UNIVERSITY OF DAR ES SALAAM

UNIVERSITY OF DAR ES SALAAM INNOVATION AND ENTREPRENEURSHIP CENTRE (UDIEC)

ASSESSMENT OF CHALLENGES ASSOCIATED WITH SOLID WASTE DISPOSAL MANAGEMENT AND PROPOSED SOLUTIONS

A CASE OF UBUNGO MUNICIPAL COUNCIL, DAR ES SALAAM

Participants

Name		Study Programme
Kusiluka Aginiwe Justice		Business Administration
Zacharia Lotary		Business Administration
Kisanga Jackline R		Bcom in Marketing
Vedasto Neema T		Molecular Biology & Biotechnology
John Raphael		Electrical Engineering
Tossi Godfrey Anakleth		Bachelor in Law
Josephat Makoba		Mechanical Engineering
Monica Mbepera		Bcom in Finance

December, 2020

ABSTRACT

Today urbanization is one of the major factors contributing to solid waste generation in most part of the world (Kumar and Pandey, 2019). Ubungo Municipality is estimated to generate about 828 tons of waste per day, which makes 302,001 tons per year. Semi structured interviews, observation and secondary data were used as tools to understand the challenges in detail. The current waste collection system is undermined by several challenges including the distance to the dumpsite, Shortage of proper vehicles for waste collection, waste haulage and dumping of solid waste. Various successful models of waste collection and recycling were studied, and the best models and solutions for the largest composition of waste, and the organic waste were identified and adapted accordingly.

ACKNOWLEDGEMENT

Table of Contents

CHAPTER ONE

INTRODUCTION

1.1 Introduction

The study is about the assessment of challenges associated with solid waste disposal management and proposed solutions. This chapter presents the background information to the study and the problem statement. It also highlights on the research objectives, significance of the study and finally it presents the organization of the study report.

1.2 Background of the study

The generation of waste and the collection, processing, transport and disposal of waste—the process of 'waste management'—is important for both the health of the public and ornamental and environmental reasons (Rushton,2003). Increasing population level, rapid urbanization, and growth of business operations has greatly accelerated the municipal solid waste generation rate in developing countries (Minghua et.al. 2009).

Today urbanization is one of the major factors contributing to solid waste generation in most part of the world (Kumar and Pandey, 2019). In Africa, waste is unsightly and lowers the morale of communities. Improper waste management is known to create conditions for the spread of diseases (World Bank, 2011). The collection of solid waste is a key step in all waste management plan. It is one of the greatest challenges confronting waste managers globally (Odonkor et al., 2020).

Monella and Lerayo argue that Mushrooming of unplanned suburbs (slums and squatters) in towns and cities has further worsened the challenges of solid wastes management. In Tanzania, for instance, low and irregular earnings in the informal sectors in urban areas has forced urban dwellers, especially youths with their families, to live in unplanned suburbs with low and poor standards of living; unable to pay for basic services including proper wastes management. This is a serious problem because studies have shown that more than 70% of city dwellers in Tanzania live in informal and unplanned settlements with very poor access to basic social services, including poor solid wastes management systems.

1.3 Ubungo Municipal

Ubungo Municipality is estimated to generate about 828 tonnes of waste per day, (which gives 302,220 tonnes per year). Solid waste collection in Ubungo Municipality is carried out by the Municipal Council, some private companies, community based organizations and informal sectors. There is deficiency in waste collection system in Ubungo Municipality as the municipal faces the following challenges:

(i) Very large distance coverage to the dumpsite,

(ii) Rapid increased in solid waste daily,

(iii) Poor infrastructure to access the collection points in the streets,

(iv) Household's unwillingness to pay collection fee,

(v) Lack of efficient tools,

(vi) Insufficient funds,

(vii)   Improper management of waste at the dumping site and

(viii)   Lack of proper waste treatment system.

