

**ASSESSMENT OF SOLID WASTE MANAGEMENT IN KINONDONI  
MUNICIPALITY**

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**A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT FOR THE  
REQUIREMENTS FOR THE DEGREE OF MASTERS OF  
ENVIRONMENTAL STUDIES (SCIENCE) OF THE OPEN UNIVERSITY OF  
TANZANIA**

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**CERTIFICATION**

The undersigned certify that he has read and hereby recommend for acceptance by the Open University of Tanzania a dissertation entitled: **Assessment of Solid Waste Management in Kinondoni Municipality** in partial fulfilment of the requirement for the degree of Master of Science in Environmental Science of the Open University of Tanzania.

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Date

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I, **Nelson Boniface Mnyanyi**, do hereby declare that this dissertation is my own original work and that it has never been presented and will not be presented to any other University for similar or any other degree award.

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Signature

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Date

**DEDICATION**

This study work is dedicated to my wife Sophia K. Mnyanyi and my children, Brightness and Bright and my mother Magdalena Sambula Mnyanyi and in memory of my late father Boniface F. Mnyanyi and my brothers Cosmas B.F. Mnyanyi and Egidio B. Fungafunga

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## **ABSTRACT**

This study aimed to assess the Solid waste Management in Kinondoni Municipality in the year 2014. The sample comprised a total number of 50 households in which two wards of Sinza and Ubungu were purposively chosen to represent the rest of wards in Kinondono Municipality. Data on solid waste management were collected using direct observation, interview and questionnaires. Both descriptive and inferential statistics were used for data analysis. Data were analysed using Statistical Package for Social Sciences (SPSS) Version 16.0.

Findings indicates that high solid waste are generated from the following sources households 80% (1618.8 t/day), informal sector waste 16% (322.2 t/day), market waste 2% (40.5 t/day) and commercial waste 1% (30.4 t/day). Furthermore, 76% of the respondents had no access to door to door solid waste collection services delivered by the municipality due to poor collection system (85%), poor road access (76%) and lack of community participation. Only 15% of the respondent had an access to the service that collect and transfer their waste to disposal site.

It can be concluded that, the overall solid waste management service is poor. Waste generated is in high quantity compared to the amount collected and transferred to disposal site. Insufficient methods of solid waste collection and transportation in kinondoni municipal are not improved and there is little access to municipal vehicle for solid waste transfer and transportation to the final disposal. It is recommended from this study that, for efficiency and effective solid waste management a cooperative effort involving all stakeholders, including citizens, businesses, community based organizations, nongovernmental organizations, government agencies, universities, and other research organizations is un avoidable.

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**LIST OF ABBREVIATIONS AND ACRONYMS**

UNEP	-	United Nations Environmental Programme
US	-	United States
UK	-	United Kingdom
LCA	-	Life Cycle Analysis
MSW	-	Municipal Solid Waste
JICA	-	Japan International Cooperation Agency
HCS	-	Hauled Container System
SCS	-	Stationary Container System
MRF	-	Material Recovery Facility
NGO	-	Non Governmental Organization
EPA	-	Environmental Protection Agency
TAF	-	The Asia Foundation
TALF	-	Transparent Accountable Local Government
USAID	-	United States Agency for International Development
LAs	-	Local Authorities
NWMS	-	National Waste Management Strategy
SPSS	-	Statistical Package for Social Sciences
SWM	-	Solid Waste Management

## **CHAPTER ONE**

### **1.0 INTRODUCTION**

#### **1.1 Introduction**

This study assessed solid waste management in kinondoni municipality in Dar es Salaam city, Tanzania. The study was conducted in Kinondoni Municipality where Sinza and Ubungo ward were taken as representative sample. In this chapter I introduce the study by providing background to the study, research problem, research objectives and accompanying research questions and significance of the study.

#### **1.2 Background of the Study**

The rapid urbanization that has been taking place during the 20th century virtually transformed the world in to communities of cities and towns facing similar challenges on environmental issues in which most of them have to be addressed at international level (Smith, 2010). Among those environmental issues solid waste management is a critical one because as long as humans have been living in settled communities, solid waste generation has been an unavoidable and critical issue both in developed and developing nations. As a result, solid waste management became a worldwide agenda at united nation conference on environment and development in Rio de Janeiro in 1992 with a great emphasis on reducing wastes and maximizing environmentally sound waste reuse and recycling at first step in waste management (UNEP, 1996).

"Solid waste" means that material that is made up of residential, domestic, institutional, commercial, agricultural, industrial and street or highway refuse. It includes garbage, rubbish, ashes, street refuse, dead animals, abandoned automobiles, demolition, and rubble and sewage sludge. In other words, Solid waste means

useless, unwanted or discarded material with insufficient liquid content to be free flowing.

Municipal solid waste (MSW), commonly known as trash or garbage (US), refuse or rubbish (UK) is a waste type consisting of everyday items that are discarded by the public.

Solid Waste Management may be defined as the discipline associated with control of generation, storage, collection, transport, treatment and disposal of solid waste in a manner that is according with the best principles of public health, economics, engineering, conservation, aesthetic and other environmental consideration. Solid Waste Management includes administrative financial, planning, engineering and environmental consideration in search of solution (Akolkar, 2005).

The term (Solid Waste Management) usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. Resource recovery is the selective extraction of disposed materials for a specific next use, such as recycling, composting or energy generation. The aim of the resource recovery is to extract the maximum practical benefits from products, delay the consumption of virgin natural resources, and to generate the minimum amount of waste. Resource recovery differs from the management of waste by using life cycle analysis (LCA) to offer alternatives to landfill disposal of discarded materials. A



number of studies on Municipal Solid Waste (MSW) have indicated that administration, source separation and collection followed by reuse and recycling of the non-organic fraction and energy and compost/fertilizer production of the organic waste fraction via anaerobic digestion to be the favoured alternatives to landfill disposal.

All wastes materials, whether they are solid, liquid, gaseous or radioactive fall within the remit or sphere of the activity of waste management (Ackerman, 1997). Municipal Solid Waste Management refers to systematic control of generation, collection, storage, transport, source separation, processing, treatment, recovery and disposal of solid waste.

Waste management face a number of challenges for example, waste transportation is very expensive; it is a labour-intensive activity, accounting for approximately three-quarters of the total cost of solid-waste management. Public employees are often assigned to the task, but sometimes it becomes economical activity for private companies to do the work under contract provided by municipality (Bartone, Bernstein and Wright, 1990). In this business, a driver and one or two loaders may serve in each collection vehicle. Kinondoni Municipality is one of the most densely populated municipalities on the African continent, whereby it's said that 75-90% of its population live in heavily populated unplanned areas. Therefore, like most developing cities, Kinondoni suffers from inadequate solid waste management.

Urban solid waste in Tanzania in general and in Kinondoni Municipal in particular, is a serious environmental problem (Kaare, 1998). Concurrent with recent socioeconomic development, coupled with liberalization of the economy and rapid population growth, the quantum of solid waste generated has increased at a rapid rate. The manner in which urban solid waste is managed in Kinondoni Municipal directly affects the city environment, the appearance of the city and the citizens' day-to-day life. Hence, a special priority is attached to Kinondoni Municipal solid waste management. The existing critical dimensions in the management of solid waste are scavenging, privatization, arresting environmental effects of waste disposal and institutional capacity building.

### **1.3 Statement of a Research Problem**

Proper solid-waste management is important aspect for the protection of public health, safety, and environmental quality. Growing amounts of global consumption and waste production, combined with high density low income living environments and very little to no road access are just some of the problems facing unplanned areas in Kinondoni Municipal. Some studies on Solid waste management have been carried out in Dar es Salaam, for example; (Mgana, 1996), (Kaare, 1998), (Kironde, 1998), (Kirango, 2000), (Majani, 2002) and (Breeze, 2012). The study by Mgana (1996) focused on solid waste stakeholders' perception, while that of Majani (2002) focused on Environmental Planning and Management in Dar es Salaam as a learning experience. Kaare (1998) focused on policy response to unplanned squatter areas in Dar es Salaam. Kirango (2000) studied about privatization of waste collection in Dar es Salaam. Lastly, Kironde (1998) studied about governance of waste management in

Africa taking Dar es Salaam as a case study. These cited studies indicate that solid waste management in Dar es Salaam needs periodic investigation as the population increase rapidly. Also may be not sufficient to manage the current level of waste due to changes in socio economic condition.

A literature review indicates that, there is little information on the service efficiency and effectiveness of solid waste management in particular collection and transportation aspects in solid waste management in Kinondoni Municipality. The aim of this study is therefore to collect information on solid waste management practices and survey in several areas in collection points and transfer station on the place of Kinondoni Municipal particularly Sinza and Ubungo ward so as to fill the gap which hinders proper solid waste management in Kinondoni municipality in Dar es Salaam city. Better solid waste management, with improved waste collection improves the health of all citizens, supports environmental sustainability, enhances the scenic beauty and facilitates economic development.

#### **1.4 Research Objectives**

##### **1.4.1 Research General Objective**

The general objective of this study is to assess the solid waste management in Kinondoni Municipality.

##### **1.4.2 Research Specific Objectives**

Specifically the study aimed to:

- i. To characterize solid waste generated in Kinondoni Municipality

- ii. Identify the methods of solid waste collection in the study area
- iii. To evaluate the methods of solid waste transportation in Kinondoni Municipality.

### **1. 5. Research Questions**

Based on the Title of the research, research questions of this study are:

- i. What are the characteristics of solid waste generated in the study site?
- ii. What are the methods of solid waste collection in Kinondoni Municipality?
- iii. What are the transport techniques/systems of solid waste in the study area?

### **1.6 Significant of the study**

There is an increased generation of solid wastes in Kinondoni Municipality due to increased population. Organic waste biodegrades quickly and releases pungent odours. The discharge of organic waste attracts flies, rats and other pests. These vectors spread diseases such as typhoid and cholera, and can also cause diarrhoea, eye problems, skin diseases etc. Improper disposal of solid waste leads to blocked drains, an increase in contaminated water bodies, an increase in the mosquito population and more diseases. All these will affect the health of the public by reducing life expectancy and increasing infant mortality. The water, air and physical environment have been affected due to bad management of solid waste. The contaminants with the solid waste and leachate from solid waste pollute water bodies. The illegal burning of solid waste causes air pollution and health problems.

Improper solid waste management not only threatens the natural beauty of water bodies, forest reserves, diversity-rich mountains and beaches but also cities and villages. Littering spoils the scenic beauty of the environment.

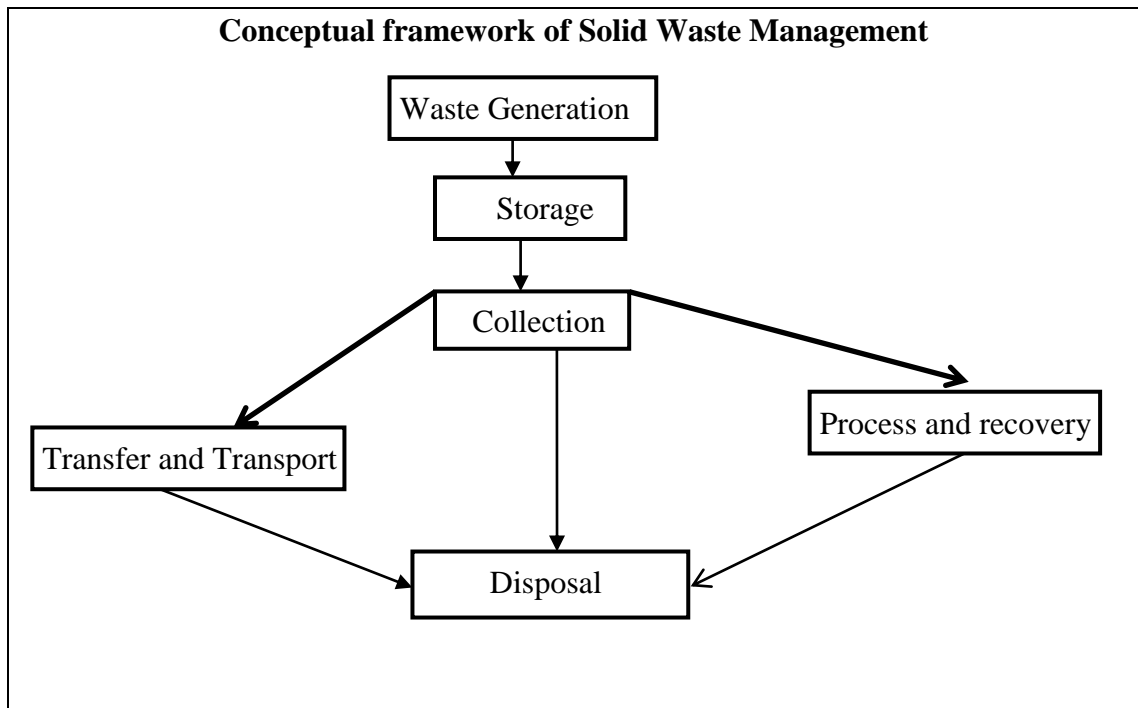
Cleaner cities are better able to attract private investments and tourists, and thus create more jobs in the locality. The inflow of investments brings economic prosperity and more revenue to the government, hence satisfactory services to its citizens.

