environmental planners cannot follow only simple market and technical principles. The role of legislation should therefore basically provide a framework for organizational decisions.

Environmental regulations need to be designed and created to protect the health and integrity of the delicate Homa Bay ecosystem and the human populations. They should also be enforced in order to prevent the need for costly remediation measures in the future. Although the small-scale private waste management sector in MCH is often forgotten, it can play a key role in the town's overall waste management strategy. Therefore, Privatization contracts and legislation should be flexible enough to permit the entry of these small-scale service providers, particularly in lower-income areas.

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 MCH 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 MCH to hire and fire its own employees. These kinds of limitations for the MCH 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 MCH 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 MCH 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 MCH, 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 MCH 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 MCH 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 MCH.

The Act gives power to the MCH 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.

The MCH has no regulations concerning SWM. However, regulations have been developed by the Municipal Council of Homa Bay to govern waste management operations in the municipality (Municipal Council of Homa Bay 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 lake 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 29th September, 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.

4.5 Solid Waste Management Costs

One of the greatest constraints of SWM was reported to be the inadequate financing process. The major sources of finance for the MCH include single business permits, market dues, parking fees, rates, service charge, water charges, rents from the Council's properties, fees and other charges. There are external sources from the central government e.g. LATF, roads maintenance levy fund, and any other donation that can arise. 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 MCH.

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. Even though SWM services are supposed to be self-financing, the available information indicates that no finance-collection system is available leading to insufficient funds to provide environmentally acceptable level of service to the town's residents. This can be attributed to lack of a policy on integrated solid waste management where recycling and composting can be established to a level of not only creating employment but also generating income to the cleansing section.

CHAPTER 5: SOLID WASTE MANAGEMENT SYSTEM

This chapter gives the results for the solid waste management system in Municipal Council of Homa Bay. It gives the SWM handling procedures from storage, collection, transportation and disposal of solid wastes from various waste generators within the municipality.

5.1 Storage of waste

The major function of storage facilities is to keep the refuse temporarily under hygienic and aesthetically satisfactory conditions until it is collected for disposal purposes. A good storage facility prevents the breeding and spreading of flies and should control leachate (liquid emanating from solid waste containing dissolved, suspended and/or microbial contaminants). Besides that, the storage volume required for household wastes is a function of the number of premises served, rate of waste generation, household size and frequency of collection. The inter-relationship among these elements will be examined in this section with major emphasis on the efficiency, compatibility, durability, convenience and public health or safety of the containers used by residents of the Municipality.

5.1.1 Storage Methods Used

For purposes of evaluation, the survey 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 MCH or the various CBOs found within the municipality.

Since such receptacles are reasonably of large capacity (1.2m^3), they are supposed to be mechanically emptied by specially designed vehicles.
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 survey. 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. The cost of a dustbin was about Kshs 100. The dustbins were not susceptible to theft because they were stored indoors. The lifespan of the dustbin was estimated to be about 10 years unless there was mishandling. 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.

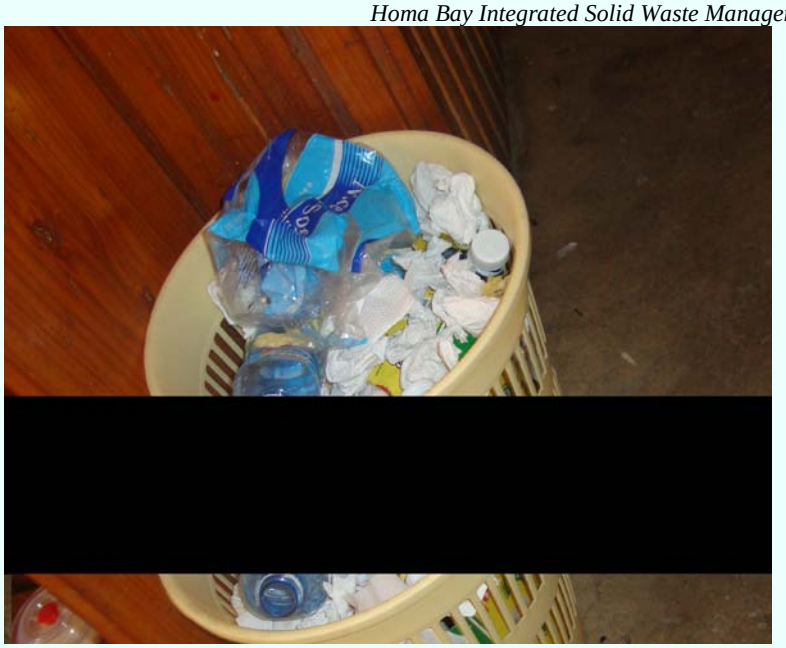


Plate 9: A dustbin placed in a hotel kitchen

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 MCH and CBOs then placed strategically at different places within the municipality. MCH gave priority to the CBD in distribution of purchased bins. Residential areas were mostly supplied by the CBOs. For instance, Women of Kanyada (WOKAN) has most of its clients in Site and Services Estates where bins are supplied to the clients and the wastes collected on a daily basis by the staff at a fee of Ksh.150 per month.

The bins were placed on streets at different intervals where different people threw in their wastes as they passed-by. These wastes would then later be collected by the MCH workers. The other bins supplied by private collectors like CBOs were labelled and given to clients (shops, banks, households and other business premises) who would then dump in their wastes. The staff of the private collectors would then collect the wastes every morning at a fee.

Plate 10: Sample of bins as seen in different parts of Municipal Council of Homa Bay

Bulk Containers (BCs)*:* These were the largest communal storage facilities used by residents with load capacities of 7tonnes and 10tonnes. They were used in areas like Got Rabuor, Makongeni, Fish market – near Pier, Old Market – Jua Kali, New Market – Concrete Transfer Station and Site – residential Area, Sofia Market – next to Stadium. Such containers were mechanically lifted into the collecting vehicle and then transported to the dumping site where they were also mechanically emptied. The lifting mechanism took less than five minutes when there was enough space to facilitate the collection process.

While the BCs were the most economical in terms of collection time, labour and durability, their cost of the 7tonne and 10tonne skip was about Kshs 250,000 and Kshs.300, 000 respectively. This makes it impossible for the MCH to afford an adequate number because of its financial constraints. They also posed a health hazard to the people around because they were left open and did not have lids. The open storage of waste in such containers left it unprotected against rain, insects and rodents. However, open storage had the advantage because the total volume of the waste was reduced by the scavengers who searched for various types of recyclables for sale.

Plate 11: A skip strategically placed in the Market

b) Unstandardized Containers: Some of the unstandardized containers (that is, not provided by MCH) observed included old basins, carton-boxes, sacks and plastic bags. These were mainly used because of insufficiency/obsolescence of containers caused by the MCH 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 Makongeni Estate, MCH and the CBOs 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.

Plate 12: Samples of unstandardized Containers

5.1.2 Criteria Used in Distribution and Location of Refuse Receptacles

The criteria used by MCH 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 "*Shauri yako*" because such areas were conceived as illegal. Industries and institutions also received the first priority in the distribution of secondary facilities because of their ability and willingness to pay for the service.

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.

5.2 Waste Collection Systems

This section examines the collection process, i.e. during the transfer of wastes from storage to the vehicle and traveling between successive collection points. The refuse collection methods used

included: Communal collection; Door-to-door or House-to-house 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. In Site Estate, for instance, the transfer station was constructed strategically to allow residents dump their wastes direct into the dumper.

Plate 13: The back (entrance) part of the transfer station) the front part of the transfer station for the collection of wastes and storage of tools.

Transfer stations were also observed at strategic points within the commercial zone. At Shauri yako market for instance, there was a transfer station and a dumper next to it. All wastes produced in the market were disposed off at the transfer station as shown below.

Plate 14: A transfer station at "*Shauri yako*" market

Plate 15: A dumper with wastes produced at "*Shauri yako*" market

In other places like Makongeni Estate, 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 Shauri yako Estate 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.

Plate 16: Scavengers as spotted in a Transfer Station in Site and Service Estate

Plate 17: A transfer station left unattended to at municipal market

b) Door-to-Door collection

With this method, the collection vessels stopped as close as possible to the entrance of the house, and the individual household containers were picked by a collector and emptied into the vessel. The collector then either took the container back or threw it on the ground for the householder to collect it. The system was observed to be used in some parts of Site estate and the CBD where it was used to serve "special clients" who usually paid a fee at the end of the month depending on

the type of client. For instance, households and small businesses paid Kshs.150 whereas banks and other big business premises paid Kshs.200 and Kshs.300 respectively.

Plate 18: An employee of E.W.P collecting wastes from clients

The Women of Kanyada (WOKAN) CBO, for instance, supplied their marked waste bins to some of the clients in Site Estate. The employees of WOKAN, who moved from one client to the other, would collect household wastes in the morning and dispose to a nearby transfer station located within Site and Service Estate.

c) 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 by either the MCH or CBOs. Milimani 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 burns up the wastes after the pits were almost filled up to give room for more wastes.

In middle-income estates like Makongeni, the method was also evidently used. According to respondents from Makongeni Estate, they were not being serviced by the MCH or any CBO within the municipality. They disposed their wastes in open spaces shared by a number of households and later burnt them once in a week. In Site Estate, the method was applicable because of the proximity of the residents to a nearby transfer station. Most respondents preferred removing the wastes from their households themselves as this reduced the costs in terms of paying from the services.

The survey revealed that in households where there was no collection especially in high and middle income areas, women and children were the ones who were charged with the responsibility of waste collection (read more from Box 3). This echoes the perception of the society that women should be charged with the responsibilities of handling garbage. In the high

residential estate of Milimani, 82.5% of the women revealed that they are the ones who removed wastes from their houses for final disposal.