The purpose of this study is to find ways and methods to reduce the challenges associated with solid waste management in Ubungo Municipal Council.
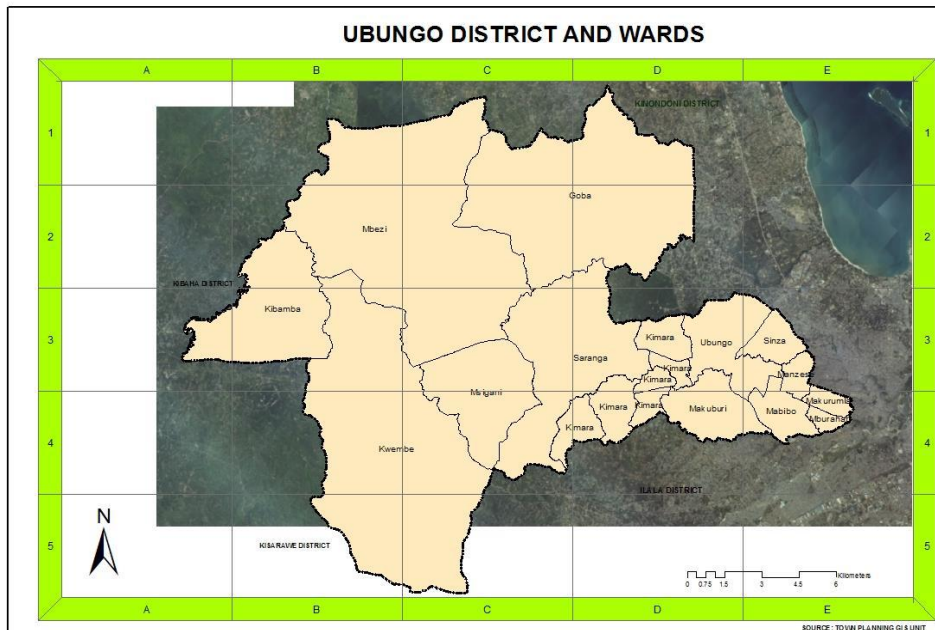

Fig 1: A map of Ubungo District and Administrative WardsSource: Ubungo Municipal Profile 2016

1.4 Statement of the Problem

Solid waste management is a challenge for the cities authorities in developing countries mainly due to the increasing generation of waste, the burden imposed on the municipal budget as a result of the high costs associated with its management, the lack of understanding over a diversity of factors that affect the different stages of waste management and the linkages necessary to enable the entire handling system function.

Solid waste management in Ubungo Municipality is carried out by both the Municipal Council, some private companies, community based organizations and informal sectors (Council, 2016). A research of challenges associated with solid waste management will enable the municipality to understand where exactly the problem is and how to manage the challenges. The strategies on assessing challenges associated to solid waste management provide road on achieving sustainable Solid Waste Management (Ubungo Municipal environmental officer, 2020).

In Ubungo Municipal Council, as one of the large city authorities in a developing country, faces challenges associated with solid waste management. Most of the studies have not successfully addressed solid waste management challenges and have resulted into inefficiency of the present policies on solid waste handling. However, there are some studies which successfully addressed some of the challenges like households willingness to pay. Such studies include the study by Mbuya, 2008 on solid waste management in Dar es Salaam, and other studies carried out of Dar es salaam city but useful as far as waste management concern, this includes The study of Emma Lunojo (2016) on household willingness to pay for waste collection in Njombe town council. Most of the studies in Dar es Salaam failed to address the issue of challenges associated with waste management and come up with the better solution. Therefore, this study plan to assess the challenges associated with solid waste management and propose sustainable solutions.

1.5 Research Objectives

Main Objective

The general objective of this research is to improve the solid waste disposal management by assessing the challenges associated with the existing system and propose solutions to Ubungo Municipality.

Specific Objectives

    i.   To assess the challenges that lead to poor solid waste management in Ubungo.

    ii.   To determine opportunities that can lead to good solid waste management in Ubungo.

    iii.   To determine ways that can increase efficiency in solid waste management in Ubungo.

1.6 Significance of the Research

The study will primarily help the Ubungo Municipality finding solutions and ways to reduce waste in the municipal. The findings of this study will add more knowledge and information about the challenges associated with solid waste disposal management in the municipal. Furthermore, it shall uncover solutions that can lead to better management of solid waste and opportunities to generate revenue out of it.

Moreover, the findings of this study shall add more knowledge in the academic arena about challenges associated with poor solid waste management and the solutions that will be proposed in this study. The study may draw special attention to those academicians who may get interested to do further study on the same subject area.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter discusses on several literature studies done by other researchers and researchers' views on the following areas; unwillingness to pay for garbage collection posed by waste producers, improper household waste/garbage disposal, lack of proper waste collection system.