This study seeks to assess the better ways to improve solid waste management through improved solid waste storage, collection and transport processes prior to disposal. The results of this study will add valuable information to be availed to the general public about solid waste collection and transport processes essential elements in solid waste management. Since better solid waste management improves the health of all citizens, sustainability of the environment, beauty of the environment and attract investors.

## **1.6 Conceptual Framework**

This section describes the general focus of the study. (Punch, 2000), states that conceptual framework represents the general focus of the study. In solid waste management processes, there are various functional elements in which if both implemented well then sustainable solid waste management can be achieved. The first element is waste generation, followed by waste storage, collection. When wastes are collected can be transferred to collection points before being transported to the

municipal or city dumping site and/or waste collected can be processed and recovered that is termed as recycling. The remaining waste after recycling can also be disposed to the municipal or city disposal site.



**Figure 1: Interrelationship of functional element comprising a SWM**  
Source: Field Data

## **CHAPTER TWO**

### **2.0 LITERATURE REVIEW**

#### **2.1 Introduction**

This chapter presents the review of literature. It includes the discussion of the related concepts of the study compared to what other researchers say. It mainly discusses on over view of the solid waste management; functional elements of waste management systems as well as other findings related to the research study.

#### **2.2 Important definition**

Functional Elements of Waste Management Systems have been grouped into six functional elements, these are:

**Waste generation:** This encompasses activities in which materials are identified as no longer being of values and are either thrown away or gathered together for disposal. The quantity and general composition of waste material that is generated is of critical importance in design and operation of solid waste management systems.

**Onsite handling storage and processing:** Those activities associated with the handling, storage and processing of solid waste or near the point of generation.

**Waste Storage** is a system for keeping materials after they have been discarded and prior to collection and final disposal. Storage facilities should be provided where people are able to use them easily.

Improved storage facilities include: household container, communal bins, shallow pits, communal depots.

**Solid waste collection:** Those activities associated with gathering of solid wastes and the hauling of wastes after collection to the location where the collection vehicle is emptied, the act of removing solid waste from the central storage point of a primary generating source to a place of solid waste disposal.

**Transfer and transport:** those activities associated with transfer of wastes from the smaller collection vehicle to the larger transport equipment and the subsequent transport of the wastes usually over a long distance to the disposal site.

Consider the following when selecting a suitable vehicle; waste generation rates, Population density, Area need to access, Distance between collection and disposal.

**Disposal:** Those activities associated with ultimate disposal of solid wastes, including those waste collected and transported directly to landfill, site, semisolid Waste (sludge) from wastewater treatment plants, incinerator, residue, compost or other substance from the various solid- waste processing plants that are of no use.

Municipal Solid Waste (MSW) collection is an obligatory task for city authorities, comprising 5-25% of public authorities' expenditure (JICA, 1996). Rising waste volumes, increased hygienic and amenity demands and environmental considerations at all impose additional requirements, increasing the cost of organizing and handling MSW collection. Public authorities also need to take into account the collection



requirements for different waste streams set in waste legislation. The choice of waste collection method is of importance because waste collection is shown to comprise 50-75% of the total MSW management costs (Breeze, 2012). Consequently, public authorities are looking for new ways of organizing MSW collection to reduce costs and improve performance.

Solid waste Collection interval and volumes of collected waste must be estimated carefully. The two factors are core function in ensuring proper solid waste management in the municipal or city. If collection intervals and volume are not estimated carefully will result into improper transfer and transportation of solid waste and hence hinder the whole system of solid waste management.

The functional element of collection includes not only the gathering of solid waste and recyclable materials, but also the transport of these materials, after collection, to the location where the collection vehicle is emptied. This location may be materials processing facility, a transfer station or a landfill disposal site. Waste handling and separation involves activities associated with waste management until the waste is placed in storage containers for collection. Handling also encompasses the movement of loaded containers to the point of collection. Separating different types of waste components is an important step in the handling and storage of solid waste at the source.

Solid Waste Sorting; Solid waste can have lots of different descriptions. Yard waste such as grass clippings and unused mulch is technically solid waste. So is regular

trash that a person may just throw away like spoiled food or paper plates. Recyclables such as cardboard and newspaper are also considered solid waste. The first step in the collection process is to sort the waste by type and define what will and won't be disposed off. Once the waste has been sorted, usually by the residents putting it in the proper bin or container, the next step in collection can take place.

Pickup; there are a variety of pickup options. Trash can be placed on the curb near a home, and garbage collectors can go house to house and take it. There are also communal trash bins in some apartment complexes, as well as county recycling containers for glass, plastic, paper and organic waste. Some sites may collect hazardous waste materials like syringes, which can't be left in regular trash sites. The waste is taken from all of these sites on a schedule and then transported to a final destination (Buclet and Olivier, 2000).

Waste collection methods vary widely among different countries and regions. Domestic waste collection services are often provided by local government authorities, or by private companies in the industry. Some areas, especially those in less developed countries, do not have a formal waste-collection system.

Overview; the overall goal of urban solid waste management is to collect, treat and dispose of solid wastes generated by all urban population groups in an environmentally and socially satisfactory manner using the most economical means available (Anderson and Richard, 1977). Local governments are usually authorized to have responsibility for providing solid waste management services, and most local

government laws give them exclusive ownership over waste once it has been placed outside a home or establishment for collection. As cities grow economically, business activity and consumption patterns drive up solid waste quantities. At the same time, increased traffic congestion adversely affects the productivity of the solid waste fleet. Productivity loss is exacerbated by longer hauls required of the fleet, as open lands for disposal are further and further away from urban centers. The challenge is to rationalize worker and vehicle performance, while expanding services to a growing urban population.

Collection represents a large percentage of the total cost, the design collection systems must be considered carefully. Collection system can be classified according to their mode of operation, into two categories:

- (i) Hauled container systems (HCS)
- (ii) Stationary container systems (SCS)

HCS- These are collection systems in which the containers used for the storage of wastes are hauled to a materials recovery facility (MRF), transfer station, or disposal site, emptied, and returned to either their original local or some other location

SCS- Collection systems in which the containers used for storage of the storage of waste remain at the point of waste generation also as a Municipal HCS.

Transportation refers to the means, facilities and appurtenances used to affect the transfer of wastes from relatively small collection vehicles to large vehicles and to transport them over extended distances to either processing centers or disposal site.

Solid waste transportation; The movement of solid waste from the point of generation to the transfer stations or collection points before carried out to the disposal site, this process takes place on a variety of scales, from small to very large. Many residents in the isolated portions of the city self-haul their solid waste and recyclables on city and municipal roads to the nearest transfer station on a daily or weekly basis.

Transfer means and methods. Waste can be transferred in different means and/or methods and may include the following: Motor vehicle transport; the vehicles must transport wastes at minimum cost. Waste must be covered during the haul operation, Vehicle must be designed for highway traffic and capacity must be such that allowable weight limits are not exceeded (Kumar and Gaikwad, 2004). Methods used for unloading must be simple and dependable, Railroad transport; used in the past, they are now used by only a few communities. However, renewed interest is again developing in the use of railroads for hauling solid wastes; especially to remote areas where high way travel is difficult and rail road line now exist, Water transport; barges, scow and special boats have been used in the past to transport solid wastes to processing locations and to seaside and ocean disposal sites ocean disposal is no longer practiced nowadays had never been practiced in Tanzania. Other method includes wheelbarrow, bicycle and motor cycle.

Solid waste management is one among the basic essential services provided by municipal authorities in the country to keep urban centers clean. However, it is among the most poorly rendered services in the basket, the systems applied are unscientific, outdated and inefficient; population coverage is low; and the poor are

marginalized. Waste is littered all over leading to insanitary living conditions. Municipal laws governing the urban local bodies do not have adequate provisions to deal effectively with the ever growing problem of solid waste management. With rapid urbanization and population growth, the situation is becoming critical.

Waste management practices can differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Management of non-hazardous waste residential and institutional waste in large cities areas is usually the responsibility of local government authorities, while management for non-hazardous commercial and industrial waste is usually the responsibility of the generator subject to local, national or international.

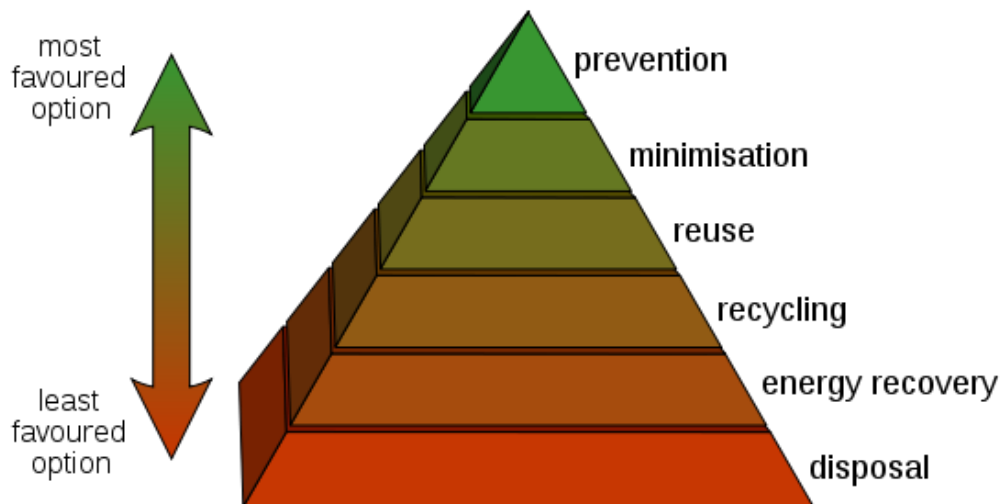
**Treatment and Disposal of Solid Waste:** Waste treatment refers to the activities required to ensure that waste has the least practicable impact on the environment. In many countries various forms of waste treatment are required by law. The treatment of solid wastes is a key component of waste management. Different forms of solid waste treatment are graded in the waste hierarchy.

The waste hierarchy is a process used to protect the environment and conserve resources through a priority approach established in waste policy and legislation. The hierarchy establishes preferred program priorities based on sustainability. To be sustainable, waste management cannot be solved only with technical end-of-pipe solutions and an integrated approach is necessary.

The waste management hierarchy indicates an order of preference for action to reduce and manage waste, and is usually presented diagrammatically in the form of a pyramid. The hierarchy captures the progression of a material or product through successive stages of waste management, and represents the latter part of the life-cycle for each product.

The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste. The proper application of the waste hierarchy can have several benefits. It can help prevent emissions of greenhouse gases, reduce pollutants, save energy, conserve resources, create jobs and stimulate the development of green technologies

Fig 2: The waste hierarchy



**Figure 2: The waste hierarchy**

Source: Field Data, 2014

### **2.2.1 Stages**

The waste hierarchy ranks waste management options according to what is best for the environment. It gives top priority to preventing waste in the first place. If waste is not produced then it has not to be disposed of. When waste is produced, it gives precedence to preparing it for reuse, then recycling, then recovery, and last of all disposal.

**Prevention:** The prevention of waste is the most vital point in the waste hierarchy. Prevention or reduction minimizes the generation of waste products in the first place. Prevention usually results in the least environmental and economic life cycle costs because it requires no collecting or processing of materials. Prevention also typically produces significant benefits in terms of production efficiencies and the use of resources. It involves using less material in design and manufacture, trying to keep products for longer, and using less hazardous materials.

**Reuse:** The reuse of waste is the next most desirable option. It is any operation where products or materials that are not waste are used again for the same purpose for which they were intended. Reusing waste often requires collection but relatively little or no processing. It involves checking, cleaning, repairing, and/or refurbishing, entire items or spare parts.

**Recycle:** Recycling of waste is the next step in priority. It is any activity that includes the collection of used, reused, or unused items that would otherwise be considered

waste. Recycling involves sorting and processing the recyclable products into raw material and then remanufacturing the recycled raw materials into new products.

Recovery: The recovery of waste is further separated into categories: the recovery of materials and the recovery of energy. Whichever of these two choices is better for the environment and human health is the preferred option. The recovery of materials is most often preferred and includes activities such as recycling and composting. These management activities generally require a collection system and a method of material processing and conversion into a new product. Recovery of energy, such as incineration, is usually the less preferred option. The conversion of non-recyclable waste materials into usable heat, electricity, or fuel is done through a variety of processes, including anaerobic digestion, gasification, and pyrolysis.

Disposal: The last resort is disposal and is only considered once all other possibilities have been explored. Disposal is any operation that involves the dumping and incineration of waste without energy recovery. Before final disposal, a considerable amount of pre-treatment may be necessary to change the characteristics of the waste in order to reduce the quantity or harmfulness of the waste and that may include physical, thermal, chemical, or biological processes. Landfills are the most common form of waste disposal and the final disposal option.

Key Obstacles; in developing countries, it is common for municipalities to spend 20-50 percent of their available recurrent budget on solid waste management (Holmes,



1984). Yet, it is also common that 30-60 percent of all the urban solid waste in developing countries is uncollected and less than 50 percent of the population is served. In some cases, as much as 80 percent of the collection and transport equipment is out of service, in need of repair or maintenance. In most developing countries, open dumping with open burning is the norm (Dobbs, 1991).

### **2.3 Solid Waste Management over View**

Solid waste management is a challenge for the cities' authorities in developing countries mainly due to the increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated to its management, the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system functioning (Deweese, 1998). Solid waste management may be defined as the discipline associated with control of generation, storage, collection, transfer and transport, processing and disposal of solid waste in a manner that is accord with the best principles of public health, economics, engineering, conservation, aesthetic and other environmental consideration and that is also responsive to public attitudes.