Box 3: Gender roles, perceptions and attitudes in household waste management

My name is Mrs. Charity Mugambi. I am the one who is in charge of handling waste in this house and as you can see I am doing a very good job since you cannot see any litter in my compound. My husband thinks it a woman's job that's why when you came in and said you were doing this survey on solid waste management he told you to talk to me. It is important that issues of proper waste management are taught to children when they are still very young because changing their attitudes when they are already grown-up is very difficult. I grew up in Mombasa and my mum was very strict when it came to proper handling of waste and whenever she found the compound dirty with litter my siblings and I would be punished. She is the one who taught me all the things I apply in my house when it comes to handling waste, for instance as you can see I segregate my wastes, I compost the organic waste and use it as manure and give out the plastics to some boys who walk around picking plastics. I believe if it were not for my mother's toughness when it came to cleanliness I wouldn't be this knowledgeable about solid waste. You know the how our culture is; the truth is that if visitors come and find my house dirty, they'll say my husband is married to a dirty woman so I have to make sure my house is free of litter. It's my obligation.

In the slum and squatter settlements like Shauri yako Estate, the system was only used because the MCH and the private collectors like CBOs 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 MCH and CBOs, 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.

Plate 19: An open space for dumping wastes which are burnt after accumulation

This method of collection was also practiced in health care facilities. There existed a placenta pit in Homabay District Hospital and St. Paul's Health Centre 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 Homa Bay District Hospital. Once full, the MCH collected it to the dumpsite. 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.

"No collection" method was also observed at *Shauri yako "Mgongo wazi" Fish Market* where all the wastes were considered useful and none therefore ended up being disposed. However, the Willingness to Pay (WTP) for the collection services varied from one area to another as shown in the table below:

Table 9: The respondents preferences in terms of paying for the collection services

AREA	WILLING TO PAY (%)	NOT WILLING TO PAY (%)	NOT DECIDED (%)	Total
Low income area	37.5	60.0	2.5	100
Middle income area	35.0	52.5	12.5	100
High income area	22.5	27.5	50.0	100
Average percentage	31.5	46.7	21.8	100

According to the data acquired from the residents of low, middle and high income areas, wastes were collected in different ways (see below)

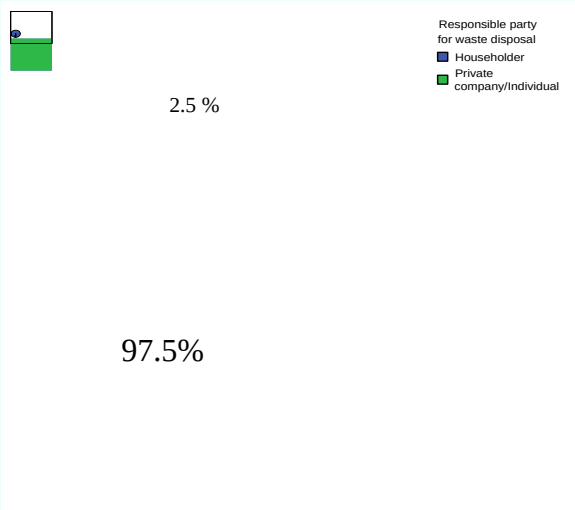


Figure 3: Waste collection in low income areas

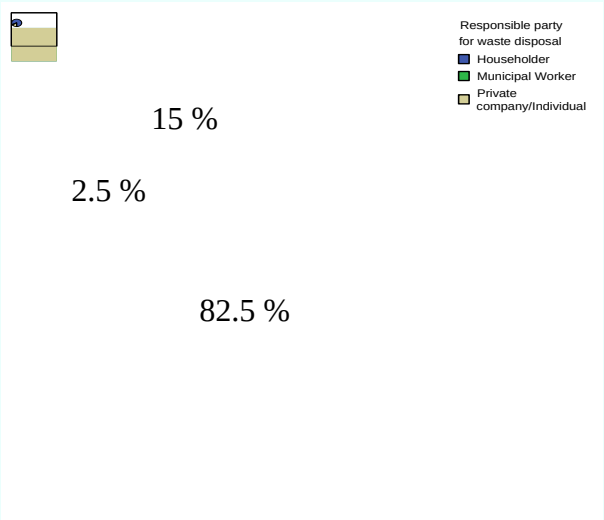


Figure 4: Waste collection in Middle income areas

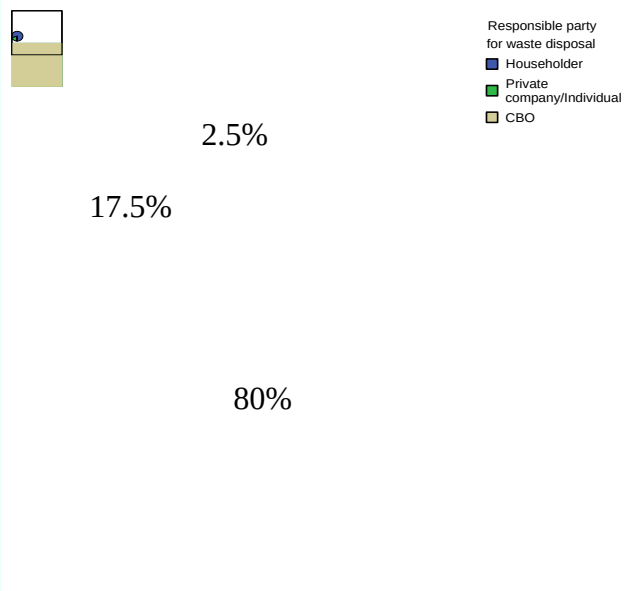


Figure 5: Waste collection in high income areas

Every refuse collection vehicle from the MCH was accompanied by 1 driver, 1 supervisor and 1 loader. This gave a maximum crew size of 3 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.

5.2.1: Frequency of Collection

The MCH's collection frequency had no basis. According to respondents residing closer to most collection points (transfer stations), there was laxity of the MCH in collecting wastes on a daily basis to the dumping site. The skips 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. Slums and squatter settlements, in particular, received no service at all because of their illegitimate status and they never paid for the service according to the E.W.P administrator. 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.

5.2.2: 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 E.W.P, 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.

5.2.3: Health Hazards among Refuse Collectors

The health hazards experienced among refuse collectors as revealed by the survey 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.

Most of the above injuries were attributed to ignorance among refuse collectors and irresponsibility of the MCH and CBOs management. For instance:-

- Collectors were recruited from the most unskilled and poorly educated segment of the working group who were difficult to train.
- Collectors received no initial or subsequent training as observed earlier in this work.
- Most collectors were undisciplined due to lack of meaningful supervision.
- Non-provision of protective clothing.

The MCH had simply ignored the incorporation of environmental health aspects into the HWM system.

5.2.4: Survival Strategies Adopted by the Refuse Collectors

Due to the various institutional, socio-economic and environmental frustrations among the refuse collectors, they had adopted several survival strategies which can be outlined here:-

- Livelihood diversification through indulging in other income-generating activities like small scale farming and businesses.
- Scavenging for valuable waste materials that can be sold or re-used. This is despite the restrictions imposed on them by their employees. For instance, E.W.P restricts its staff (collectors) from picking any material collected. This is based on a past incidence

where one collector was almost imprisoned for picking a mobile phone from the wastes. It took the intervention of Advocate Nyauke, the director of E.W.P, for the case to be withdrawn.

5.3 Transportation of waste

Transportation of wastes is the process of transferring solid wastes from the collection sites to the place of final disposal. Transportation process constitutes a key stage in the overall SWM system as discussed in the following sub-section. The different sectors sampled within Municipal Council of Homa Bay 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.

5.3.1 Refuse-Vehicle Types under Operation

Factors that should be taken into consideration in selecting refuse collection vehicles for purchasing or hiring include: the ease of entry and exit of personnel; the materials loading efficiency; loading capacity and nature of wastes; capital, operation and maintenance costs; housing density and configuration of streets; and the distance from the collection site to the landfill(s). Results from Homa Bay municipal council however reveal that they did not put any factors into consideration while purchasing their own vehicles. On the contrary Un-Habitat put these factors into consideration while purchasing the vehicles to be donated to the municipality.

These vehicles were mainly used for transportation of wastes from the skips at the transfer stations which were located at designated points within the municipality. The main establishments that dumped their wastes at the skips at the transfer stations included the commercial zone (butcheries, shops, hotels restaurants and food kiosks, the bus park, markets photocopying shops, supermarkets, cyber cafes, tailoring shops etc), garages, financial institutions, offices, construction sites, and private clinics (non-sharp waste).These wastes were dumped at the skips at the transfer stations by private waste companies mainly operating as community based organizations (CBOs).

During the period under study, the following types of vehicles were under operation:

a. Ndume Little Pick-ups (Dumpers)

The equipment, developed and modified to UN-HABITAT specifications include a little pickup tractor and trailer (the Ndume Little Pick-up) manufactured by NDUME Engineering Ltd of Gilgil in Kenya which is powered by two wheeled tractor. These units were designed to easily manoeuvre along narrow roads in densely populated settlements. Two Ndume little pick-ups were dispatched to the municipality in October 2008 and are currently in use, with significant improvements already being noticed in the municipality. During the survey, only one of the dumpers was in use while the other one was at the garage for repair.