2.2 Unwillingness to Pay for Garbage Collection

According to Samson Elisha Kasala (2014) in Keko Machungwa research, survey results showed that 63% of the respondents have the perception that solid waste collection is the responsibility of the Government. In addition, the study revealed that local community is more willing to pay

for other public services like electricity and water unlike solid waste collection. For successful solid waste management, a positive perception of a service being rendered and willingness of the service users are important parameters to consider.

Mbuya (2008) in a study on solid waste management in Dar es Salaam found that waste collection contractors operate inefficiently because the communities are not paying their charges for solid waste collection due to inability and lack of willingness among city residents to pay for solid waste management (SWM). This is because of having many service-demands such as water, energy, transport, education and health care to pay for. With that long list of charged services, paying for solid waste collection is not the main concern. Therefore, lack of willingness among city residents to pay for solid waste collection leads to the failure on the part of solid waste contractors to perform their duties to the required standard. Because they fail to pay for operational costs in terms of labor, fuel, vehicle repair and maintenance.

Emma Lunojo (2016) in examining respondent's willingness to pay for improved solid waste management services at Njombe Municipal Council, the result showed that 77.3% of respondents were willing to pay for improved solid waste management while 22.7% were unwilling to pay for improved solid waste management services. The major reason for respondent's unwillingness to pay was solid waste management system being not in place/lack of information about solid waste management system (54.7%), not satisfied with the current services (29%) and belief that the general taxes should cover the cost of the service (24.2%).

As for this study from the information we obtained from the Ubungo municipal environmental officers through official interviews, they said the household's unwillingness to pay is because of the poor services received from the waste contractors. The households are willing to pay if the collection services are of good quality. The statements from Ubungo officials supported by previous studies and researcher's observation can lead to say if the systems of collection are made easy, frequent and effective, the households shall pay for the waste collection services.

2.3 Lack of proper waste collection system.

Several studies showed that collection, storage, transportation and final disposal of solid wastes are a major problem in urban cities and areas. Cities in East and North Africa as well as most developing countries are also facing the same serious problems related to Solid waste generation. The main reason of these problems is attributed to the poor economy of these areas which

accounts for the low achievement in solid waste management. Most of these developing countries fail the in solid waste management and issue due to the limited available resources and the competing priorities over their resources. (Abdel-shafy & Mansour, 2018)

Socio-cultural, economic, legal, political and environmental factors as well as the available resources are the main issues that affect the municipal solid waste management in all countries. That is why adoption of any new technology for municipal solid waste management and sold waste generation should take into account the effect and the influence on the socio-cultural and the economy of the community. (Abdel-shafy & Mansour, 2018)

According to A. Oketola (2018) Municipal solid waste in developing countries is commonly collected through labor-intensive systems, sometimes using hand or animal drawn carts. The waste discharged for collection seldom is stored in a plastic or metal container and covered with a lid. More typically, the waste is placed on the ground directly, thus requiring being shoveled by hand; or it is left in an open carton or basket to be picked up by hand. In either case, the waste awaiting collection is readily available to insect and rodent vectors and scavenging animals. Collection workers in developing countries have significantly more direct contact with solid waste than their counterparts in high-income countries, who predominantly handle sealed plastic bags and covered dustbins.(Oketola, 2018)

Mhache argued that specific challenges facing solid waste management include: Poor practice or inappropriate alternative waste management methods. There are no proper and well-known methods of collecting, disposing and treating waste in most urban areas. The lack of sites designated for carrying out waste activities such as collection points, transfer stations and sanitary landfills.

Currently, solid waste collection in Ubungo Municipality is carried out by both the Municipal Council, some private companies, community based organizations and informal sectors. The system is undermined by several challenges including the distance to the dumpsite, shortage of proper vehicles for waste collection, waste haulage and dumping of solid waste. Most of the cars used in waste collection are in very bad state of repairs mostly due to lack of funds, they break down several times on the way to the dump site. Furthermore, when such vehicles break down, they can stay in one area for number of days. The dumpsite at Pugu Kinyamwezi, 30km from city center, is the only current final dumpsite for solid waste in Dar es Salaam city. The dump

started operation in 2009 to date after the closure of previous dumps, which due to poor management had led to discomfort to people residing near the dumps.