In its scope, solid waste management includes all administrative, financial, legal, planning and engineering functions involved in solutions to all problems of solid wastes. The solutions may involve complex interdisciplinary relationships among such fields as political science, city and regional planning, geography, economics, public health, sociology, demography, communication and conservation as well as engineering and material sciences (Cunningham, 2006).

## **2.4 Solid Waste Collection Systems**

In most developing countries, solid waste collection includes both primary secondary and direct collection system which is prevailing in most developing countries. Primary collection refers to individual households placing raw solid waste into their personal refuse bins. Secondary collection refers to the collection of solid waste from refuse bins or other primary sites and its transport to the transfer station, dumping site or landfill. Direct collection is defined to be the collection of raw solid waste from households by the collection vehicles of solid waste management organizations and its subsequent transport to the final disposal site (Cointreau, 1983). Most of the developing countries spend their solid waste management budget in collection systems and still cannot collect all solid waste generated. Most of the developed countries have well organized collection systems. Collection bins are provided in curb to collect solid waste. Different colored collection bins are placed in curbs for different types of waste materials.

These collection bins are also provided for recyclables such as glass, cans, plastic bottles etc. Communities carry waste and put in these containers (Kassim & Ali, 2006). These recyclables are later removed and used for recycling industries Curbside collection system is efficient in many developed countries. Wastes are carried out from house and are placed in curb with different colored bins. These wastes are later picked by collection vehicles. These vehicles are single compartmented and multi-compartmented to collect recyclables separately. However, developing countries have different collection systems. The collection system is divided into primary and secondary collection system. A primary collection system consists of collection of

waste from household and put into community collection container. Primary collection equipments are easy to operate and maintain. These primary collection equipments are tricycles which are driven by human power (Ishengoma, 2000). In order to prevent fall of waste from these equipment, it is enclosed from all four sides. The collected wastes by primary collectors are deposited in waste bins. Trolley bins for use in conjunction with compactor trucks. The primary and secondary collection system is carried out by small mechanical vehicles, trucks. These collection vehicles collect solid waste from community collection centers, wastes from street corners (Cointreau and Sandra, 1994). Solid waste collection is also done using tractor.

These tractors are effective solid waste collector vehicles in many developing countries. The trolley is fixed based on the amount of waste to be disposed. Trucks used as a collection vehicle in developing countries. Due to unavailability of adequate number of container, people are bound to throw their waste in street corner, later collected by collection vehicles which are normally truck, tractors etc. Street sweeping is also another most important activity. Municipalities recruit or contract sweepers to clean street of cities. The sweeping is carried out manually unlike developed countries where it is done using mechanical sweepers. Broom and baskets are used for street sweeping for waste collection.

Furthermore, solid waste collection system is classified from several points of view, such as the mode of operation, the equipment used and the types of wastes collected. Collection system can be classified according to their mode of operation, into two categories:

- (i) Hauled container systems
- (ii) Stationary container systems

The individual systems included in each category lend themselves to the same method of engineering and economic analysis. The principal operational features of these two systems are delineated below.

### Hauled Container Systems (HCS)



The HCS involves an open top trailer loading the entire container from a collection point and transporting to the transfer station. It is commonly used in industrial areas where the solid wastes can be bulky or are bundled up in bales

**Figure 3: Hauled Container System (Source: EPA)**

Source: Field Data, 2014

These are collection systems in which the containers used for the storage of wastes are hauled to a materials recovery facility (MRF), transfer station, or disposal site, emptied, and returned to either their original local or some other location. There three main type of vehicles used to hauled container systems; hoist truck, tilt frame container and track tractor trash trailer.

**a) Application of tilt-frame loaded vehicle**

Systems that use tilt-frame-loaded vehicles and large containers often called drop boxes are ideally suited for the collection of all types of solid waste and rubbish from location where the generation rate warrants the use of large containers. Open top containers are used routinely at ware houses and construction sites. Large containers used in conjunction with stationary compactors are common at commercial and industrial services and at transfer stations. Because of the volume that can be hauled, the use of tilt-frame hauled container systems has become widespread, especially among private collectors servicing industrial accounts.

**b) Application of trash-trailers**

The applications of trash-trailers are better for the collection in particular heavy rubbish, such as sand, timber and metal scrap and often are used for collection of demolition wastes at construction sites.

Hauled container systems are ideally suited for the removal of wastes from sources where the rate of generation is high because relatively large containers are used. The use of large containers eliminates handling time as well as the unsightly accumulations and unsanitary conditions associated with use of numerous small containers. Another advantage of hauled container system is their flexibility: containers of many different sizes and shapes are available for the collection of all type of wastes.



**Figure 4: Various type/shape of trash –trailers (Source: Kathmandu Municipal Council)**

Source:

### **Stationary Container System (SCS)**

Collection systems in which the containers used for storage of the storage of waste remain at the point of waste generation, except when moved for collection are defined as stationary container systems. Labour requirement for mechanically loaded stationary-container systems are essentially the system the same as for hauled container systems.

There are two main types of stationary container systems

- (i) Those in which self-loading compactors are used
- (ii) Those in which manually loaded vehicle are used

Container size and utilization are not as critical in stationary container systems using self loading collection vehicles equipped with compaction mechanisms as they are in the hauled container system. Trips to the disposal site, transfer station or processing

station are made after the contents of a number of containers have been collected and compacted and the collection vehicle full. Because a variety of container size and types are available, these systems may be used for collection of all types of wastes.



**Figure 5 : Mechanically Loaded Vehicles used in SCS (Source: EPA)**

Source: Field data

## 2.5 Solid Waste Transportation System

Transportation of the waste stored at waste storage depots at regular intervals is essential to ensure that no garbage bins/containers overflow and waste is not seen littered on streets. Hygienic conditions can be maintained in cities/towns only if regular clearance of waste from temporary waste storage depots (bins) is ensured. Transportation system has to be so designed that it is efficient, yet cost effective. The system should synchronize with the system of waste storage depot and should be easily maintainable.

Transfer and Transport; the functional element of transfer and transport refers to the means, facilities and appurtenances used to affect the transfer of wastes from

relatively small collection vehicles to large vehicles and to transport them over extended distances to either processing centers or disposal site.

**Note:** Transfer and transport operations become a necessity when haul distances to available disposal sites or processing centers increase to the point that direct hauling is no longer economically feasible.

c) **Transfer means and methods**

Motor vehicles, railroads and ocean-going vessels are the principal means now used to transport solid wastes. Pneumatic and hydraulic systems have also been used. Still other systems have been suggested, but most have not been tested.

Motor vehicle transport: Motor vehicles used to transport solid wastes on highways should satisfy the following requirement:

- (i) The vehicles must transport wastes at minimum cost.
- (ii) Waste must be covered during the haul operation
- (iii) Vehicle must be designed for highway traffic
- (iv) Vehicle capacity must be such that allowable weight limits are not exceeded
- (v) Methods used for unloading must be simple and dependable.

**Note:** The maximum volume that can be hauled in highway transport vehicles depends on regulations in forces in the state in which their operated.

In recent years, because of their simplicity and dependability, open top trailers and semi-trailers have found wide acceptance for the transport of wastes.





**Figure 6: sample of sump trailer**

Source:

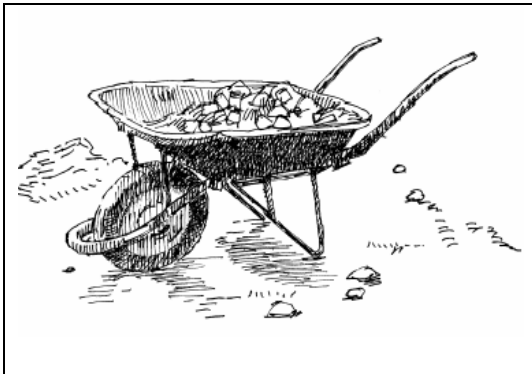
Some trailers are equipped with sumps to collect any liquid that are accumulated in the solid waste. The sumps are equipped with drains so that they can be emptied at the disposal site. Methods used to unload the transport trailers may be classified according to whether they are self-emptying or require the aid of auxiliary equipment. Self emptying transport trailers are equipped with mechanisms such as

**Railroad transport:** Although railroads were commonly used for transport of solid wastes in the past, they are now used by only a few communities. However, renewed interest is again developing in the use of railroads for hauling solid wastes; especially to remote areas where high way travel is difficult and rail road line now exist.

**Water transport:** Barges, scow and special boats have been used in the past to transport solid wastes to processing locations and to seaside and ocean disposal sites, but ocean disposal is no longer practiced nowadays, and had never been practiced in Tanzania.

**Pneumatic Transport:** Both low pressure air and vacuum conduit transport systems have been used to transport solid wastes. The most common application is the transport of wastes from high density apartments or commercial activities to a central location for processing or for a loading into transport vehicles. The largest pneumatic system now is used in the United States is at the Walt Disney World amusement park in Orlando, Florida.

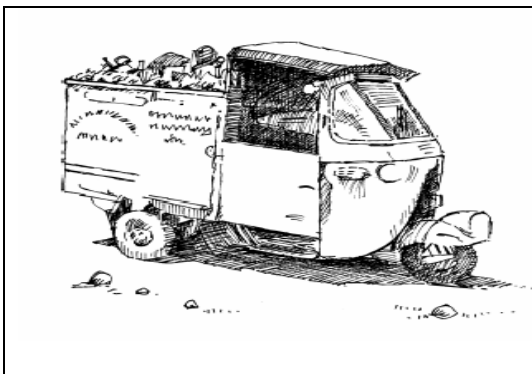
Common Transport: The urban areas around cities have been spreading, leaving fewer nearby acceptable solid waste disposal sites. The lack of acceptable sites has led to the contraction of incinerators, resource recovery facilities or processing facilities in cities or their outskirts or the transportation of waste. The common transports are mentioned in figure 7. (a-d)



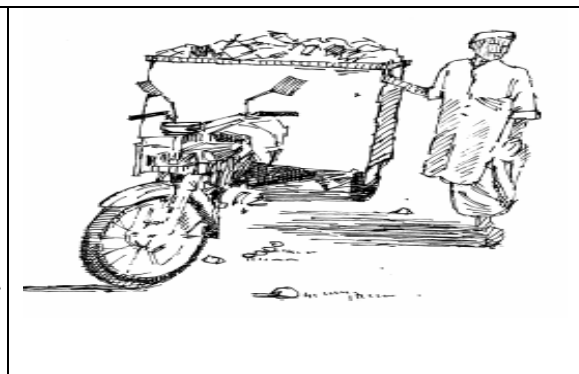
**Figure 7: (a) Wheelbarrow**



**Figure 8: ( b) Bicycle**



**Figure 9: (c) Motor cycle**



**Figure 10: (d) Motor cycle**

When selecting suitable vehicles, waste generation rates and densities need to be considered along with: areas they need to access (e.g. narrow alleys or uneven paths); and distance between collection and disposal points. For example, a wheelbarrow could collect waste from approximately 50 individuals before requiring emptying.

## **2.6 Solid Waste Disposal System**

From prehistory through the present day, the favored means of disposal was simply to dump solid waste outside the city or village limit. To minimize the volume of the waste, the dump was often burned; unfortunately these methods are still used in some parts of the world. Better waste disposal technologies were developed, emphasis on health and environmental consideration. Dumping and open burning of waste is no longer acceptable practice from an environmental or health perspective.

Open dumping –SW collected from the town is deposited in low-lying land, usually on the outskirts of the town. The open dumps are uncovered and therefore attract flies, insects and rodents and odours are produced. This method is unscientific and cause nuisance to the public, It is also subject to fire hazard, It cause health and pollution hazards. Yet, this method being the easiest, is adopted in many developing countries.

Methods of MSW disposal, five techniques are used; Sanitary landfill, Incineration, Composting, Source reduction and Recycling.

Sanitary Landfill; Modified form of open dumping, Waste is deposited in 0.9-4.5 thick layers in depressions and then compacted and covered at least once a day by earth with bulldozers. The covering prevents breeding of flies, rats, e.t.c. In selecting a site consider underground potable water source, the process is completely sanitary, highly skilled personnel are not required, Land can be safely overloaded without

causing any problem, Converts low-lying, marshy wasteland into useful area, Natural resources are returned to soil and recycled.

Sanitary Landfills have some short falls; a large area is required, transportation cost is high, can cause fire hazard due to formation of methane in wet weather. Incineration; The refuse is burnt in a controlled manner; Incinerators are built with lined furnaces, grate area for burning, air blowers for aiding combustion and oil burners to provide additional heat to burn wet garbage. The primary products of combustion is carbon dioxide, other products are water vapour, nitrogen, solid residue of glass, ceramics, mineral ash etc. Sometimes additional fuel is required for complete combustion; drastically reduce the amount of MSW up to 90% by volume and 75% by weight. Modern incinerators have many pollution devices that trap nearly all of the pollutants produced, The residue is only 20-25% of original weight, It require very little space, Cost of transportation is not high as incinerators are located within city limits, Safest from hygienic point of view. Some Disadvantages of this method includes; it is capital and operating cost is high, Needs skilled personnel, Air pollution may be caused.