Plate 20: A dumper with waste collection containers

b. High Tipping Container Pick up Trailers (Tractors)

Tractor trailed container system are used in many countries for picking up, transporting and emptying large containers of waste and have proved to be much more efficient than truck container systems where there are short to medium length haul distances between the collection areas and the disposal sites. The container pick up trailers are able to pick up both $4m^3$ low side and $8m^3$ capacity high side containers. A full container will hold up to 4,000 kg / 5,000 kg. This reduces the number of tractor trips to a quarter of what would otherwise be required, thereby maximizing efficiency in the use of the tractor with a corresponding reduction in fuel, labour and maintenance costs. The introduction of the container systems is accompanied by a very regular collection service. Each container is located on a concrete slab large enough to accommodate two containers so that the tractor can drop off an empty container before picking up the full one. The sides of the slab are extended at least 25cms below ground level or fitted with steel mesh to prevent rats from burrowing underneath.

During the survey only three were in good working condition while one was in the garage. It is however important to note that the three that were in good working condition were provided by UN-habitat in 2006 while the one in the garage was purchased by the municipality in 1985.

Plate 21: Transportation of wastes from the transfer stations using the high tipping container pick up trailer

Type of Vehicle	Number Operating	Average Age (years)	Life-span (years)
Ndume Little Pick-ups (Dumpers)	2	5	10
High Tipping Container Pick up Trailers (Tractors)	3	5	10
Main tractor	1	25	0
MEAN	**6**	**11.7**	**10**

Table 10: Age and Life-Spans of Vehicles under Operation

5.3.3 Human transport

Wheelbarrows were used for manual transport. They were mostly used to transport wastes to the transfer stations which were located strategically at various points within the municipality. This was done by either the municipal workers who swept and collected wastes from the streets of the municipality as well as staff of private waste companies mainly registered in the form of

CBOs .These wastes were transported to the skips at the transfer stations Similarly establishments that disposed their wastes internally i.e. onsite disposal, such as hospitals also used wheelbarrows to transport their wastes.

The middle income estate of site and service was the only estate that had a private waste company handling its wastes for them. Wheel barrows were therefore used to transport the wastes from the houses to the skip at the transfer station.

Plate 22: A Wheel barrow for transporting waste to the transfer stations; Owned by a CBO

Although the MCH owned several wheel barrows through the *"kazi kwa vijana"* project, only four wheel barrows were assigned the task of collecting waste. There were only 5 active CBOs which own a total of .11 wheel barrows.

Serial no.	Name of Private Waste Company	No. of Wheelbarrows	Average no. of trips/day
1.	ASEDHWA Women Group	1	1
2.	Environmental Watch Programme (E.W.P)	4	20
3.	WOKAN (Women of Kanyada)	2	7
	Homabay Women Juakali Association	1	2
	Town Hawkers	Hire 3 wheel barrows/day	12
	TOTAL	11	42

Table 11: A summary of the number of wheel barrows owned by private waste companies

This mode of transportation basically involved the use of hands to transport the wastes from their point of generation to the skips at the transfer stations or to dumping pits. This mode of transportation was utilized by establishments and individuals whose wastes were neither collected by neither the municipal council nor the private companies operating within the municipality.

This mode of transportation was commonly used by food kiosks to transport their wastes to skips at the transfer stations for final disposal at the municipal disposal point. Similarly, most of the learning institutions surveyed revealed that they transported their wastes manually to the point of final disposal since their wastes were disposed internally.

5.3.5 Postal/ E.M.S speed post

One financial institution revealed that it transported its waste paper to the head office in Nairobi by postal / E.M.S speed post for shredding. Transportation to Nairobi was done on a weekly basis and the wastes were taken to the E.M.S office speed post every Friday evening by a designated member of staff.

5.3.6 Service Operations and equipment Requirements

The SWM service was done with the vehicles outlined in Section 4.4.1 .Though there were specific routes assigned to the above 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 skip at a transfer station. 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 12.00 noon .The Municipal cleansing supervisor revealed that they were not able to work in the afternoon due to harsh weather conditions (too much heat). The refuse collection vehicles transported wastes from the skips at the transfer stations from Monday to Saturday i.e. 6 days a week. The survey however revealed that there were more than enough vehicles for refuse transportation in Municipal Council of Homa Bay since there were always two tractors packed at the municipality at one particular time. There was no garage or workshop to park the vehicles hence they were always parked outside the municipality building.

Wheel barrows from the MCH were not assigned specific routes by either the municipal council. They therefore collected and transported wastes to the skips based on the need. On the other hand, workers from CBOs collected and transported wastes from the specific clients who had contracted them.

There were 11 wheel barrows per day collecting and transporting wastes from the points of generation to the skips at the transfer stations. These wheel barrows made an average of 42 trips per day. These shifts lasted from 6.00 a.m to 12.00 noon.

5.3.7 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 survey revealed that MCH 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 period of time taken for which broken down vehicles were out for service typically depended on the nature of the break-down. Minor repairs averagely took 3 days while major repairs took two months.

The MCH used both preventive and breakdown maintenance for their wheel barrows. CBOs on the other hand only used breakdown maintenance for their wheel barrows hence there was no servicing of their wheel barrows to prevent frequent breakdowns.

5.3.8 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 survey 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.

5.4 Waste Disposal Methods and their Environmental Aspects

This section evaluates the existing methods of disposing waste keeping in view the extent of environmental pollution caused. Disposal is normally the last operation in the handling of refuse but it is never the least. Due to the heterogeneity of the waste as observed in Section. 3, 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 MCH, which had the obligation of disposing wastes, was entirely using open dumping or unsanitary landfilling. Hence, much of the discussion in this section is focused on this method of disposal.

5.4.1 Open or Crude dumping

During the survey period, the municipality had only one area set aside for the disposal of all types of solid wastes. The municipality dumping site is located 1.5 km away from the CBD in "*Katuma*"

ward. It has an overall plot size of 1.6 hectares. However, this has not been designed and present the dump area occupies 0.5 acre. The site has a fence but no gate and its proximity to residential areas allows easy access to people and animals, which might lead to transmission of diseases The dump site is already full hence its life span has expired (UN-HABITAT, 2005).

Approximately 75% of wastes from the municipality were disposed through open dumping at the disposal site. The municipality collected these wastes from the skips at the transfer stations and transported them to the disposal point .These wastes were mainly generated from the commercial zone, offices, markets, financial institutions, construction. sites and the middle income residential area of site and service.
Similarly open dumping of household wastes in open spaces within the compounds was practiced in high income residential areas.

The MCH openly disposes all its solid wastes at the dumping site posing serious environmental issues. There is no sanitary landfilling and of concern is that the cleansing officer even revealed that he did not know anything about sanitary landfilling. In sanitary landfilling, 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;

a) 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.
b) There was no litter and dust control. The site was generally untidy and dusty.
c) Human settlement was very close to the dumping site.
d) 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.
e) The dump was also a health menace to the surrounding residential areas because it was a source of objectionable smoke and odour.
f) The site security was quite unsatisfactory as reported by the MCH employees interviewed.
g) There were dogs inhabiting the dumping site which could attack and injure someone.
h) The road to the dumping site was not tarmacked and accessibility was a problem for the vehicles transporting waste. Access was particularly difficult during the rainy season. There were no special arrangements for bad-weather conditions.
i) The area was had no gate and was accessible to human beings and animals like dogs. There was a case of a person who was growing crops at the dumping site. He had planted beans, maize sun flower, among others.
j) 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 MCH'S financial constraints.
k) There was ground water pollution at the disposal site in cases where it rained due to leachate generation.
l) There was no control of gas-movements and fire on the site. Such gases could cause explosions outbreaks of fires in the dumping site. Infrequent explosions from gas-pockets within the dump were also reported.
m) There were no municipal council employees at the disposal site therefore there was no one to ensure security, record-keeping on waste deliveries and other duties.

n) 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 MCH disposal site.

. Plate 23: Open dumping of wastes in high income residential areas

5.4.2 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 are only two incinerators in the municipality one at Homa Bay District Hospital and one at St.Paul's mission health centre. The incinerator at St.Pauls's mission health centre was however sub-standard since there was cases of incomplete combustion of the wastes.

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 Homabay District Hospital. At all the health care facilities surveyed, the residue ash resulting from incineration was taken to the skips at the transfer stations for final disposal by the municipality at the municipal dumping site.

5.4.3 Open burning

This method of waste disposal was mainly used by low and high income residential areas and learning institutions .All the learning institutions surveyed 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.