2.4 Improper household waste/garbage disposal

Monella and Leyaro argued that when all kinds of wastes are mixed up in a single storage facility without separation in the first place, and then transferred to designate areas for disposal, it then becomes very difficult to recover them for reduce, reuse and recycle. As households are the main generators of wastes, contributing to over 50% of the total collected wastes in Dar es Salaam, the key question this study is to examine what determines and influences households' willingness to participate in wastes separation for reduce, reuse and recycle. Thus understanding households' behavioral factors (and determinants) that influence their involvement in solid wastes separation for reduce, reuse and recycle are important first in implementing the 3Rs imitative approach as well towards both reducing the austerity of poor wastes disposal and tapping the many benefits of wastes management.

They continue to explain that there are different waste storage practices, with the more affluent households using big dustbins containers; while sacks, plastic bags, cut jerry cans and cardboard boxes are mainly used by the less affluent ones. There is no sorting as such, but household's separate components of wastes considered of value – example, plastics, food leftovers, plastic bags, bottles, plastic tins and scrap metals—the rest of waste is usually stored mixed. Waste separation also takes place at transfer stations where pickers search for materials worthy for resell. The rest is moved on transit to landfill or dump sites where sorting is also done.

In Ubungo Municipality, waste is collected by private contractors who enter contracts with local government authorities to collect waste. When the contractors do not do effective work in waste collection and waste is piled in households, people dispose waste on rivers, roads, streets, and so on. The reason for ineffectiveness include lateness of the responsible waste collectors to reach the point of collection, which in turn people who are not responsible for the collection take charges of removing waste from one points and dump to the other improper places. These people take waste from streets they collect dumping to another informal place for waste dumping such as rivers or streets when no one is looking at late nights.

2.5 Research Gap Identified

From the above empirical literature review it is evident that in previous researches referred above, there was no consideration of real methods to combat the types of waste produced by households. It is on the basis of these gaps that this research is conducted to try to explore. The study aim to add some information based on assessment of challenges associated with solid waste disposal management and propose innovative solutions that can alleviate the challenges. The information was collected from different areas of Dar es Salaam and Bagamoyo.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction.

This chapter presents research methodology and procedure which the researcher used to carry out this study.

3.2 Research Methodology

The research methodology shows the way the research was designed and conducted, the sampling procedures and where the study was conducted. It will also show variables used and data collection instruments

3.3 Research Design

The study employed qualitative methods during data collection. Since this study was researching on assessment of challenges associated with solid waste disposal management and proposed solutions, a qualitative approach was used as it was an appropriate method to conduct exploratory research due to the fact that perceptions, beliefs, ideas and opinions are difficult to measure in a quantitative way.

As for primary data, the researchers relied on semi-structured interviews and observation. For secondary data, the researcher used variety of books, journals and websites relevant to the study.

3.4 Area of the Study

The chosen area for the study was Dar es Salaam and Bagamoyo. The selected participants were targeted specifically due to particular functions they did in recycling or dealing with waste. The researcher firmly believed the choice of the area helped in meeting the main and ultimately the specific objectives of the study.

3.4 Research Participants

The research participants included in this research included Mabibo food market, Zaidi recyclers, Baobab Schools for biogas and Guavay Company Limited. They were interviewed with semi structured interviews on the process they use to collect and recycle waste. Their opinion about the proper waste disposal method was taken into consideration.

3.5 Data Collection Methods

3.5.1 Primary Data Collection

Semi structured interviews were used to extract data from respondents i.e. Municipal environmental officers and other government officials and business owners. Also, the researchers used observation method in collection of particular data.

3.5.2 Secondary Data Collection

The researcher also employed secondary data collection techniques. The researchers spent time revising various documents, published reports, books, journals, websites, brochures and other papers relevant to the research topic.

3.7 Data Analysis Methods

3.7.1 Qualitative Method

Qualitative techniques involved logical statement to analyze the data to be collected on semi-structured-interviews and documentation in the study. In this research study theoretical framework, developed through the assessment of the literature review was used as the guiding tool of the qualitative analysis.