Composting; Biological decomposition of organic substances available in the waste under controlled condition, Involves the laying of alternate layers of sort and the putrescible material such as night soil, animal dung, garbage etc. The mass is usually turned double during the compost process, there are two systems by which compost can be produced i.e. Anaerobic and Aerobic. The disadvantages of anaerobic are; the

process is slow, extending over a period of 4-12 months, it is a low temperature process and produces offensive odour.

During composting the following steps are involved; Sorting- removal of non biodegradable waste such as tins, glass, rags, plastics, etc, Shredding of refuse – Chopping of refuse into small pieces, the shredding increases the rate of decomposition and aeration, Window system – The refuse is stacked in piles in rows of 1.5-1.8m height, Turning – Refuse in pile is turned frequently so that the aerobic process is continued, Bottom aeration – material are normally stacked on a perforated floor and forcing air into the pile by way of bottom aeration. Normally composting is highly mechanized and may need various types of machinery. Merits of this method includes; When added to the soil, it increases water retention and ion-exchange capacity of the soil, A number of industrial solid wastes can also be treated by this method, It can be sold thereby reducing the cost of disposing of wastes, Re-cycling occurs.

Shortfall of this method include the following; When mechanized, it involve high investment and hence cost of compost is high, The non biodegradable waste have to be disposed of separately, Use of compost has not yet attracted many farmers and hence no assured market.

Source reduction; is the practice of designing, manufacturing, purchasing, using, and reusing materials so that the amount of waste or its toxicity is reduced. E.g. Design low weight soft drink bottles, change the manufacturing process so that to produce less waste.

Recycling; Environmentally friend method of waste management, Benefits include resource conservation, pollutant reduction, energy saving, job creation and reduce need for landfill and incineration, Incentives are needed to encourage people to participate in recycling programs

### **2.7 Report Findings from other similar/related studies**

The study conducted in Asia on Solid Waste Management Particularly in Sri Lanka legislation, under the support of Asia Foundation (TAF) implemented the Transparent Accountable Local Governance (TALG) Program with financial Support from the United States Agency for International Development (USAID) from January 2005 - September 2007. Published a training module on solid waste collection and transportation. This Service Delivery Training Module on Solid waste collection and transportation revealed that Local Authorities (LAs) are legally responsible for providing SWM services. However, SWM has become a burning issue as most LAs do not have proper plans in place to execute this task effectively. In general, Sri Lanka.

LAs spend nearly 35-40% of their annual budget on SWM of which 60–70% is spent on waste collection and transportation (Alam, 2006). Despite this expenditure, many LAs do not satisfy their citizens' expectations for waste management services (JICA, 2004).

Waste Transportation; Waste transportation is well recognised as being the most costly component of the waste management function. Waste management is transport

intensive with many different types of vehicles required to perform the function successfully. As new landfills are developed, which are typically distant from collection areas, transportation costs are increased as well as collection times which directly impacts on the quality of the service, if collection vehicles are used for haulage. As such transfer stations are typically required where waste is transferred into more conventional bulk transport carriers (Kaseva & Mbuligwe).

## **2.8 Challenges associated with the collection and transportation of solid waste**

Key obstacles with regards to waste collection include: Collection systems, Kerbside collection is feasible and practical in established urban townships with infrastructure but is not appropriate in rural and informal settlements. Collection in informal settlements is hampered by poor access and lack of roads within the settlements themselves. As such, conventional collection vehicles (compactors) cannot access individual households and therefore providing an individual household service in these areas is impossible.

Furthermore the lack of title and ownership of property restricts municipalities' collection budgets, as rates are not collected in these areas. (Kombe, 1997)

Collection in rural areas is constrained by both poor road access and collection distances, which make collection in rural areas difficult due to excessively high transportation costs. Although most municipalities supply conventional black bags, they are of poor quality and have problems in terms of compaction on landfill sites as they do not breakdown easily and trap air which takes up airspace. There is no

standard as to the number of black bags/ collection vessels that are allocated. There is a trend for municipalities to use wheelie bins for household collection. This however has its own form of challenges as they requires specialised handling equipment, regular washing and slow collection times (Kizito, 1999).

Collection in central business districts is constrained by lack of space due to increased pedestrian activity on pavements and informal traders etc. There is therefore a lack of space for conventional collection containers and alternative more expensive options (subsurface storage bins) are being investigated (Pikitup pers. comm.). The success of collection frequencies is largely determined by the availability and condition of collection vehicles.

Key obstacles with regards to waste transportation include; the capital outlay for a compactor (conventional collection truck) is high and as a result some rural municipalities collect waste in inefficient collection vehicles such as tractor-trailer combinations. Transportation is a volatile industry aggravated by volatile fuel prices. Municipalities seldom have back-up or standby vehicles to replace those that are out-of-order. Most municipal waste collection vehicles are old (greater than ten years) and as a result they are often out of order (Tchobanoglous *et al*, 1993). This affects the frequency and consistency of waste collection. Collection vehicles are privately owned and maintained to which the municipality contract on a five year period. As a result the vehicles are generally new and well maintained which makes their collection service more reliable and efficient. Most of the Where access is limited to the municipal waste collection vehicles, such as in informal settlements, example; the



City of Cape Town uses closed top, lock up containers in the informal settlements, where the local communities are responsible for disposing their wastes into these containers. These containers are kept locked until the municipality comes to collect the waste. Round balancing studies are seldom undertaken to determine optimisation of collection rounds and hence reduction in transportation costs. It is also important to flag transport and transport distances as a key structural factor that will affect the future sustainability of waste management services (Pfeffer, 1992).

Inefficient and Unscientific Manual Loading of Waste; in most of the cities/towns there is no synchronization between waste storage depots and transportation of waste. Waste stored in open spaces is either loaded manually or with the help of loaders in traditional trucks. Manual loading takes time and reduces the productivity of the vehicles and manpower deployed. Besides, manual handling of waste poses a threat to the health of the sanitation workers as the waste is highly contaminated (Teerioja, *et al* 2012).

Irregular Transportation; Cities and towns generally have limited fleet of vehicles and most of them are old necessitating frequent repairs with the result the transportation of waste does not take place regularly. The waste is generally seen lying in heaps or scattered at the unscientifically designed dust bins giving unsightly appearance besides causing nuisance and unhygienic conditions.

Underutilization of Fleet of Vehicles; Most of the vehicles are manually loaded and the Lorries which can easily take 5 to 6 tonnes of solid waste in one trip carry only 1-

3 tonnes of waste as strict monitoring system do not exist. In several cities, small vehicles and even bullock carts are taken directly to landfill sites located at long distances. This makes the transportation operation very inefficient and uneconomical (United States Environmental, 2012).

**Open Trucks Cause Nuisance;** Open trucks loaded with garbage wade through cities and towns. They emanate fowl smell and cause nuisance to people. At places where cover material is arranged, covering of trucks is done half-heartedly and nuisance continues.

Solid waste management programmes in South Africa have proved success due to direct involvement of the communities and communities are seen as partner in the management of solid waste. Community programme such as Clean Community system has recorded an 80% reduction in litter.

## **CHAPTER THREE**

### **3.0 RESEARCH METHODOLOGY**

#### **3.1. Introduction**

This chapter presents the methods of data collection process. The section includes the study area, population, sampling techniques, data collection methods and data analysis procedures.

#### **3.2 Study area and population**

Altogether two wards of Ubungo and Sinza under the jurisdiction of the Kinondoni Municipal were chosen for this research where total numbers of 50 households were surveyed. These two wards were purposively chosen to represent the rest of wards in Kinondono Municipal to investigate the assessment of solid waste management in Kinondoni Municipal. Additionally, the chosen area is highly populated and the generation of solid waste is at high level due to different human activities, a lot of shops, bars and restaurants are found within the area. Ubungo area is located about 9km from city centre, in the city of Dar es salaam.

Ubungo is residential area with a population of about 56,015 (census, 2012) people, While Sinza area is located about 12km from city centre. Sinza is also a residential area with a population of about 40,546 (census, 2012) people. The area is more ethnically mixed, there are families with high income per month and others have low income per month. The main social economic activity conducted in these areas includes business, brick making, small scale commercial activities and gardening



ward were chosen respectively. District health officer, district waste management officer, 2 ward health officer out of four (4) were involved in the study. Gender was also traced in data collection process, this aimed to know who are mostly involved in the waste collection activities.

Locality, the sample size was drawn from planned areas and unplanned areas in relation to waste management services. The issue of availability, efficiency and effectiveness of solid waste management services was in focus.

### **3.4 Data Collection Methods**

#### **3.4.1 Primary Data**

Questionnaires were used during this research to obtain important information about solid waste management in the study area. Each item in the questionnaire was developed to address specific objectives or research questions, the objectives were; to characterize solid waste generated in Kinondoni Municipality, Analyze the methods of solid waste collection in the study area and to examine the methods of solid waste transportation in Kinondoni Municipality and Questionnaires were used; Part three of the Appendix B. Open/structured or closed ended questionnaires were formulated for the purpose of this study. The questionnaires were both hand and electronically delivered to the respondents and thereafter collected after being completed, solid waste management was the major theme focused. Personal Observation was also used to obtain data/information on solid waste management, the main focus was an over view of solid waste management in Kinondoni Municipality particularly Ubungo and Sinza ward respectively.

#### **4.4.2 Secondary Data**

Secondary data were collected through documentary information collected and compiled by various researchers and stakeholders. Among others included, Dar es Salaam Metropolitan Development Projects, The study on the solid waste management for Dar es salaam City in the United Republic of Tanzania, Progressive report (2), Dar es Salaam city commission. (Appendix 2&3)

### **3. 5. Data Analysis Procedure**

Data collected from the questionnaire survey were digitally compiled, coded and edited. Data entry was manually cross-checked to ensure accuracy. The coded items were summed up to provide frequencies and percentages were calculated using SPSS software, Version 16.0. Data from the interviews and site observations were further processed and edited. Comments from SWM professionals, the authors' judgments and results from interviews were used as a basis for the analysis and interpretations of the qualitative data.

Both descriptive and inferential statistics was used for analysis of data. A correlation test was performed to determine the relationship between waste generation and population.

## CHAPTER FOUR

### 4.0 RESULTS AND DISCUSSION OF FINDINGS

#### 4.1 Introduction

This chapter contains a presentation of the research findings. The presentations are based on the research objectives and questions addressed in chapter one. Prior to the analyses of the findings the gender and age characteristics of the respondents is explained. Also an education characteristic of the respondents is explained in relation to solid waste management.

#### 4.2. Population Structure

It was observed that out of 50 respondents, 76.0% were male and 24.0% were female as shown by Table 1. 70.0% were adults ranging 21-40 years, this age characteristics indicates that most of respondents had gone to school or universities and therefore it was assumed that they had knowledge on solid waste management as indicated in Table 2. Also table number three below indicates that 80% of the respondents had attended University education and so were able to think critically and respond to the questions asked to the questionnaires and so it can be assumed that most of their responses were valid.

**Table 1: Gender characteristics of the respondent**

Gender Characteristics	Frequency	Percent
Male	38	76.0
Female	12	24.0

Source: Field Data

**Table 2: Age characteristics of the respondent**

Age characteristics	Frequency	Percent
5 - 20 Years	6	12.0
21 - 40 Years	35	70.0
41 - 60 Years	9	18.0
Total	50	100.0

Source: Field Data

**Table 3: Education characteristics of the respondent**

Education Characteristics	Frequency	Percent
Secondary	7	14.0
Tertiary	3	6.0
University	40	80.0
Total	50	100.0

Source: Field Data

### **4. 3 Characteristics of Municipal Solid Waste**

For effective and efficient management of municipal solid waste generated in a particular city, adequate knowledge and data about the characteristics of solid waste is essential. In order to decide or determine types of facilities required for solid waste management, best disposal options, and projecting future needs requires precise



information about quantities, compositions, densities, moisture content and calorific value of solid waste produced in a city (Rushbrook, 1999 in G/tsadkan,2002). Though all the above characteristics are important, for this study the researcher emphasize only on municipal solid waste quantities and physical composition of the solid waste produced in Kinondoni Municipality.

#### **4.3.1. Waste Composition**

The generation of solid wastes is from households (domestic waste), industrial areas, and commercial establishments like markets, hotels, restaurants and informal areas. Information on the composition of the solid waste is important in evaluating equipment needs, collection system, disposal methods, and management plans. The composition of solid waste in the city of Dar es Salaam is to a great extent food waste, garden waste, grass and wood.

Solid waste was also classified in Biodegradable (52%) and non-biodegradable (48%) groups. Biodegradable waste among others included waste from households' i.e. Food remains, ash, dust, manure etc. The challenge posed by these types of waste is that during rainfall season they absorb large amount of water and hence increase in weight so is the cost of collection and transportation. Their decomposition can result into offensive odour to the community and pose threat to public health and the environment. Non-Biodegradable among others included glass, plastics, leather, textiles etc. This involved taking/asking data from administrative offices, field study and response from the questionnaire, field observation revealed that plastics and/or plastic bottles are collected by many people where they sell to the industries which

recycle these products. According to collectors of these plastic bottles, they sell 1kg for about 250-300 Tsh. Further observation revealed that wastes are not separated into biodegradable and non biodegradable using special waste containers or bins. That is wastes are mixed and therefore hinders the proper solid waste management practices. Separation of waste is very important in waste management since biodegradable waste can be used in making compost and/or compost manure and hence resource recovery.