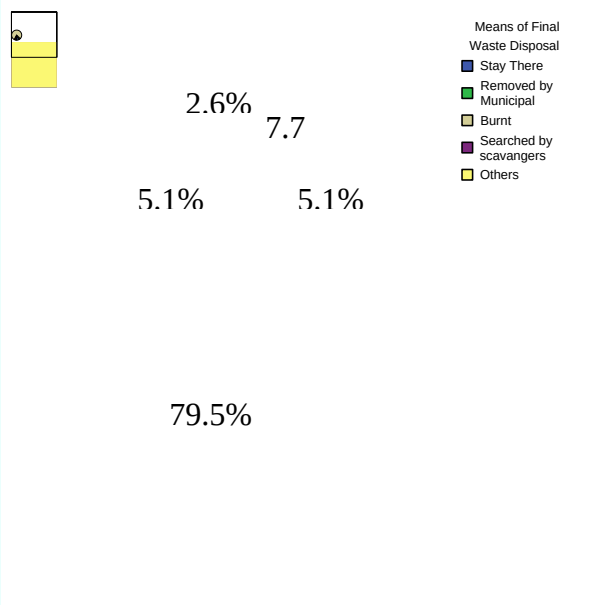


Figure 6: Means of final waste disposal in low income residential areas

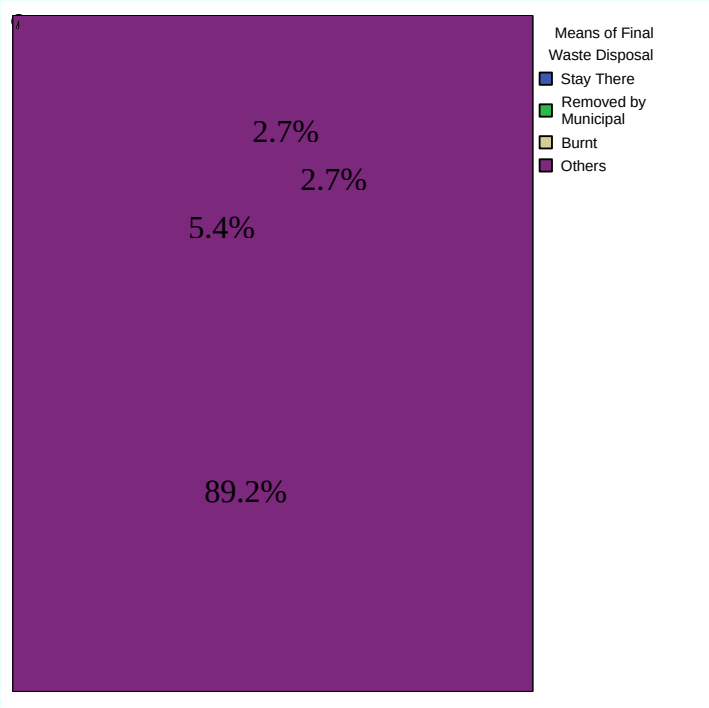


Figure 7: Means of final waste disposal in high income residential areas

Plate 24: Open burning of wastes at high income residential areas

5.4.4 Other Solid Waste Disposal Methods

- There were placenta pits at the two hospitals surveyed in the municipality for disposal of placentas.
- The survey 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.
- There was controlled tipping of general wastes at one of the hospitals surveyed while food remains were given to pig farmers to use as pig feed.
- Highly infectious waste from the TB section of Homa Bay District hospital was disposed in a special pit. The wastes were however first autoclaved before final disposal due to their highly infectious nature,

In some cases, pits were dug by the householders on the self-help basis but these filled up soon and when the garbage started to rot there was a nauseating stench that was emitted. This method was common in some high and middle income residential areas which did not receive any service from both the MCH and private collectors. In the low income residential areas, 50% of the respondents revealed that they had dug pits for disposal of wastes However, these wastes were not let to decompose but were burnt once the pit was filled .

5.4.5 Factors Hindering the Operation, Siting and Planning of Sanitary Landfills

From the foregoing discussion on the current disposal methods in use, it is quite evident that open dumping handled most of the solid waste collected by both the public and private agencies. Sanitary landfilling is the most recommendable method for disposal of solid waste in developing countries, because of its low cost, the researcher attempted to investigate the reasons for the MCH

not incorporating environmental considerations into the current operations. When the cleansing superintendent was interviewed on factors responsible for such a discrepancy, he cited 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 MCH and needed no planning.
- Lack of equipment. There was neither a bulldozer nor a compacter at the municipality for spreading the waste into thin layers, compacting and covering with fresh layer of soil.
- The method was simple, reliable and adaptable.
- The method handled all types of wastes without any prior treatment.
- The method never required any complex mechanical installations and skilled labour.

The survey 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 S.W.M.

CHAPTER 6: SOLID WASTE RECOVERY PRACTICES, ACTORS AND THE EXISTING ORGANISATIONAL NETWORKS

6.1 Actors involved in solid waste recovery and the existing organizational network

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.

CBOs were not involved in recycling activities; they mainly concentrated on the collection of solid waste although some members of the CBOs retained some materials such as bottles, plastics and cans for reuse. These different groups of people or entrepreneurs engaged in waste recycling and reuse have a hierarchical network (see Figure.9). They also had different roles to play in the informal recycling sector.

6.1.1 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, residential and industrial zones. They obtained all kinds of waste materials from; open spaces, roadsides, communal dumps, dustbins, skips and other waste receptacles. There were no dumpsite waste pickers operating at the official municipal dumping site. This result is in line with the Municipal council of Homa bay CDS document, 2006-2010 which revealed that there is no scavenging at the dumpsite.

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).

6.1.2 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 survey 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.

6.1.3 Participation of the waste dealers in the recycling process

There were only six waste dealers in the municipality who acted as brokers i.e. a linkage between the waste pickers and the *jua-kali* workshops in town. The waste dealers also prepared or upgraded various items (papers, scrap metals, plastics, old vehicle tyres etc.) bought from the waste pickers before they sold them to the Jua-Kali industry, Waste Recycling Industries (WRI's) in Nairobi and other market outlets.

They acquired some of their items from residents and bought others from the itinerant waste pickers and other waste dealers. The six dealers operated in the residential and industrial areas and mainly concentrated on plastic and scrap metal materials. Textile, rubber (tyres and tubes) and paper dealing activities were not well established in the municipality. A special observation to be noted was that the municipality had no large waste wholesaler in existence.

The Waste Buying Centres (WBCs) were scattered mainly in the residential and commercial zones. Those operating in the residential zone were sited on private land while those at the commercial zone including the Jua-kali workshops operated on municipal council land. The waste dealers operating in the commercial zone paid a tax fee of 20 shillings to the council everyday which they said is too much and should be reduced. Most waste dealers within the commercial zone said that the space in which they operate is inadequate.

No upgrading activities to increase the value of the materials were observed apart from cleaning. Each WBC had an average of three employees who carried out different roles from collecting wastes, cutting metals and repairing tyres. There were a total of 15 employees in WBCs.14 of them were males while 1 was female. No children were being employed in this business. Four of the six waste dealers sampled in the town have worked in this sector for less than 10 years. The highest experience recorded was 15 years while the lowest was 3 years. Only three of the waste dealers said they entered into this business to conserve the environment while the rest were doing it to earn a living.

The survey revealed that neither the waste dealers nor their employees had undergone any relevant training on solid waste management or recovery processes. The skills used by the waste dealers were acquired i.e. when one inherits the business.

In terms of the legal status of the waste dealers, the survey revealed that 4 of the waste dealers were not registered by the government to carry out their businesses. It also indicated that five of the waste dealers were not licensed by the Municipal council to trade in waste materials.

The major source of finance to the waste dealers was the income and profits obtained from their businesses. It was impossible to calculate the exact profit margins of the waste dealers given the fact that they do not keep financial records. The survey indicated that three of the respondents observed that their profits were low while 3 indicated that they were high.

Stiff market competition for certain waste materials was reported to be one of the most serious problems facing this group of actors in the recycling hierarchy. Plastic dealers said that currently there are so many brokers involved in plastic therefore they do not get as much profit

as they did some years ago.Secondly, the waste dealers mentioned the deteriorating economic conditions in the country as one of the causes of their poor performance. Many said they lacked funds to expand their businesses. Waste dealers were also facing protests and harassment from residents accusing them for environmental health problems. Finally, the waste dealers mentioned some occupational health problems, for instance scrap metal dealers mainly faced the problem of cuts from sharp metallic objects. These health problems affected them because they performed their duties without protective gear.

6.1.4 The Jua-kali waste recycling industry

Homabay municipality does not have a formal Waste Recycling Industry however recycling activities forms a large part of the *Jua-kali* industry. The survey revealed that the *Jua-Kali* workshops operated on a small scale and mainly manufactured a wide range of consumer end product from different waste materials.

The proprietors of these workshops revealed that they obtained their input materials from several sources, which included; waste dealers, cloth making shops, vehicle owners and in some limited incidents, they buy them directly from other Jua-kali recycling workshops for instance an artisan interviewed revealed that he obtained rubber material for making bicycle banners from an *"Akala"* workshop where sandals are being made from vehicle tyres. The source of waste materials is determined or dictated by the price, type, quality and quantity of the material required to make a particular product.

Plate 25: Bicycle banners made from vehicle tyres (rubber waste)

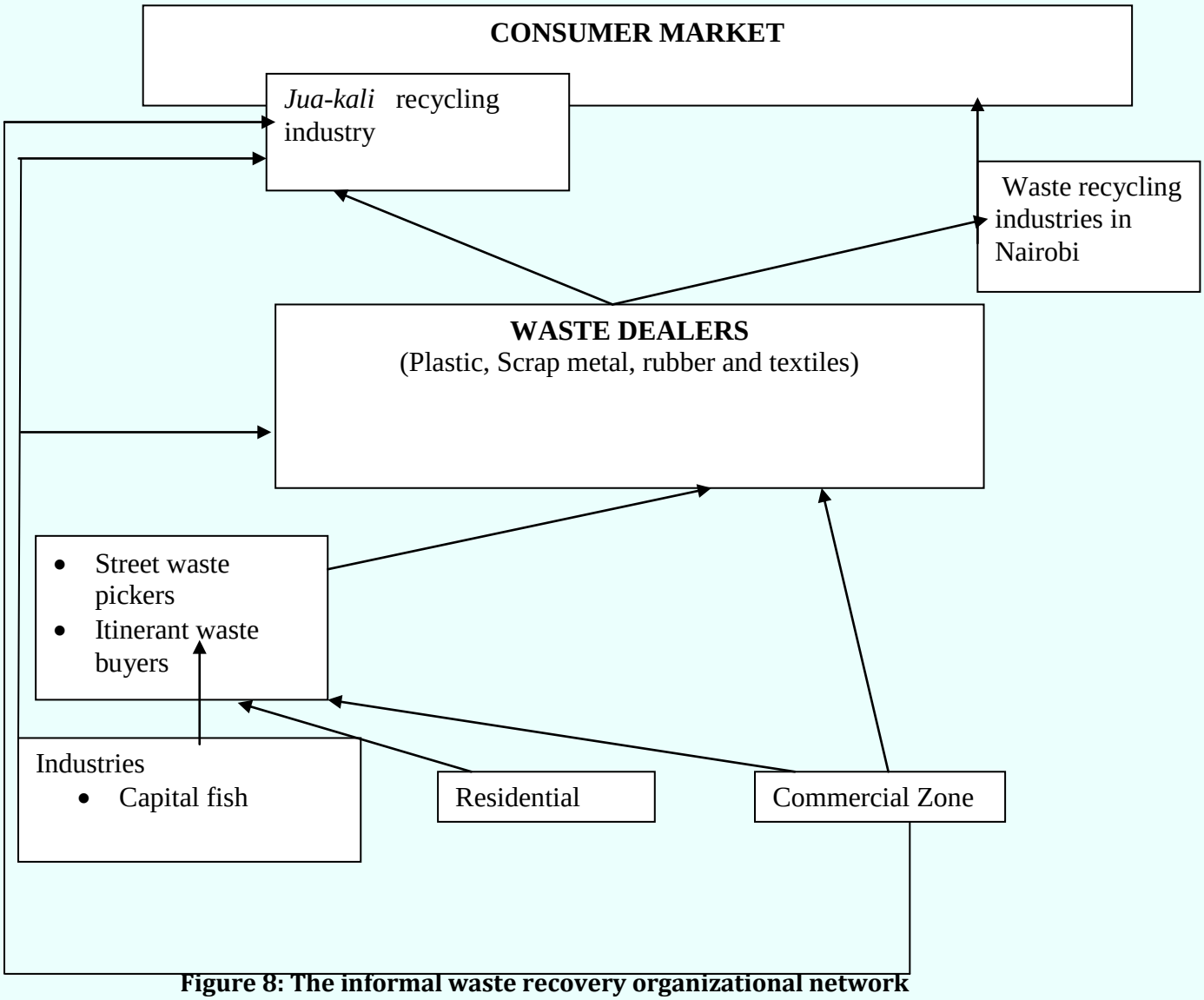


Figure 8: The informal waste recovery organizational network

6.2 Waste producers and sources of recyclable materials

The two major zones from which waste materials were being recovered include the commercial and residential zones .The industrial zone was discovered to be fairly developed being that there was only one functional industry known as Capital fish (k) LTD. The industry is involved in fish processing activities and produces a considerable amount of wastes. The fish wastes were being reused and recycled into different products. There was also a slaughter house where cow dung and urine were being utilized in the production of biogas-methane.

6.2.1 Residential Zone

It was discovered that householders do not play an active role in supporting recycling efforts since waste is never sorted out at the household level apart from a few valuable items that some housewives and servants keep aside to reuse mainly for packaging and storage. These means that most of the materials are very dirty and contaminated with other household hazardous wastes like batteries and chemicals. Separation at source could provide more secure jobs with less risk for the health and better working conditions to many of the urban poor involved in waste recycling (UNHABITAT September, 1994).

6.2.2 Commercial Zone

Waste in this zone is generated by workshops (including Jua-kali workshops), retail shops, supermarkets and wholesalers, hotels and restaurants, offices and various institutions within the commercial areas. Other wastes were also obtained from construction sites.

6.3 Recovery points of recyclables

There were several collection points in the municipality where waste materials were being recovered. These points can be classified as recovery at source, recovery from waste bins, communal receptacles, open spaces and the dumpsite. There was no recovery from collection vehicles.

6.3.1 Source recovery

There was limited source separation and recovery activities in the municipality apart from some housewives and servants in residential areas retaining some materials i.e. plastics containers, polythene paper bags and bottles for purposes of storage and packaging. For instance in Milimani area 66.7% of the residents said that they recover some items for reuse.

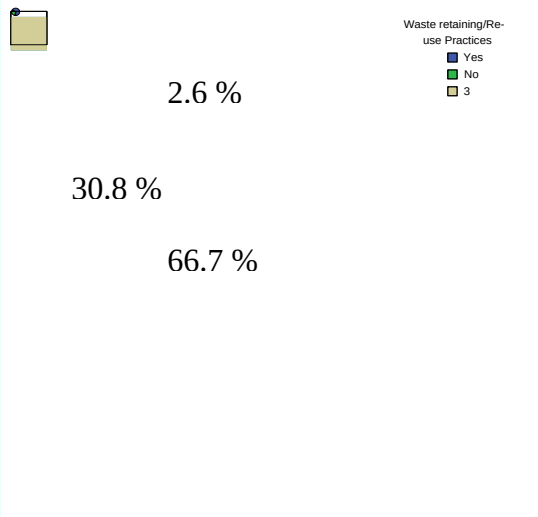


Figure 9: Waste retaining/Re-use Practices in Milimani (High income area)

Papers were used to light "*jikos*" in most homes while very few retained metallic materials. In most developing countries some level of separation at source, though still insufficient already exists (UNHABITAT September, 2004). No detailed resource recovery takes place at this point due to the lack of awareness on the economic and environmental benefits associated with source recovery activities.

The isolated cases of source recovery by housemaids and servants were based on poverty and not oriented towards environmental conservation. Lack of source separation and recovery makes the work of the waste pickers difficult and reduces the quality of most waste materials. Industrial and commercial separation of wastes at the source occurred in some points of the municipality. The few commercial waste producers that were selling their waste to Jua-kali recycling workshops, itinerant buyers or dealers, also did so from the economic point of view and not because of being environmentally conscious.

6.3.2 Recovery from the Waste Bins, communal receptacles and Open Spaces

Waste pickers obtained materials from waste dumped in open spaces; bins placed outside private premises or from communal receptacles such as the lagoons (concrete transfer stations) and skips specifically designed for commercial, institutional, industrial and low-income areas. According to UNHABITAT September,1994 ;in cities where communal bins or open–space dump collection instead of door-to-door collection methods are used, street scavengers recover recyclables from communal bins and open dumps.

Plate 26: Scavenging from a communal receptacle (skip)

6.3.3 Recovery from the dumpsite

There were no scavenging activities at the municipal dumpsite. A resident in the area was however obtaining organic waste from the dumpsite and utilizing it as compost manure in his small garden.

Plate 27: A garden utilizing compost manure obtained from the dumpsite

6.4 Profiles of solid waste material reuse and recycling

This section focuses on the reuse and recycling profiles of plastic waste, scrap metals, rubber and organic waste in the municipality. The chapter outlines a brief history of each of the waste materials, followed by identification of sources of the materials, recovery practices, upgrading processes, recycling capacities, marketing issues, advantages and disadvantages of recycling, and the incomes and employment in the recycling sub-sector. It further assesses the environmental and occupational health aspects of recycling each of the above mentioned waste materials. Lastly it establishes the kinds of technical know-how and skills used in waste recycling.

6.4.1 Plastic waste reuse and recycling

The major source of land pollution in the district is the plastic bags (NEMA, 2009).The major sources of plastic waste in the municipality were the households, hotels and construction sites i.e. water pipes. Street pickers collected all types of plastic materials and sold them to plastic waste dealers. The dealers in turn sold them to residents or water vendors for storage of water, milk or paraffin.

Each time recyclable waste changes hands in the waste recycling chain, value is added to it because inputs in terms of labour and capital go into the process and the waste changes form and utility. Scavengers input labor to separate the recyclables; the waste dealer sorts, cleans,

stores and transports the waste to the wholesaler (UNHABITAT September, 1994). There were three major plastic waste upgrading processes observed in the field. These included sorting, washing and drying.

***Sorting**:* The waste pickers sorted plastic wastes from the earlier mentioned recovery points and sold them to the dealers. Plastics were not sorted out in terms of density or color. There prices were basically determined by their size and they fluctuated from time to time. The sorting process was manual because of the existence of cheap labour.
***Washing**:* After the sorting process they were washed manually in hot water with detergents to remove grease, oils and all dirt in general.
Drying: The plastics were then dried in the sun.

There were no plastic recycling industries in the municipality although there were many plastic pickers and dealers. Most of the dealers operated in small-scale apart from one who mentioned that he had customers in Nairobi.
The plastic dealers said that there were very many people dealing in plastic waste than before and this has impacted negatively on them. The survey revealed that they lacked outside markets and only depend on the local community for their market. The residents were interested in buying the 5 and 20 litre plastic containers. The 20 litre containers were also popular with water vendors within the town. The small water bottles were bought by shop owners who used them to package water for sell.

The field surveys revealed that there existed opportunities of setting-up small scale plastic processing enterprises that could focus on the washing, sorting and shredding of plastic waste materials or pellets. Such small enterprises would be able to benefit from the cheap labour available within the municipality's informal sector.

All the people working in this sector were casual employees. Their wages were extremely low averaging to about 360 shillings per day. Plastic reuse activities have created many job opportunities for waste pickers, cleaners and dealers. Lack of records on inputs and sales made the calculation of profits difficult, because most transactions were handled in cash. It was revealed that there was lack of market outlets for plastics.

Reuse and recycling of plastics has a number of positive and negative environmental implications. Incineration or burning of plastic waste in open dumps releases highly hazardous environmental substances into the atmosphere which causes the 'greenhouse' effect and might be toxic to man and plants. Hence, the reuse and recycling of plastic waste in the municipality will obviously be an environmentally sound method. Reuse and recycling of plastic waste also reduces the problems of littering and help in the reduction of volume of transportation and space requirement for dumping at the only dumping site in the municipality.