Solid waste volume generated and collected (tons/day)

**Table 4:** waste volume generated and collected

<b>Municipality</b>	<b>Generated volume</b>	<b>Collected volume</b>	<b>Collected (%)</b>
<b>Kinondoni</b>	2026	823	41

Source: Kinondoni Municipal 2012

#### **4.3.2. Waste generation & Waste composition**

Kinondoni Municipality is estimated to generate about 2026 tonnes of waste per day according to the current generation projections based on the 1997 JICA study. The generation of solid waste is mainly from residential areas, industrial areas, institutions, commercial establishments like, markets and other informal sectors comprise this amount. Information on the composition of the solid waste is important in evaluating equipments needs, collecting system, disposal methods and management plans. The waste generation amount is shown below.

**Table 5:** Sources of solid waste

<b>Types of waste</b>	<b>Amount generated</b>	<b>Tones/day</b>
Household waste	1618.8	Tons/day
Commercial waste	30.4	Tons/day
Institutional waste	12.1	Tons/day
Market waste	40.5	tons/day
Streets waste	2.0	tons/day
Informal sector waste	322.2	tons/day
<b>TOTAL</b>	<b>2026</b>	<b>tons/day</b>

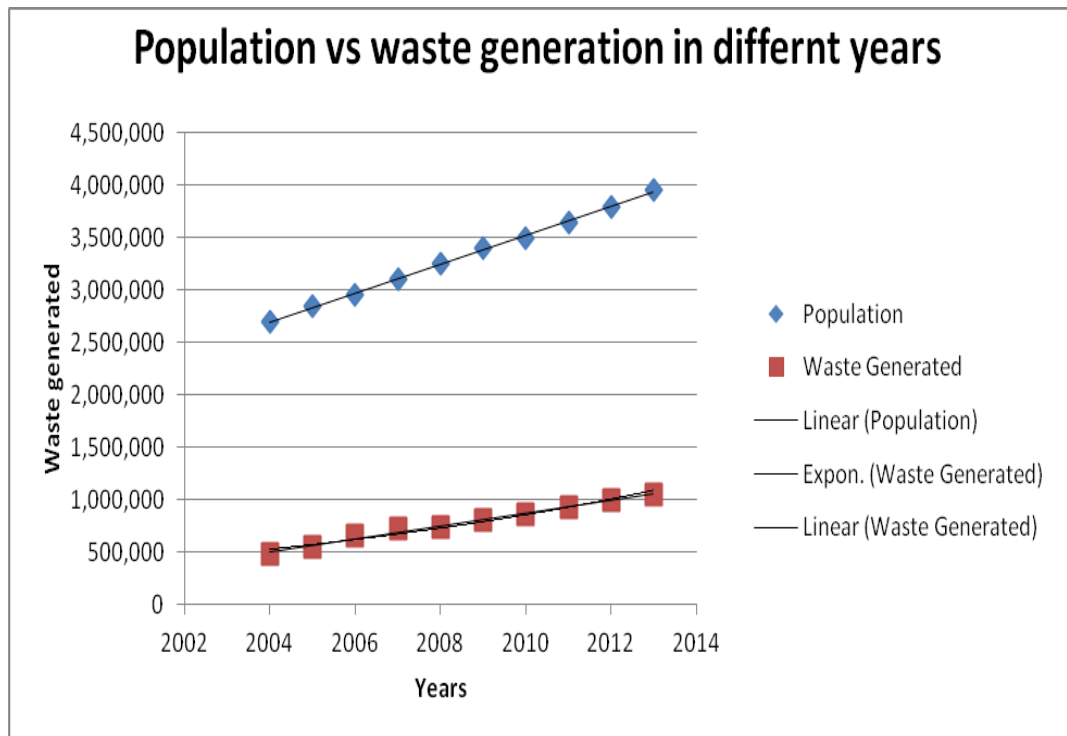
Source: Kinondoni Municipality

Findings indicates that high quantities of solid waste are generated from households, about 1618.8 tonnes per day, informal sector waste about 322.2 tonnes per day, market waste about 40.5 tonnes per day commercial waste about 30.4 tonnes per day, institutionalwaste about 12.1 tonnes per day and street wastes about 2 tonnes per day.

### **Relationship between population growth and Waste management**

It has been observed that population increase result into more waste generation. Since the population is growing very fast and so create an alarm on Waste Management practices.

The data for ten years were taken in order to study the relationship between population and waste generation.



**Figure 12: Relationship between populations versus waste generated**

Source: Field Data, 2014

Data analysis indicates that there is a positive relationship between population and waste generation, as the population increases in each year; waste generated also increases as shown from the figure 9 above. Since the population increases each year, if the Solid Waste Management system in Kinondoni Municipality will not be improved and/or reviewed means that more waste will remain uncollected and hence pose environmental burden.

#### **4.4. Identification of the methods of solid waste collection**

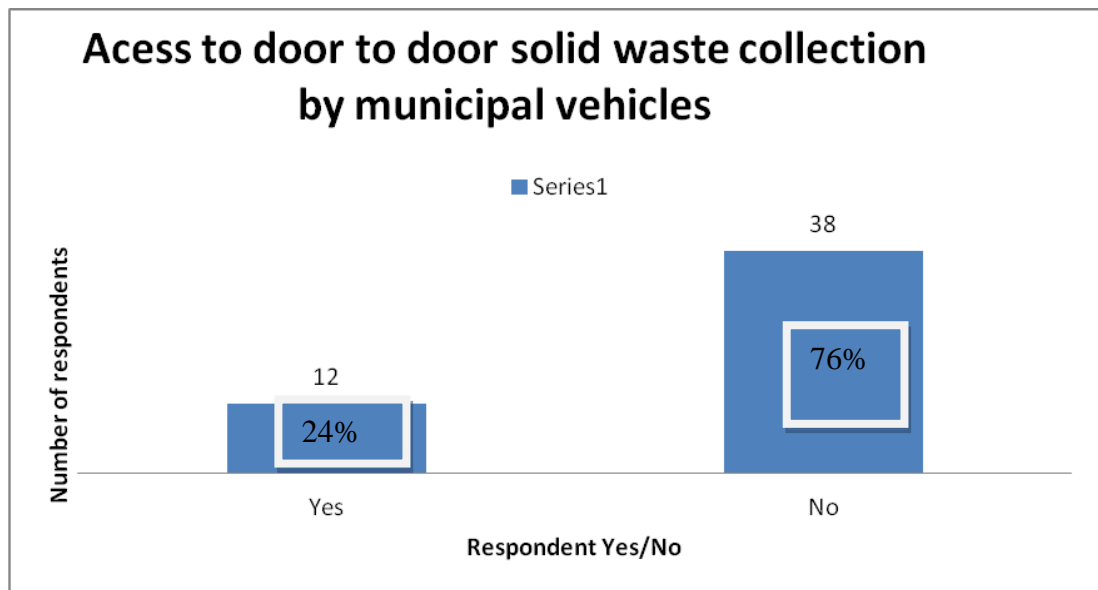
In most developing countries Solid waste collection includes both primary and secondary collection system. Factors affecting collection systems are also described.

Most of the developing countries spend their solid waste management budget in collection systems and still cannot collect all solid waste generated.

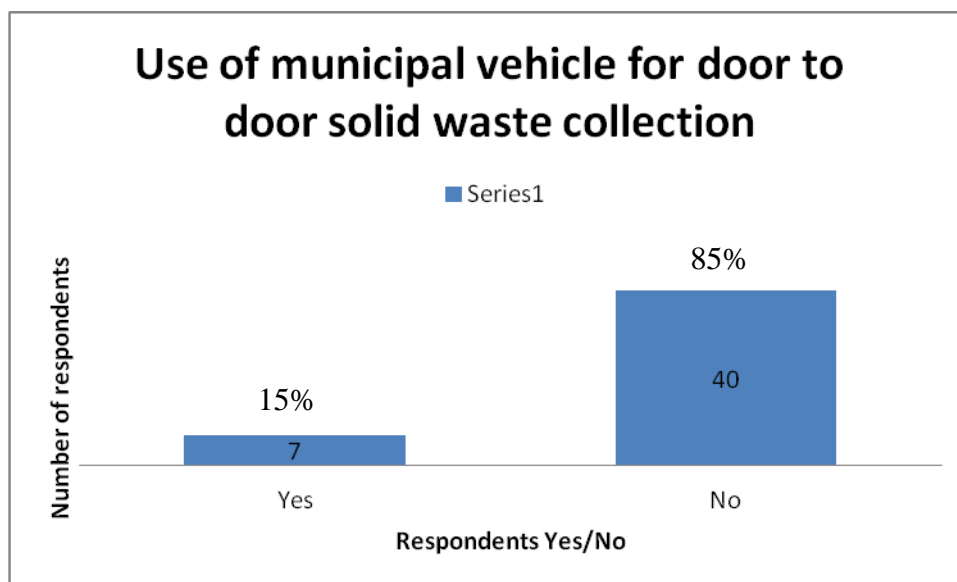
The study revealed that about 76% of the respondents have no access to door to door solid waste collection services delivered from the municipality solid waste collection vehicle. That means only 24% of the respondents have access to door to door solid waste collection services delivered by the municipality solid waste collection vehicle.

Most of solid wastes are collected using primary collection system which is done by the individual households placing raw solid waste into their personal refuse bins. This study revealed that most of the individuals also dispose their wastes in river sides' and gullies which are around their premises. About 85% of the respondents also indicated that they have no access to municipal vehicles for door to door solid waste collection services from their residence, that means only 15% have access to municipal vehicles for door to door solid waste collection services from their residence.

*“Do you have access to door to door solid waste collection services delivered from the municipality solid waste collection vehicle?”*



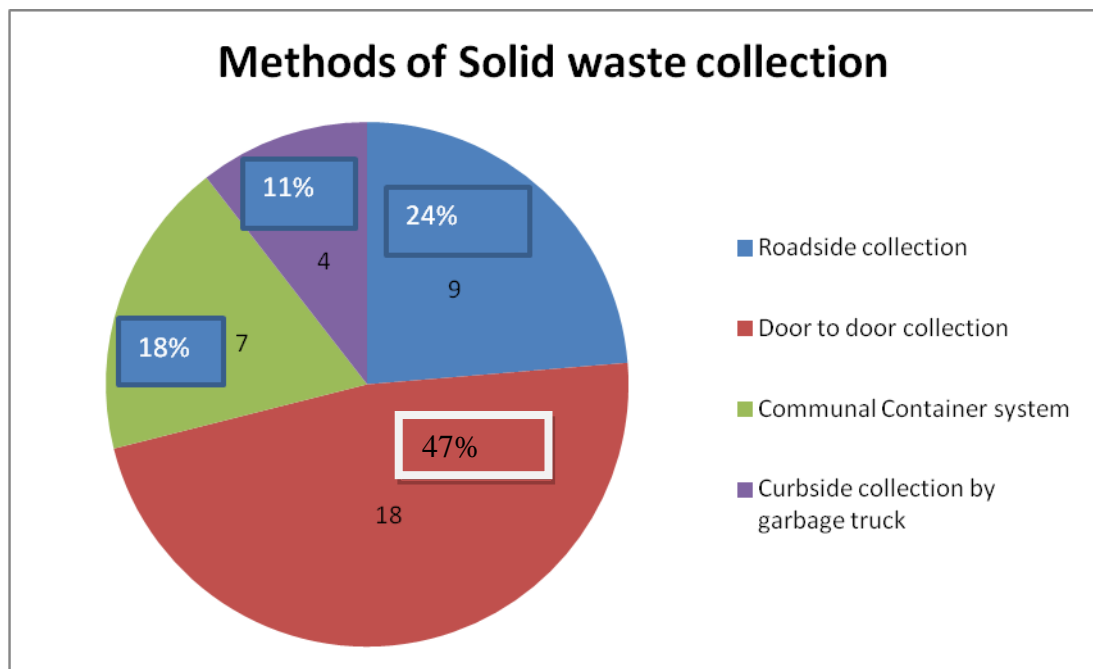
**Figure 13: Access to door to door solid waste collection by municipal vehicle**  
Source: Field Data, 2014



**Figure 14: Use of municipal vehicle for door to door solid waste collection**  
Source: Field Data, 2014

#### 4.4.1 Methods of solid waste collection

There are different modes, methods for solid waste collection system in Kinondoni Municipality. The following are some of the methods that have been identified or obtained from this research study.



**Figure 15: Methods of solid waste collection**

Source: Field Data, 2014

Door to door collection; 47% of the respondents had opted the use of door to door method. This is done by private collectors groups or organization in Kinondoni Municipality though efficiency and effectiveness of this method is not much effective due to the reasons that individual or owners of the houses they do not contribute the small amount of money that they are supposed to contribute. Collection is sometimes done by small community groups which pass house to house, though community participation is poor, most of the solid waste households are disposed to the rivers and gullies.

Roadside collection; 24% of the respondents, this is one of the methods of solid waste collection in Kinondoni Municipality; there are collection points which are located near the road. Streets which are not planned or no municipal vehicle access are supposed to collect their waste from their households and dump at secondary collection points where the municipal vehicle can pass and load the waste ready to be transported to the main dumping area or landfills. The main challenge is the performance of the municipal vehicle and quantities of the waste produced, this cause most of wastes to be a burning issue to negative environmental effects, cause nuisance to people by emanating foul smell.

Communal Container System; About 18% of the respondents use Communal container systems. The system have been in place in many years and are very help full in waste management processes by keeping the city/municipal clean. Communal bins are introduced to help those people, in flats and bedsits who don't have enough space to store their waste, over a week, 24 hours a day, and 7 days a week. The study revealed that in most areas there no communal bins placed to keep the waste. Most of the areas in Kinondoni municipal have no communal bins for keeping waste. It is believed that extending the coverage of communal containers is the best way of ensuring various streets to stay clean. There are Containers or bins which are seagull and rodent proof, which will mean:

- (i) no more waste strewn across the streets from ripped bags
- (ii) less seagulls and vermin - most of their food comes from our refuse
- (iii) you don't need to store refuse in your property, it can be placed in the communal bins 'little and often'



If the municipal can place more bins, most of the households will no longer need to store their waste inside their property or outside their front door until collection day or brave the basement bin store. Instead they will be able to put their rubbish into the communal bin whenever it's convenient for them. The containers must be emptied regularly to prevent them from overflowing and ensure safe and healthier environment.

Curbside collection by garbage truck; the study revealed that about 11% can have access of curb side collection by garbage truck or vehicle. Curbside collection is a service provided to households, typically in urban and suburban areas, of removing household waste. It is usually accomplished by personnel using purpose built vehicles to pick up household waste in containers acceptable to or prescribed by the municipality. In Kinondoni there are few areas which have access to such service, but in most of the municipal areas this service is very limited.

Curbside collection is today often referred to as a strategy of local authorities to collect recyclable items from the consumer. Curbside collection is considered a low-risk strategy to reduce waste volumes and increase recycling rates. Materials are typically collected in large bins, coloured bags, or small open plastic tubs, specifically designated for content. Curbside collection is commonly considered to be completely environmentally friendly.

#### **4.5 Methods of solid waste transportation in Kinondoni Municipal**

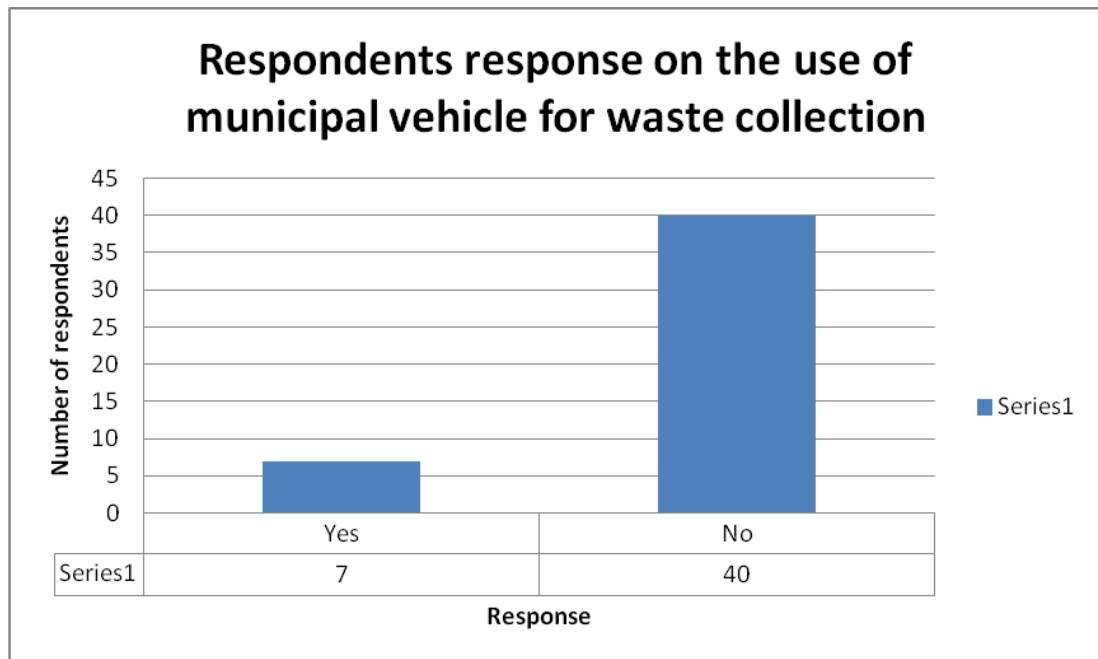
Transportation of the waste stored at waste storage depots at regular intervals is essential to ensure that no garbage bins/containers overflow and waste is not seen littered on streets. Hygienic conditions can be maintained in cities/towns only if regular clearance of waste from temporary waste storage depots (bins) is ensured.

Transportation system has to be so designed that it is efficient, yet cost effective. The system should synchronize with the system of waste storage depot and should be easily maintainable.

In most of the cities/towns there is no synchronization between waste storage depots and transportation of waste. Waste stored in open spaces is either loaded manually or with the help of loaders in traditional trucks. Manual loading takes time and reduces the productivity of the vehicles and manpower deployed. Besides, manual handling of waste poses a threat to the health of the sanitation workers as the waste is highly contaminated.

The study revealed that few residence of the Kinondoni Municipality receives municipal services for collection and transportation of the waste to the final disposal. This means that most of the areas within the municipal does not receive services of transporting their wastes and so are left uncollected or thrown to roadside or rivers. Out of forty seven respondents from the questionnaire distributed, it was observed that only 15.0% have an access to collect and transfer their waste to disposal site.85% of the respondents have no an opportunity to collect and transfer their waste. Vehicle means of transportation of solid waste is very limited in the study area and therefore

Kinondoni Municipality. There are few areas in which vehicle means of transport is used.



**Figure 16: Use of municipal vehicle for solid waste transportation**

Source: Field Data, 2014

#### 4.6 Challenges Associated with Solid Waste Management

Key obstacles with regards to waste collection include: Collection systems, Curbside collection is feasible and practical in established urban townships with infrastructure but is not appropriate in rural and informal settlements. Collection in informal settlements is hampered by poor access and lack of roads within the settlements themselves. As such, conventional collection vehicles (compactors) cannot access individual households and therefore providing an individual household service in these areas is impossible. Furthermore the lack of title and ownership of property restricts municipalities' collection budgets, as rates are not collected in these areas (Kombe, 1997).

Collection in rural areas is constrained by both poor road access and collection distances, which make collection in rural areas difficult due to excessively high transportation costs. Although most municipalities supply conventional black bags, they are of poor quality and have problems in terms of compaction on landfill sites as they do not breakdown easily and trap air which takes up airspace. There is no standard as to the number of black bags/ collection vessels that are allocated. There is a trend for municipalities to use wheelie bins for household collection. This however has its own form of challenges as they requires specialised handling equipment, regular washing and slow collection times ( Kizito, 1999).

Collection in central business districts is constrained by lack of space due to increased pedestrian activity on pavements and informal traders etc. There is therefore a lack of space for conventional collection containers and alternative more expensive options (subsurface storage bins) are being investigated (Pikitup pers. comm.). The success of collection frequencies is largely determined by the availability and condition of collection vehicles.

Key obstacles with regards to waste transportation include; the capital outlay for a compactor (conventional collection truck) is high and as a result some rural municipalities collect waste in inefficient collection vehicles such as tractor-trailer combinations. Transportation is a volatile industry aggravated by volatile fuel prices. Municipalities seldom have back-up or standby vehicles to replace those that are out-of-order. Most municipal waste collection vehicles are old (greater than ten years) and as a result they are often out of order (Tchobanoglous, *et al*; 1993). This affects

the frequency and consistency of waste collection. Collection vehicles are privately owned and maintained to which the municipality contract on a five year period. As a result the vehicles are generally new and well maintained which makes their collection service more reliable and efficient. Most of the Where access is limited to the municipal waste collection vehicles, such as in informal settlements, example; the City of Cape Town uses closed top, lock up containers in the informal settlements, where the local communities are responsible for disposing their wastes into these containers. These containers are kept locked until the municipality comes to collect the waste. Round balancing studies are seldom undertaken to determine optimisation of collection rounds and hence reduction in transportation costs. It is also important to flag transport and transport distances as a key structural factor that will affect the future sustainability of waste management services (Pfeffer, 1992).

However, the study on “Assessment of the status of waste service delivery and capacity at the local government level” Conducted by the Government of South Africa under the Department of Environmental Affairs and Tourism; Directorate of General Waste Management produced a report on Local Government Waste Capacity Assessment, summary in the report revealed that by virtue of the fact that waste service delivery has traditionally been viewed as the collection and disposal of waste, it has been deemed unsustainable. Recently there has been a paradigm shift in the way that waste delivery is perceived; the emphasis is now on waste minimisation and reduction at source with the ultimate goal being a National sustainable waste service delivery program (South Africa Government).

The obstacles that are preventing local municipalities from providing a sustainable waste service are numerous. These range from budget restrictions to illegal dumping, service backlogs, lack of effective bylaws and insufficient skills development. In order to provide a sustainable waste service that is based on waste minimisation principles and to address the obstacles being faced by local municipalities a host of interventions can be implemented. These include institutional arrangements, financial, technical and service delivery. At a municipal level the primary obstacle to a sustainable waste management service at a municipal level is the lack of 'in house' capacity to run the service in an efficient and effective manner as well as the lack of knowledge to move the service from an 'end of pipe' scenario to a waste minimization approach.

The primary intervention that is recommended in this vein is the strengthening of municipal human resource capacity (Karanja, 2005). To further augment the waste minimization approach cooperation is required between the waste producers and the local municipalities; this can be reinforced by bylaws. Furthermore, the provincial and national government should act in a supportive and complementary role to the local municipalities by providing policy guidance; developing legal deterrents against illegal dumping of wastes and the use of open dumps, coupled with adequate capacity for enforcement; and providing assistance with standards for segregation, storage, treatment, and disposal of each category of waste. (Karanjit & Shrestha, 2005).

**Waste Collection;** The long-term objective of the general waste collection component of the NWMS is to provide sustainable, affordable, and environmentally friendly

acceptable general waste collection services to all people in South Africa. Waste collection has always been the focus of the waste service provided by municipalities. In terms of the metropolitan municipalities a waste collection service is provided to all urban households including informal settlements. Rural areas are poorly serviced although some municipalities are planning to extend their collection service to rural areas.

*“The proportion for waste which remains uncollected is increasing and in South Africa it is estimated that in excess of 20 million people, mostly in rural and informal peri-urban and urban communities, do not receive acceptable waste management services,” NWMS 1999.*

The purpose of the Solid Waste Management is to ensure solid waste is managed in such a way that protects both public health and the environment. The Solid Waste Management Program are formulated in order to help the Kinondoni Municipal to manage better their solid wastes. Through the cooperative efforts of citizens, businesses, industry and government, Kinondoni Municipal can continue to increase material reuse and recycling from all solid waste sources. Reducing the amount of solid wastes generated remains the program's primary goal. Municipality households, businesses and industry generate millions of tons of solid waste annually. While landfill disposal continues to be an option, new disposal facilities face strong public examination and are costly to site, build and operate. Solid waste management permitting, monitoring and enforcement efforts can prevent illegal dumping and other factors that may cause long-term social, economic and

environmental problems.

Effective solid waste management is a cooperative effort involving state, regional, and local entities. For solid waste policy to be effective, inputs should come from stakeholders, including citizens, businesses, community based organizations, non governmental organizations, government agencies, universities, and other research organizations. These inputs form the basis of policy frameworks that influence solid waste management decisions.

Solid waste management challenges and issues that should be considered while framing solid waste policy include proper waste generation, segregation, collection, transportation, and disposal methods, landfill management, hazardous and other toxic material management, treatment, incineration, recycling and other technology standards, monitoring, evaluation, and continuous improvement methods. In addition to these issues, policy has to address the short term and long-term economic, environmental, and social costs and benefits, funding methods, and roles of various stakeholders. However poor waste management practices have been revealed from this study that is contributed by poor infrastructure, shortage of man power in community organization groups and waste management officers and financial constraints.



## **CHAPTER FIVE**

### **5.0 SUMMARY OF THE MAJOR FINDINGS, CONCLUSION AND RECOMMENDATIONS**

#### **5.1 Introduction**

This chapter presents a summary of findings, conclusion and recommendations of the study, as per research questions: What are the characteristics of solid waste generated in the study site? What are the methods of solid waste collection in Kinondoni Municipality? What are the transport techniques/systems of solid waste in the study area?

#### **5.2 Summary**

The overall objective of the study was assessment of solid waste management in Kinondoni Municipality. In carrying out this research study, the research process was guided by research objectives which were accompanied with questions; and the study was mainly quantitative with some elements of qualitative for description purposes. The sample comprised fifty (50) households from Kinondoni Municipality purposively Ubungo and Sinza ward, Health and Environmental Officers of Kinondoni Municipal and Ubungo and Sinza ward. Ward executive officers and mtaa readers were also involved in contributing their ideas on solid waste management in Kinondoni Municipality- Dar es salaam region.

Data were collected through questionnaires and field observation to obtain important information about solid waste management in the study area. Each item in the

questionnaire was developed to address specific objectives or research questions. Open/structured or closed ended questionnaires were formulated for the purpose of this study. Solid waste management was the major theme focused.

Also, secondary data were collected through documentary information collected and compiled by various researchers and stakeholders. Among others included, Dar es Salaam Metropolitan Development Projects, The study on the solid waste management for Dar es salaam City in the United Republic of Tanzania, Progressive report (2), Dar es Salaam city commission.