Handling of plastic containers for packaging and dispensing of a variety of chemicals was also observed to be a potential health risk to workers who do not use gloves on the excuse that plastics are not sharp to cause any injuries. Since sorting of the plastic waste takes place before it is washed, the working conditions for those employed to carry out this task, are quite unhygienic.

Plate 28: Plastic waste buying and selling on one of the streets in the town

6.4.2 Scrap metal recycling

Like other waste materials, scrap metals have a recycling value and constitute a nuisance if they remain mixed with other waste. In the Municipality, scrap metals are recycled in small scale by the local *Jua-kali* industry.

The major sources of scrap metals were the construction and demolition sites, engineering and *jua-kali* workshops, motor vehicle garages, streets or open spaces. Scrap metal materials obtained by the waste pickers were numerous and included, domestic appliances e.g. Gas cylinders cookers, tin cans, old iron sheets and plates, off-cuts or trimmings from workshops, wire mesh, nails, water pipes, drums and automobile parts, etc.

All scrap metals are collected by the waste pickers and sold to the scrap metal dealers at a cost of Ksh.10 per Kg. The dealers sell them to other scrap metal dealers and Jua-kali workshops at Ksh.25 per Kg. The *Jua-kali* artisans manufactured numerous products from the scrap metal such as; "*Jikos*", metal boxes from oil drums, watering cans, cyclones for posho mills, frying pans, pressure lamps, rain water gutters, tin lamps and *"sufurias"* (cooking pots) from aluminum plates.

Plate 29: Jikos made from scrap metals

Most of the "*jua-kali"* artisans have undergone informal training where they acquired the skills by working as apprentices in their relatives or friends workshops. For some this is was a family business passed down from father to son. The trainings however lacked the major component on business management, marketing and simple accounting skills. Most of the artisans did not keep any financial or accounting documents and do not have knowledge of their production capacities over a period of 5 years. The artisans also did not have access to loan facilities hence the lack of proper and mechanized equipment to expand the business.

The "*jua-kali*" scrap metal recycling sector is offering considerable employment to most of the unemployed youth in the municipality, despite the low incomes earned. The 4 *Jua-Kali* artisans that were interviewed earn an average of Ksh.250 per day. Several women are also benefiting indirectly from the *jua-kali* businesses by operating food-eating kiosks within the workshop area.

No harassment was reported at the working site because the government supports the sector. Albeit the lack of capital or access to credit facilities, the amounts that are required for one to start a *jua-kali* workshop is generally low. The key respondents perceived the taxes paid to the council as being high because there are days when they lack customers. There is also unreliable supply of cheap scrap metals that are used as inputs forcing some of them to travel to Nairobi to acquire them.

Lack of funds for expanding the jua-kali investment was one of the leading problems i.e. lack of mechanized equipment. This is due to lack of access to financial facilities because artisans lack the required financial security. Many artisans declared their operating space to be inadequate; in one case, 4 artisans were sharing a 30 m^2 space where their shade also stood.

The study revealed that the workers involved in the recycling production process were exposed to risks of burns from welding, ear impairment from the noise involved in hitting and shaping the metals, eye injuries from solder flakes during welding and cuts from sharp metallic materials. They were also exposed to wounds caused by tools or machines used or during material handling process. The artisans lacked first aid kits and protective clothing.

6.4.3 Organic waste recycling

The main sources of organic waste comprised butcheries, Capital fish (k) LTD, slaughter house, hotels, households and the markets. The survey revealed that organic waste recycling was not a popular concept among the people. Those who practiced organic waste recycling included; the Municipal slaughter house, *"Mgongo wazi"* and "*Kabunde"* fish market operators, NGOs such as Community mobilization against desertification (C-MAD) and very few residents living in the affluent society of Milimani. The recycling done by the NGOs and in the residential areas was in small scale and mainly involved collection of the food waste in a dug out pit, the compost manure was then used in flower beds and small agricultural plots.

Organic wastes from butcheries such as bones were disposed at the transfer stations (skips) after which they are collected and transported to the dumpsite. The wastes from the hotels were collected by residents and used as animal feed. The organic waste from both Municipal market and "*Shauri Yako"* market were all disposed in the transfer stations (skips) and transported to the dumpsite. A large quantity of organic waste was being generated from Shauri

Yako market (an agricultural produce market) especially after the market days. It was observed that on the day after the market day the 10 ton skip at the market was almost filled up. There were no groups or women who collected this waste for purposes of composting (market cleaner and cleansing foreman).

Wastes from the slaughter house included, waste flesh, cow dung, urine, bones, horns and the tail ends. As per the slaughter house attendant, waste flesh and meat were being collected by the municipal for disposal. 80% of the cow dung and urine was being recycled into biogas-methane in the biogas plant. The biogas project was initiated by the United Nations Industrial Development Organization (UNIDO). The horns were being collected by dealers from Nairobi, when the dealers failed to come the horns were dumped into the open space and burnt.

The waste from capital fish mainly included; *"Mgongo wazi"* (fish skeletons) that remain after filleting and fish skin. The survey revealed that an average of 3 tons of *"Mgongo wazi"* was being generated daily from capital fish. These were then sold to the fish market operators who sold them at Ksh.8 per kg to residents as food. The Nile perch skin was dried and grounded to make chicken feed.

It was revealed that there was an adequate and reliable supply of organic waste from the markets, slaughter house and the fish plant. The local market for *"Mgongo wazi"* and the fish skins was also sufficient. Other wastes from the Nile perch were being exported for various uses. The fish waste sector has employed more than 232 people and does not require much training. The wages in this sector were discovered to be very low.

Box 4: The working experience of a *"Mgongo wazi"* cleaner

My name is Emelda Akinyi, I have been a "*Mgongo wazi"* cleaner at this fish market for 3 years now. On good days when there is a lot of fish from the plant I may be lucky to make Kshs.30 for every 100 "*Mgongo wazi"* (fish skeletons) washed. I love my job because it is the only way I know to fend for my family. In the process of cleaning the fish skeletons I am normally pricked by the fish bones to the extent that I can't even use the palm of my hands to eat *"ugali"*.I get extremely fatigued after a day's job and I find it difficult to hold and take care of my baby when I go back home since am usually very tired.

The workers at the slaughter house sited bad odours as a health risk to them. Back pains were also mentioned as a problem especially by the loader at the slaughter house. The fish operators especially the cleaners get hurt from being pricked by fish bones.

Plate 30: Organic waste from the municipal market

Plate 31: Fish skin wastes

6.4.4 Rubber waste reuse and recycling

Rubber was being collected from vehicle garages, tyre repair workshops, vehicle owners and in rare case from other rubber recycling workshops. The rubber was used to make *"Akala"* sandals, bicycle banners, rubber stamps and rubber ropes for tying goods.

Plate 32: Jua-kali rubber recyclers

6.4.5 Textile waste reuse and recycling

Cloth making shops generated numerous amounts of textile waste. The individuals involved in the recycling of such waste were the carpenters (seat makers) who used these materials to stuff the chairs and cushions. The carpenters purchased this waste at Ksh.500 per sack. The carpenter's preferred this textile waste to the foam they use to make the seats because they are cheaper hence helping them save on costs.

6.4.6 Construction waste

Construction site waste was composed of cement bags, plastics water pipes, metals, nails, glass, sand, soil, wood cuttings and blocks. The main sources of these wastes in municipality were construction and demolition sites. Cement bags were reused in filling up gaps while building, in some cases these bags were collected by local women and used to store grains.

Large metals were reused in other construction work while the very small ones that have no more use were mixed together in the ballast. Other metallic items were collected by waste pickers from the construction sites and were sold to scrap metal dealers. Nails were collected and reused in other construction work. Wood cuttings were collected by women to be used as fuel for cooking.

Most constructors admitted that they do not have a way of disposing some of the construction waste such as broken building blocks, glass, broken plastics pipes; they normally bury such waste. In cases where there was no space to bury the waste, they were being dumped on the open ground causing health hazards to themselves and other residents. The soil and sand

wastes from some construction sites was being collected by residents and other constructors to repair muddy roads.

Plate 33: Demolition waste

6.4.7 Recycling and Re-use of End of Life Vehicles (ELV) waste -

The biggest bulk of ELVs in the Municipality are found in "Juakali" garages with only a few being observed in residential areas especially the high income area of Milimani. One of the ELV owners in Milimani revealed that he did not know what to do with his vehicle since he could not repair it anymore because the vehicle had become un road worthy and could not find any market for it.

Second hand vehicles imported into the country which although affordable to many, which are prone to recurrent breakdowns and eventually add to the already existing stockpile of unwanted ELVs and vehicles written off through accidents make up a bulk of abandoned vehicles in the *"Juakali* "garages. The municipality has approximately 50 garages which each having an average of one ELV.

There is improper disposal of ELVs with observations in, most garages revealing ELVs lying unused in most garages. A respondent at one of the garages said that they had a vehicle that had stayed at the garage for over 10 years. A major problem cited by most garage owners was that most vehicle owners would bring their broken down vehicles saying they would bring money for their repair but never come back hence they had just had to wait. This survey therefore revealed that there was little or no recycling and re-use of ELVs with most of them staying in the garages indefinitely with the garage owners and vehicle owners not knowing what to do with their vehicles.

The survey however revealed that there was use of Scrap metals from ELVs in the recycling industry and that they were used to make products such as; Jikos, metal boxes, watering cans, cyclones for posho mills, frying pans, pressure lamps, rain water gutters, tin lamps and *"sufurias*" (cooking pots) from aluminum plates.

CHAPTER 7: ROLE OF COMMUNITY BASED ORGANISATIONS (CBOs) IN PROVISION OF SOLID WASTE MANAGEMENT SERVICES

7.1 Brief Historical Background of Community Based Organisations (CBOs) Refuse Collection in Homabay Town

As one starts to appreciate the municipal Council's limitations in the provision of SWM services, the need for privatization to solve the problem becomes increasingly important. Privatization here does not imply wholesale transfer of services from the MCH to the community, but rather the gradual taking over by CBOs, as a result of the failure of MCH to provide the necessary level of performance. In the municipality, there were ten (10) CBOs but there were only five (5) active ones. The focus was on five active CBOs that were operational during the survey period which were: *"Asedhwa" Women Group*, *Environmental Watch Programme*, *WOKAN Women Group*, *Homabay "Juakali" Women Association* and *Town Hawkers*. A good number of community based waste collectors are informal, although the municipal council mentioned that they are now registering all the interested groups, and will zone them operational areas. This was reported to have taken root following persistent lowering of service coverage in the recent past, due to chronic logistic and managerial problems faced by the Municipal Council. The data presented here was obtained by use of the questionnaires. This was supplemented by observant participation and key informant interviews. In this Chapter, the writer also attempts to compare the role and efficiency of these five CBOs and that of the MCH in order to draw comprehensive conclusions and recommendations.

7.2 Organizational Structures and Service Arrangements

The Chairlady is the most executive position in the management of *"Asedhwa"* women group. Other positions in the management includes: vice chairperson, secretary, treasurer and other committee members. The EWP has board of directors composed of the Chairman, the secretary, and the treasurer who play executive roles. The secretary oversees the activities of the waste collectors, the treasurer deals with the finances and both are bank signatories of this CBO.

The WOKAN Women Group had executive and other members who are waste pickers. The executive was composed of chairperson, treasurer, and secretary. The Chairperson was the overall coordinator, the secretary was responsible for records and documentation, the treasurer was responsible for organisation's revenue and members were responsible for decision making. Homa Bay *"Juakali"* women Association had a patron, chairperson, treasurer, secretary and committee members (the last three fell on the same rank), and cleaners. The patron was the overall supervisor of the other officers. The chairperson ensured cleanliness of the area, the treasurer keeps money, the secretary is responsible for documentation and the committee is the decision making organ. For Town hawkers, the management had five positions, namely: Chairman, vice chairman, secretary, treasurer, organising secretary and other members of staff.

7.3 SWM Methods used by CBOs

This section gives an overview of the storage, collection, transportation and disposal methods used by the CBOs.

7.3.1 Storage

Only dust bins both standardized and un standardized were used for waste storage. Unstandardized dust bins included recovered fats containers, water tanks and buckets. They range in volume from 20 litres to 100 litres. They supply these dust bins to only clients who agree to pay the negotiated collection fee which ranges between Kshs 150 to 300 at the end of month. They supply different sized dustbins to different clients depending on the amount of wastes generated by the client.

Plate 34: Unstandardized dust bins used by CBOs

Plate 35: Standardized dust bins used by CBOs

7.3.2 Collection

The CBOs utilized the door-to-door collection systems. These organizations provided dustbins to their clients to avoid scattering of wastes in the clients premises.

7.3.3 Transportation

CBOs used wheel barrows in transportation of wastes from their clients to the transfer stations, skip or open space (for crude dumping). MCH transported these waste from the transfer stations or skips to the dumpsite.

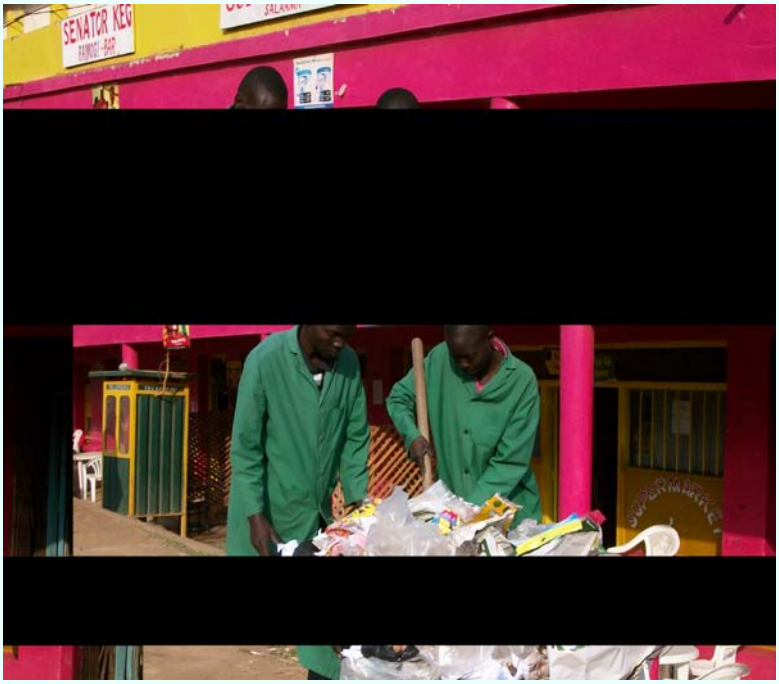


Plate 36: wheelbarrows used in waste transportation

Table 12: A summary of the number of wheel barrows owned by private waste companies

Name of Private Waste Company	No. of Wheelbarrows
ASEDHWA Women Group	1
Environmental Watch Programme (E.W.P)	4
WOKAN (Women of Kanyada)	2
Homabay Women Juakali Association	1
Town Hawkers	Hire 3 wheel barrows/day
TOTAL	11

7.3.4 Disposal

None of sampled CBOs transfer waste directly to the dumping site. They either transport waste to the skips or collects wastes on an open space for burning or crude dumping.

7.4 Organizational Structure of Community Based Organizations

CBOs used a simple organizational framework consisting of executive body, committee and employees. In executive body, there were three posts, namely: Chairperson, Treasurer and Secretary. *Homa Bay Women Juakali Association* had a patron who was the overall supervisor of the other officers. The general organizational of CBOs can be summarized using the below structure.

7.5 Role of Community Based Organisations (CBOs)

Areas serviced by the CBOs were those that MCH operated but client's preferred CBOs because they provided quality services than the municipal. For instance, CBOs collected wastes daily compared to the municipal council which sometimes failed almost by a full week. MCH's refuse collection fleet mostly concentrated at the market places and left most areas uncovered. CBO's have been able to penetrate into various residential areas (both middle income and high income). None of CBO operated in low income areas. Hence, the CBO's have enhanced the public's sense of responsibility towards environmental cleanliness in general. There are inter- linkages between MCH and CBOs. Wastes collected at the transfer station were transported to the dumpsite by the municipal council; this showed that MCH did appreciate the positive role played by the CBOs.

Table 13: Responsible parties for waste disposal at middle level income areas

Responsible party	Frequency	Valid Percent
Householder	33	82.5
Municipal Worker	1	2.5
CBO	6	15.0
Total	40	100.0

Table 14: Responsible party for waste disposal at high income areas

	Frequency	Valid Percent
Householder	32	80.0
CBO	8	20.0
Total	40	100.0

Only 2.5% of the households at middle income level estates and none at high income areas are provided with SWM services by the municipal council as shown by the table 1 and 2 above. This shows clearly that there is a need to privatize to achieve effective SWM services.

With reference to the organizational structures and service arrangements of both the MCH and the CBOs, it is clear that CBOs had managed to innovate in simple and non-bureaucratic

institutions compared to the municipal's complex management system which was characterized by bureaucratic and clumsy procedures with several red tapes. CBO's used simple administrative structure which ensured efficiency in service delivery contrary to the municipal council.

These organizations used simple tools for collection, storage and transportation of wastes such as dustbins, spades and wheelbarrows which increase efficiency. To ensure an efficient and effective SWM system, the CBOs have also been increasing their environmental investment especially in the transportation equipment. Even though the capital investment figures were not available from the CBOs, it is important to note that, *Town Hawkers* in particular, had major long-term plans to purchase a pick up in order to increase efficiency.

Some socio-economic benefits that have accrued from the private provision of SWM services were also revealed by the survey. CBOs provide employment to the people, for example, *WOKAN Women Group* has 13 permanent and 2 casual employees (Refer to table 10)

7.6 Constraints Faced By Community Based Organizations.

The internal and external constraints that limited the operations of CBOs are discussed under the following four subheadings: organisational, socio-economic and fiscal concerns, technical issues and environmental constraints. EWP lack enough finances which leads to lack of enough personal protective equipments such as gloves and other equipments. Lack of enough finance was attributed to low payment rates from areas of operation, for example, the monthly collection fee from a kiosk is KShs 150, 300 from hotels/banks and 200 from offices. Workers at WOKAN women group revealed that their working conditions were poor and this exposed them to occupational health hazards. There was lack of coordination concerning wastes collection hence leading to frustrations of employees is the constraints facing Homa Bay *"Juakali"* women association. There is also lack of enforcement from municipal council to deal with defaulters.

The CBOs survived on a single source of finance, that is, service price that was paid by their clients which is between Kshs 150 to 300. Most of interviewed CBOs are not able to meet their financial needs hence they rely on other survival strategies such as investments and members' contribution to support their operations, for example, "*Asedhwa"* women group sells cereals and WOKAN women group had monthly contribution of Kshs 100 per member. Community based organizations reported limited financial sources and the survey revealed that since they started their operations, they had not got any donor from within and outside Kenya. But, the writer feels that the CBOs qualified for both domestic and international donations and/or loans for purposes of improving their SWM programmes.