Both descriptive and inferential statistics were used for data analysis and SPSS, Chi-square was applied where deemed necessary. The findings showed/ indicated that high quantities of solid waste are generated from households, about 1618.8 tonnes per day, informal sector waste about 322.2 tonnes per day, market waste about 40.5 tonnes per day commercial waste about 30.4 tonnes per day, institutional waste about 12.1 tonnes per day and street wastes about 2 tonnes per day. These wastes are not separated into biodegradable and non biodegradable wastes using separate containers for re-use or recycling or making compost. Field observation revealed that there are an individual who collects plastic bottles for selling to recycling industrials. Proper collection and transportation of solid waste is not practised effectively and efficiently. Proper waste disposal was seldom practised in few planned areas but most of households dump their wastes in river canals, open space and near roads. There is a need to improve waste management systems in Kinondoni Municipal for health of the residents and protection to the environment to ensure sustainability.

### **5.3.1 Characteristics of Solid Waste generated in Kinondoni Municipality**

The findings indicate that high quantities of solid waste are generated from households, about 1618.8 tonnes per day, informal sector waste about 322.2 tonnes per day, market waste about 40.5 tonnes per day commercial waste about 30.4 tonnes per day, institutional waste about 12.1 tonnes per day and street wastes about 2 tonnes per day. The rate of waste generate increases with the population, since the wastes are not separated and the wastes that can be transported to disposal site is only about 41% and the remaining waste, i.e. 59% are not collected and transported to disposal site. This means that waste management in Kinondoni Municipal is not efficiency and effectively implemented, it is the responsibility of the Municipal and every citizen to ensure that waste generated are handled well and managed properly.

### **5.3.2 Identification of the methods of solid waste collection**

The findings revealed that there various methods of solid waste collection that are employed by the residents and the council of Kinondoni Municipal, these included; door to door solid waste collection, about 47% of the respondents had access to door to door solid waste collection, roadside solid waste collection methods, about 24% had access on this method. Communal Container system of solid waste collection about 18% of the respondents had access to it and curbside collection methods, only 11% had access to this method. The research study revealed that these methods are not implemented in efficiency and effective manner in the whole process of solid waste management system, but if these methods are used and implemented well in efficiency and effectively means that solid waste management in Kinondoni Municipal can be improved regardless of the increasing population.

### **5.3.3 Methods of solid waste transportation in Kinondoni Municipal**

The findings showed that few residence of the Kinondoni Municipality receives municipal services for collection and transportation of the waste to the final disposal. This means that most of the areas within the municipal does not receive services of transporting their wastes and so are left uncollected or thrown to roadside or rivers.

### **5.4 Conclusion**

The overall assessment of solid waste management in Kinondoni municipal reveals that solid waste management in kinondoni municipality is poor. Since waste generated is in high quantity as compared to the amount collected and transferred to disposal site. Insufficient methods of solid waste collection system, methods of solid waste transportation in kinondoni municipal are not improved and there is little access to municipal vehicle for solid waste transfer and transportation to the final disposal. The purpose of the Proper Solid Waste Management is to ensure solid waste is managed in such a way that protects both public health and the environment. For efficiency and effective solid waste management a cooperative effort involving all stakeholders, including citizens, businesses, community based organizations, nongovernmental organizations, government agencies, universities, and other research organizations is un avoidable.

These inputs from stakeholders form the basis of policy frameworks that influence solid waste management decisions

### **5.5 Recommendations**

- (i) For proper solid waste management practises in Kinondoni Municipality,

(ii) waste generated must be segregated/ sorted for recycling and re use purposes.

Biodegradable waste can be used to make compost, non biodegradable waste are the only waste that can transported to the final disposal site.

(iii) Methods of solid waste collection should be improved; door to door solid waste collection which is done by community based organization unplanned areas should be emphasized by the Municipal authority, households must pay for the solid waste collectors at a time. Municipal vehicles should be available at required regular interval to ensure roadside collection of solid waste. More communal containers or bins should be placed in many areas/places of the municipal for solid waste collection and must be emptied on time to ensure the city is clean. Curbside collection should be encouraged in all planned areas and the municipal has to hire more vehicles.

(iv) Both private sector and the municipal authorities must improve their methods of solid waste transportation by allocating or buying more vehicles for transportation of solid waste. This will ensure more collection and transportation of the waste generated.

(v) The Municipal Council should formulate a long-term and comprehensive solid waste management programs that would encourage and motivate the public to give their support.

(vi) Massive information dissemination campaign on solid waste management should be conducted to promote public awareness and change the culture of throwing the waste every place

## REFERENCES

- Ackerman, F. (1997). 'Why Do We Recycle? ', Washington D.C, Island Press.
- Akolkar, A.B. (2005). Status of Solid Waste Management in India, Implementation Status of Municipal Solid Waste, Management and Handling Rules 2000, Central Pollution Control Board, New Delhi.
- Alam, R; Chowdhury, M; Hassan, G; Karanjit, B & Shrestha, L. (2008). Generation, Storage, collection and transportation of municipal solid waste- A case study in the city of Kathmandu, Capital of Nepal. *Waste Management*. Vol 28, pp. 1088-1097.
- Anderson, R & Richard, D. (1977). 'Tax Policy and Secondary Material Use', *Journal of Environmental Economics and Management*, 4, 68-82.
- Bartone, C; Bernstein, J & Wright, F. (1990). 'Investments in Solid Waste Management: Opportunities for Environmental Improvement', Policy Research and External Affairs Working Paper No. 405, The World Bank, Washington D.C.
- Breeze, R. (2012). "Municipal solid waste management in dar es salaam, draft baseline analysis", The World Bank Washington, DC. Toronto- Canada.
- Buclet, N & Olivier, G. (2000). 'Municipal Solid Waste Management in Europe: A Comparison of National Regimes' in Nicholas Buclet, and Olivier Goddard (ed). *Municipal Solid Waste Management in Europe: A Comparative Case Study in Building Regimes*', Kluwer Academic Publishers, Netherlands, 203-224.
- Cointreau, L & Sandra, J. (1983). 'Environmental Management of Urban Solid Waste in Developing Countries: A project guide; Urban Development Technical

Paper Number 5, The World Bank, Washington D.C, USA.

Cointreau, L & Sandra, J. (1994). 'Private Sector participation in Municipal Solid Waste Services in Developing Countries', in Volume 1 of the Formal Sector, Washington DC; World Bank.

Cunningham, W.P (2006). Principle of Environmental Science: Inquiry and Application, McGraw Hill.

Department of Environmental Affairs (DEA). (2014, March 12) Solid waste Management. Retrieved from Department of Environmental Affairs website: <http://www.environment.gov.za>

Deweese, D. N. (1998). 'Comment on Palmer, Sigman and Walls: The Cost of Reducing Municipal Solid Waste', Working Paper; University of Toronto.

Dobbs, I. M. (1991). 'Litter and Waste Management: Disposal Taxes versus User Charges,' *Canadian Journal of Economics*, 24(1), 221-27.

Holmes, J.R. Ed, (1984). Managing Solid Waste in Developing Countries. John Wiley.

Ishengoma, A. (2000). Solid Waste Management in Promoting Environmentally Sustainable Urban Development in Dar es Salaam City. Work from Solid Waste. Women Paid as Managers Paper presented at the International Conference on Environmental and Social Perspectives for Sustainable Development in Africa, Arusha, Tanzania.

Japan International Cooperation Agency (JICA) (1996). "The Study on the Solid Waste Management for Dar es Salaam City in the United Republic of Tanzania, Dar es Salaam:" Progress Report (2), Dar es Salaam City Commission.



- JICA, (2004). Feasibility Study of solid waste management in Kathmandu metropolitan city. Japan International Cooperation Agency.
- Kaare, S. K. (1998). "Public Policy Performance in Developing Countries: Urban Housing Policy with Special Reference to the National Sites and Services and Squatter Upgrading in Tanzania," A Thesis submitted for the degree of Doctor of Philosophy of the University of Canberra.
- Karanja, A. (2005). Solid Waste Management in Nairobi. Actors, Institutional Arrangements and Contributions to Sustainable Development. Institute of Social Studies, The Netherlands, PhD Thesis.
- Karanjit, B., Shrestha, L. (2005). Solid waste management of Kathmandu metropolitan city. BSc Engineering thesis, Civil and Environmental Engineering Department, Shah Jadal University of Science and technology, Sylhet, Bangladesh.
- Kaseva, M. E., & Mbuligwe, S. E. (2005). Appraisal of Solid Waste Collection Following Private Sector Involvement in Dar es Salaam City, Tanzania. *Habitat International*, 29(2), 353-366.
- Kassim, S., & Ali, M. (2006). Solid waste collection by Private Sector: Households' Perspective - Findings from a study in Dar es Salaam city, Tanzania. *Habitat International*, 30, 769-780.
- Kirango, S. (2000). "Senior Health Environmental Management Officer Dar es Salaam City Commission," Discussion held on Privatization of Refuse Collection by the Dar es Salaam City Commission.
- Kironde, J. M. L (1995). "The Governance of Waste Management in Africa Cities: The case of Dar es Salaam," Dar es Salaam:, Ardhi Institute.

- Kizito, N. (1999). Health Environmental Officer in the Solid and Liquid Waste and Pollution Control Unit, Dar es Salaam City Commission ‘Discussions held between Mr. Kizito and the Principal Researcher.
- Kombe, W. (1997). “Participatory Environmental Planning and Management: Is SDP Making It?” in Kombe W and V. Kreibich, *Decentralised Development and Prospects for Planning in Africa*, N.P., University of Dortmund, 1997.
- Kumar, S. & Gaikwad, S.A. (2004). “Municipal Solid Waste Management in Indian Urban Centres: An Approach for Betterment”, *Urban Development Debates in the New Millennium*, Edited by K.R. Gupta, Atlantic Publishers & Distributors, New Delhi, pp. 100-111, 2004.
- Majani, B (2000). Institutionalizing Environmental Planning and Management in Dar es Salaam: A global Success Story and Learning Experience. *Journal of Building and Land Development* Vol. 9.No 1.67-72.
- Majani, B. (2002). Environmental Planning and Management in Dar es Salaam.
- Mgana, S. (1996). Research on solid waste management in Dar es Salaam, the Dar es Salaam solid waste stakeholders.
- National Bureau of Statistics (2012). United Republic Of Tanzania, Population and Housing Census- Population distribution by administrative areas.
- Pfeffer, J.T. (1992). *Solid waste Management Engineering*. Prentice Hall. Series, Second Edition.
- Tchobanoglous, G., Thiesen, H. & Vigil, S. (1993). “Integrated Solid waste Management: Engineering Principles and Management Issues”. McGraw Hill.
- Teerioja, N; Moliis, K; Kuvaja, E; Ollikainen, M; Punkkinen, H and Merta, E. (2012). Pneumatic vs. door -to- door waste collection systems in existing urban areas:

a comparison of economic performance. *Waste Management*. Vol 32, pp. 1782-1791.

United States Environmental Protection Agency (2014, March 12) Solid Waste Management: A Local Challenge with Global Impacts. Retrieved from Environmental Protection Agency website: <http://www.epa.gov>.

## APPENDICES

### Appendix 1: Appendix B: Questionnaire

#### ASSESSMENT OF SOLID WASTE MANAGEMENT IN KINONDONI MUNICIPALITY

Dear Sir/Madam,

I am Nelson Boniface Mnyanyi, a student of the Open University of Tanzania pursuing Master of Science in Environmental Science. Currently I am doing my research in assessment of solid Waste management in Kinondoni municipality-Dar es salaam city.

This Questionnaire is prepared for an academic purpose for the fulfillment of MSC degree in Environmental Science. Specifically the objective of the study is to characterize solid waste generated in Kinondoni Municipality, Analyze the methods of solid waste collection in the study area and to examine the methods of solid waste transportation in Kinondoni Municipal Therefore, your response is very important for the success of the study because all information that you provide determines the analysis and conclusion of the research. Hence, you are kindly requested to give your response by selecting (circling) your answer from the given alternative choice or describing your opinion. Please be informed that your response is kept in confidential and you are not required to write your name. I would like to thank you for your cooperation.

#### Part one: Back ground information about the respondents

1. Sex: Male ( ) Female ( )
2. Age
  - A. 5-20 Years ( ) , B. 21-40 Years ( ) , C. 41-60 Years ( ) , D.61-80 Years ( )
3. Education:
  - A. Primary Education ( )
  - B. Secondary Education ( )
  - C. Tertiary Education ( )
  - D. University Education ( )

#### Part two: Waste segregation and reduction

1. i) Do you segregate the wastes that come from your premise/house? (If yes , go to question 2)

Yes		No	
-----	--	----	--

ii) What are the reasons for not segregating your solid waste?

.....  
.....

iii) In your own opinion, how can the culture of segregating solid waste at source level are mainstreamed in the solid waste management system in Kinondoni Municipality?

.....  
.....

2. i) Do you experience any challenge(s) in segregating the solid waste that come from your promises/house?

Yes		No	
-----	--	----	--

ii) If yes, what is/are the challenge(s)?

.....  
.....

iii) In your own opinion, how can the challenge(s) identified in ii above be dealt with?

.....  
.....  
.....

3. i) Do you have a mechanism in place to help reduce the amount of solid waste generated by your premise/house at production or consumption level? (If no, go to ii))

Yes		No	
-----	--	----	--

ii) If yes, what is/are the mechanism(s)

.....  
.....

iii) How effective is/are the mechanism(s)

.....  
.....

iii) Do you have any reasons for not having such a mechanism in place?