This sub-section outlines some of the operational constraints experienced by CBOs in the storage, collection and transportation and stages. A few storage constraints were observed and reported. There were cases of reported stolen receptacles thus affecting their operations. During the transportation process, the major problem observed was lack of vehicles for transporting wastes to the transfer stations instead they relied on wheel barrows which had small carrying capacity and could make few trips per day leaving wastes uncollected.

Environmental constraints that limited the operations of the CBOs sector were also reported. During the rainy season, collection of waste becomes difficult and sometimes there were delays due to lack of enough protective equipment. The survey revealed that none of CBOs provided waste

pickers with rain coats and most specifically, Homabay *Jua kali Women Association* did not provide any protective equipment to its employees. The lack of enough personal protective equipment also exposed waste collectors to health risks. Roaming and scavenging animals (pigs, dogs, goats etc) scattered the waste and increase labour demands.

Plate 37: Animal scavengers

In conclusion, CBOs provides better services than those provided by the MCH because they are directly answerable to their clients. The writer points out that proper partnership between CBOs and MCH can increase the efficiency of solid waste management services to the public.

CHAPTER 8: CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion

Municipal solid waste issues represented major problems to the MCH. 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 survey, it was apparent that the MCH had the legal obligation to collect solid waste. However Council was often unable to cope with the quantities of waste because of inadequate funds, lack of equipment and poorly trained management resources. The survey 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 survey that the MCH 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 organisations 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 survey was for the ISWM system for MCH to come up with baseline indicators that would be used as a basis for monitoring and evaluating the interventions to be implemented in the next five years, i.e. between 2010 and 2015. This baseline report therefore provided benchmarks for monitoring intervention schedules for the MCH ISWM Strategy. Due to a general reluctance by players in all sectors to actively engage in waste management issues in the town, there is a challenge in implementing an integrated strategy.

8.2 Recommendations

8.2.1 Capacity Building

There is an urgent need for the enhancement of community initiatives and partnerships by the MCH to increase awareness of the importance of solid waste management and its contribution to a healthy living environment. The Council should stimulate public awareness and encourage waste producers to take more responsibility for treatment and disposal.

An efficient urban solid waste management service should be formulated comprising of appropriate combinations of public, private, community and individual involvement, while focusing on simple management information systems that allow the waste management sector to use a range of local service providers.
The informal sector waste recycling needs more promotion. Such small-scale waste recycling initiatives are able to provide much-needed income for the urban poor. Source reduction programs should be designed to reduce the quantity and toxicity of materials entering the municipal waste stream. Both goals, if reached, could have significant impacts on the operation of other waste management alternatives.

The MCH, CBOs and other stakeholder coordination of solid waste management should focus on clearer definitions of monitoring and evaluation, particularly the use of indicators that can promote recycling and reuse of organic wastes. Suitable indicators that can be currently considered by MCH that should be incorporated in the municipality's By-Laws include:

• Municipal recovery rates;
• Household recycling rates;
• Household waste composted; and
• Home composting participation rates.

MCH should contract waste management practices to private firms because some citizens considerer them more cost effective than equivalent municipality operated firms.

8.2.2 Storage

The waste storage pits should be deep enough to avoid spillage of waste. The council should also provide enough storage material and frequent collection of waste. Standard litter bins should be provided at strategic points not only in the CBD area but also in the estates. The bins should also be compatible with planed recycling systems.

8.2.3 Collection

MCH and private (CBOs) collectors should ensure frequent and timely collection and proper disposal of waste. In some cases Landlords should also help in the collection and disposal. Transfer stations and skips should be provided in slum areas especially where accessibility is possible to avoid crude dumping.

8.2.4 Disposal

Burning of waste should be discouraged. Since the existing dumpsite is full, there is urgent need of identifying a new site for waste disposal. Health considerations should be taken into account in disposal strategies.

8.2.5 Recycling and Re-use

Waste management practices in Homa Bay have largely concentrated on how to collect and dump waste in the dumping site. Now, however, there should be a greater emphasis on techniques and approaches that avoid or minimize the need for waste disposal in the dumping site through diversion and recovery. Recycling and reuse will divert a significant quantity of materials from ultimate disposal. This will require:

- Establishment of drop off points for recyclable materials
- Training and deployment of personnel on waste segregation at source
- Provide containers designed for waste separation

8.2.6 Composting

In Municipal Council of Homa Bay, much of the waste generated was organic material. Not only is this a reclaimable resource in itself, but recycling can also help reduce demand for the scarce dumping space. In addition, organic waste dumped greatly increases greenhouse gas emissions. Similarly its use in agriculture is a possibility, and therefore composting would be a sensible option.

This should be increased through capacity building to the existing CBOs by taking advantage of the current high prices of chemical fertilizers in the country. Simple and small-scale composting methods like use of open piles and backyard composting should be piloted and replicated city-

wide. This component is important because over 60% of Kisumu solid waste is organic. This component requires a lot of awareness on source separation of organics from inorganic materials.

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APPENDICES

APPENDIX I

LISTS OF RESPONDENTS FROM HOUSEHOLDS

Respondents from low income households (Shauri Yako)

	Name of the respondent	contacts of the respondent
1	Lucy Odhiambo	.
2	Ogweno Rebbeca	254718766486
3	Petronila Achieng	.
4	Holman Ongoro	254723738911
5	Elizabeth Anyango	254710580607
6	Paul Mboya	254723908463
7	Philip Ochieng	254728146267
8	Ruben Owino	254717703132
9	Job Omondi	254715766423
10	Kennedy Otieno	254735983011
11	Joseph Ogola	254724423670
12	Lilian Achieng	254724423670
13	George Okello	254725910416
14	Steven Odhiambo	254711226939
15	Ruth Auma	.
16	Judith Akoth	254720903753
17	Polline Aoko	.
18	Theodoes Rugar	254750948053
19	Fransisca Achieng	254721262707
20	Kennedy Okoth	254700413038
21	Eunice Achola	.
22	Pauline Atieno	254726430712
23	Mercy Akech	.
24	Revine Anyango	.
25	Sypras Auma	.
26	Eunice Ochola	254729149779
27	Rose Achieng	254723132705
28	Milicent Mboy	254727560328
29	Rose Keta	254727971083
30	Kennedy Onyango	254719137314
31	Joshua Ogembo	254723881338
32	John Otieno	.
33	Beryr Akinyi	254728242524
34	Jackline A Odoyo	254718592276
35	Steven Odhiambo	254710354619
36	Victor Odira	254722794113
37	Beryl Achieng	254728131265
38	Floreance Mbai	254721859111
39	Japheth Choge	254721571496
40	Roselyn Adero	254726093266

Respondents from middle income households (Makongeni and Site service)

	Name of the respondent	contacts of the respondent
1	Samuel Olang Ayoo	254736404265
2	Judy Akinyi	.
3	Susan Onduru	254716988610
4	Josphine Agoth	254728755054
5	Trizah Caroline	254728942625
6	Ogolla Otieno	254721382500
7	Eliver Akoth	254729217161
8	John Ojal	254700190820
9	Boniface Ochieng	254716560120
10	Milicent Adhiambo	.
11	Hellen Achieng	.
12	Emmy Achieng	254712036718
13	Lilian Kwamboka	.
14	Patrick Lumumba	254712232379
15	Judith Atieno	.
16	Milika Oucho	254727053423
17	Charles Ochieng	254720487294
18	Eve Achieng	254725214033
19	Mary Adhiambo	254716291187
20	Benta Achieng	254717201088
21	Norah Akeyo	.
22	Eunice Aoko	.
23	Agnes Ochola	.
24	Kevin Onyango	254713878068
25	Roselyn Aoko	254728359273
26	Caroline Chepngetich	254719218872
27	Jentor	.
28	Nancy Achieng	.
29	Linet Adhiambo	254712693124
30	Judith Akinyi	254723017018
31	Monica Wanjiku	.
32	Dorothy Akinyi	.
33	Anthony Karugu	254722160509
34	Naomi Akelo	254729283248
35	Ismael Otieno	2547207774999
36	Sophy Otieno	2547736757404
37	Ogollo Milka	254733527407
38	Belinda Atieno	254728395619
39	Eric Okingo	254711693456
40	Tabitha Ojillo	.

Respondents from high income households (Milimani)

	Name of the respondent	contacts of the respondent
1	Caren Aoko	254725789797
2	Charity Mugambi	254722982847
3	Hesbon Okoth	254724246137
4	Millicent Atieno	254738500703
5	Dorothy Auma	254714355993
6	Walter Ochieng	254723526071
7	Stephen Nyakundi	254712338774
8	James Momari	.
9	Mary Otieno	254735602738
10	Martha Dede	254724591896
11	Adero Nesy	254723537497
12	Isiah Owala	254727603904
13	Paul Ologe	254733268459
14	Waweru Njuguna	254722504382
15	Rose Awuor	254700808098
16	Gilbert Abwaku	254724142464
17	Ellen Odiwour	254719235965
18	Maureen Atieno	.
19	Edwin Kemboi	254723930260
20	Viola Kibebe	254714598015
21	Edwina Atieno	254724763310
22	Sandra G	254732756758
23	Penina Ager	254710504322
24	Elvis Kithini	254724913314
25	Steve Okoth	254723473258
26	Emily Nyawade	254736027130
27	Elisha Oyugi	254717674798
28	Peter Nyauke	254722923462
29	Valentine Lala	254722985326
30	Ngira A. Lenies	254725884761
31	Benard Omondi	254700719383
32	Edwin Okumu	254720656382
33	Mary Apondi	254721515927
34	James Amenya	254733598120
35	Scholastic Akinyi	254724169141
36	Margret Menda	254713295568
37	Mrs. Agai	254722211516
38	John Owili	254724299126
39	Ruth	254724609720
40	Sarah Abdi	254721667440