.....  
 .....  
 4. Which of the following item do you separate/segregate for selling? (*Possible to select more than one*)

A. Metals B. Plastics C. Glass, Bottles, Can etc. D. Organic wastes E. Electronic waste F. Textile and old shoes G. If others please specify it.....

5. For what purpose do you separately store ( *Possible to select more than one*)?

A.Using as fertilizer B. Giving to other users C. To use as a fuel D. To use as feeding animals  
 E. If others please specify it.....

6. Do you know the idea of solid waste recycling and reusing?

Yes		No	
-----	--	----	--

7. If your answer for question number **6 above is 'yes'**, do you recycle or reuse solid waste generated from your house?

Yes		No	
-----	--	----	--

8. If your answer for question **number 7 above is 'yes'**, what type of materials do you reuse or recycle (possible to select more than one)

A.Used paper B.Used glasses, bottles and glass materials C. Used metallic materials  
 D.Used plastic and plastic materials E. If others please specify.....

9. Do you know that compost can be prepared from solid waste?

Yes		No	
-----	--	----	--

10. If your answer for question **number 9 above is 'yes'**, do you prepare compost from solid waste produced at your house/premises?

Yes		No	
-----	--	----	--

### **Part Three: Storage, Collection and Transportation of solid waste**

1. a) Do you store the solid waste that is generated from within your premises/house?

Yes		No	
-----	--	----	--

b) Where do you store the solid waste that is generated from within your premises/house?

- A. Sack B. Basket C. Metal Container D. Plastic Container E. Private pit F. If others please specify  
it.....

*Note: You can tick more than one response*

2. What is the duration for which the waste is stored?

- A. 1-5 days  
B. 6-10 days  
C. 11-15 days  
D. Others, please specify-----

3. (a) Is the stored solid waste collected? (If no, go to b))

Yes		No	
-----	--	----	--

- (i) Who collects the waste?.....  
(ii) How often is the waste collected.....

iii). How would you rate the services provided by the waste collectors?

Rating	Tick where appropriate
Very Good	
Good	
Bad	
Very Bad	

b) What are the reason(s) why the stored solid wastes are not collected?  
.....

4. Which mode is used in waste collection? *Tick appropriate answer, you can tick more than one response/alternatives*

- A. Roadside collection  
B. Door to door collection  
C. Communal Container collection  
D. Block collection system  
E. Curbside collection by garbage truck

5. Which equipment's are commonly used in waste collection? *Tick where appropriate, you can tick more than one response*

	By hand	
--	---------	--

Primary collection	Handcart	
	Tricycle	
Direct collection	Tricycle	
	Tractor	
	Open truck	
Secondary collection	Tractor	
	Open truck	
	Container carrier	

6. Do you have access to door to door solid waste collection service delivered from the Municipality solid waste collection vehicle?

Yes		No	
-----	--	----	--

7. If your answer for question no 5 is 'yes', in how many days interval you get this service?

A. 1-3 days ( ), B. 4-7 days ( ), C. 8-15 days ( ), D. 16-30 days ( ), E. above 30 days ( ) F. as available ( ).

8. Do you use Municipal vehicles for door to door solid waste collection from your residence?

A. Yes ( ), B. No ( ).

9. Do you use informal sectors such as daily workers, laborers, etc. for door to door solid waste collection from your residence?

A. Yes ( ) B. No ( )

10. Apart from the above bodies i.e. municipal and/or city what are other means you frequently use to dispose the solid waste of your household?

A. at the road sides and open fields ( )

B. dumping in bridges ( )

C. burry inside my compound ( )

D. simply dispose in my compound ( )

E. dumping in river side's and gullies ( )

F. burn in my compound ( )

G. if other please specify \_\_\_\_\_

11. Do you have solid waste collection points in your area?

A. Yes ( ), B. No ( )

12. If your answer for question no 10 is 'yes' how many times..... per month these waste are collected by the municipal vehicles

A. 1-4 times ( ). B. 5- 8 times ( ), C. 9-13 times ( ), D. 14-17 times ( ) E. 18-21 times ( ).

13. Do you need the hauled containers to be placed in your surrounding?

A. Yes ( ), B. No ( )



14. If your answer for question no 20 is 'yes' is it possible to have a place for the containers to be placed in your surroundings or near places. A. Yes ( ), B. No ( ), C. Others .....

15. Do you know any organization/private sector that deals with waste collection in your premises/house?

Yes		No	
-----	--	----	--

16. If your answer for question number 15 above is yes, mention these organization/private sectors

.....  
 .....

17. Does solid waste management service in your area is a burning issue as it compared with other service like road service, water supply etc.

A. yes ( ), B. no ( ), C. if other please specify it.....

18. Have you ever obtained training, education or information about solid waste management, and environmental and other problems created due to carelessly thrown solid waste?

A. yes ( ) B. no ( ). C. If others please specify it.....

19. Would you be interested to learn more about solid waste management, environmental impact of waste and different methods of minimizing and treating the waste?

Yes		No	
-----	--	----	--

20. If so, what would be your favored methods of increasing your knowledge?

A. Open seminars B. Brochures distributed to residents C. Solid waste management campaign

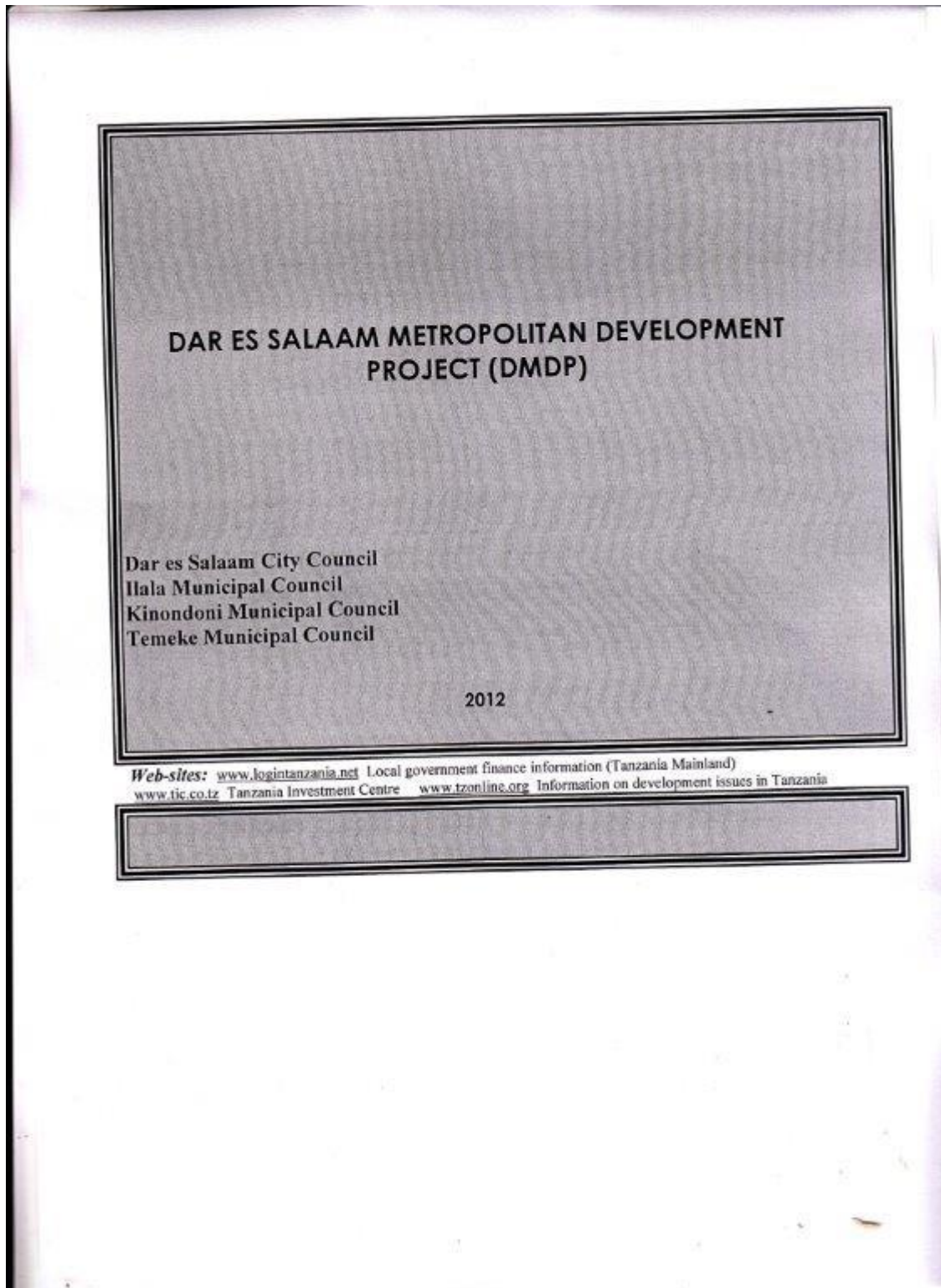
D. Door to door education. E. If others please specify it.....

21. Comment on the status of the solid waste storage, collection and transportation system

within Dar es salaam City.

.....

**Appendix 2: Dar es Salaam Metropolitan Development Project (DMDP)**



**Appendix 3: Draft Baseline Analysis**

**MUNICIPAL SOLID WASTE MANAGEMENT  
IN DAR ES SALAAM**

**DRAFT BASELINE ANALYSIS**

Prepared for the

The World Bank  
Washington, DC

Prepared by

Robert Breeze  
Toronto, ON, Canada

**October 2012**

*This is an abridged version of a report prepared by Robert Breeze, a consultant engaged by the World Bank. The statements, findings, interpretations, and conclusions expressed in this document are those of the author, and do not necessarily reflect the views of the World Bank.*

## Appendix 4: Research Clearance

THE OPEN UNIVERSITY OF TANZANIA  
DIRECTORATE OF RESEARCH, PUBLICATIONS, AND POSTGRADUATE STUDIES

P.O. Box 23409 Dar es Salaam, Tanzania,  
Fax: 255-22-2668759  
<http://www.o.u.tz>



Tel: 255-22-2666752/2668445 ext.2101  
Fax: 255-22-2668759  
E-mail: [drc@ou.tz](mailto:drc@ou.tz)

18/03/2014

To whom it may Concern

**RE: RESEARCH CLEARANCE**

The Open University of Tanzania was established by an act of Parliament no. 17 of 1992. The act became operational on the 1<sup>st</sup> March 1993 by public notice No. 55 in the official Gazette. Act number 7 of 1992 has now been replaced by the Open University of Tanzania charter which is in line with the university act of 2005. The charter became operational on 1<sup>st</sup> January 2007. One of the mission objectives of the university is to generate and apply knowledge through research. For this reason the staffs and students undertake research activities from time to time.

To facilitate the research function, the vice chancellor of the Open University of Tanzania was empowered to issue research clearance to both staffs and students of the university on behalf of the government of Tanzania and the Tanzania Commission of Science and Technology.

The purpose of this letter is to introduce to you **Mr Nelson Boniface Mnyanyi Reg. No. HD/S/044/T.13** is a Master's student at the Open University of Tanzania. By this letter **Nelson Boniface Mnyanyi** has been granted clearance to conduct research in the country. The title of his research is "**Assessment of Solid Waste Management in Kinondoni Municipality**". The research will be conducted in Dar es Salaam region.

The period which this permission has been granted is from 24<sup>th</sup> March, 2014 to 24<sup>th</sup> June, 2014.

In case you need any further information, please contact:  
The Deputy Vice Chancellor (Academic)  
The Open University of Tanzania  
P.O. Box 23409  
Dar es Salaam  
Tel: 022-2-2668820

We thank you in advance for your cooperation and facilitation of this research activity.  
Yours sincerely,

Prof Shaban Mbogo

For: VICE CHANCELLOR

THE OPEN UNIVERSITY OF TANZANIA

**Appendix 5: Research Permit**

**KINONDONI MUNICIPAL COUNCIL**

ALL CORRESPONDENCES TO BE ADDRESSED TO THE MUNICIPAL DIRECTOR

Tel: 2170173  
Fax: 2172606



MUNICIPAL DIRECTOR  
KINONDONI MUNICIPAL COUNCIL  
P. O. BOX 31902  
DAR ES SALAAM

In reply please quote:

Ref. KMC/R.18/1

Date 24/04/2014

Mr. Nelson Boniface Mnyanyi,  
The Open University of Tanzania,  
P. O. Box 23409,  
**DAR ES SALAAM.**

RE: **RESEARCH PERMIT**

Refer to the above heading.

I am pleased to inform you that your above request has been considered by the Municipal Director, and has offered you a place to research from **24<sup>th</sup> March, 2014** to **24<sup>th</sup> June, 2014**.

Upon receipt of this letter, please report to the **Municipal Medical Officer of Health** and **Ward Executive Officer – Ubungo & Sinza** from commencement of your research.

Hoping to see you soon.

.....  
A. B. Tutuba  
For: **THE MUNICIPAL DIRECTOR**  
**KINONDONI**

For: MUNICIPAL DIRECTOR  
KINONDONI MUNICIPAL COUNCIL  
DAR-ES-SALAAM

Copy:

For: Head of Dept. – *Environmental Studies*  
~~Sociology and Social Work~~,  
The Open University of Tanzania,  
P. O. Box 23409,  
**DAR ES SALAAM.**

*AgHIMS-Reseach Co*  
*Assist him accordingly*  
*Attended*  
*Environment Health Officer*  
*scrib him accord*