3.8 Ethical Issues

This study complied with research code of ethics. Consent was obtained before getting any respondent participates in the study. The researcher did not use any undue influence to convince people to participate in the study. In case of any recording done, the permission was asked from respondents.

CHAPTER FOUR
FIELD STUDY RESEARCH FINDINGS

4.1 Introduction

The study was carried out in Mabibo Food Market where the challenge of waste management is at large, Kipawa where they recycle paper waste, Baobab High School where they recycle organic waste by producing biogas, and Guavay Company limited located at Gongo la Mboto where they are recycling waste by producing organic fertilizers. This chapter provides what was observed and obtained from those areas.

4.2 Mabibo food market

The Market is under the Ubungo Municipal council divided into various department; department of onions and potatoes, department of vegetables, and department of tomatoes. The market received food products from different regions in Tanzania such as tomatoes, beetroots, cabbages, oranges, pineapples, passions, banana, avocado, potatoes, watermelons, ginger, carrots and other vegetables. The activities on the market result into the high production of solid waste as the market produces 18 tons of waste per day, which in turn poses challenges to the municipal on how to manage the waste so as to keep the market place clean and to protect market user from health problems.

The Municipal Council collects waste within the market and temporarily store the waste in two dumping area within the markets before they transport the waste to the dumping site at Pugu. 17 men are employed to collect waste around the market and take them to the dumping area within the market. Challenges on the whole process include businessmen and women who do not pay fee for the waste collection so funds come from the municipality. The men employed to collect

waste and security guards also take waste from outsiders on private arrangements. Further, the equipment used to collect waste is not enough, while the large distance to the dumping site at Pugu causes the trucks to take up to six hours for just one trip. During the rainy season, the challenges on managing waste in the market increase considerably.

4.3 Zaidi Recyclers, Kipawa

The company deals with paper waste recycling. Out of four stages of paper waste recycling Zaidi Recyclers perform three stages which is collection, packaging and transportation. However, they don't undertake final product creation. After the three stages, the company sends the product to another industry such as Mufindi Paper and Tanpack Tissue for further recycling. The company deals with four types of waste paper which are Brown paper, BBC, Card and newspaper. In Tanzania, we can only recycle fully only the brown paper while other types are exported to countries like India where they can be fully recovered. The main mission of Zaidi recyclers is to use waste to create employment. It achieves this through the value chain they have created so as to obtain the waste paper. Zaidi recyclers buy paper waste from their agents who buy from youth who collect in the streets and offices. Some of the agents are under Zaidi while others are independent agents. They buy one kilo of brown paper for TZS 100/= and white papers for TZS 250/=. The big advantage of recycling waste is because one roll of brown paper recycled saves four to six big trees to be cut down and moreover other people create various products such as egg trays, boxes, tissues, from paper waste. The challenges they face on collecting waste paper include having paper waste with water especially in rainy season.

4.4 Guavay Organic Fertilizers

The company deals with the production of organic fertilizers from organic waste called Hakika Fertilizers. It takes Guavay 100kg of organic waste to produce just 35kg to 40kg of organic fertilizer. At first they started collecting waste from the food markets but nowadays they use tricycles to collect organic waste from several places and deliver them to their site. Their organic fertilizer is useful and focused on avocado, onions and rice at the moment where one ton of hakika fertilizer is enough to cover one acre. Their organic fertilizer is divided into mineral organics and purely organic. Mineral organics is used in rice and onions while the pure organics is used for avocado plants.

The production process involves three up to four machines the first machine does mixing of organic waste and minerals, second machine is granulator which turns waste to granules and the third machine is shaper which turns them into shapes and then packaging. The three machines used in production process cost about TZS 70 million. Organic waste needs air, moisture, Carbon-Moisture ratio, temperature to decompose, larvae is also generated in the process. The organic waste fed should be half fresh not rotten as some nutrients get lost on the way.

The challenges associated with the production of organic fertilizers: The big challenge they see and have experienced in household's waste is sorting. They performed a small research at Manzese by distributing bags for 10 households to do sorting and dump in organic waste for seven days. After a week, only 30% of the households successfully sorted while the other 70% mixed organic waste with in-organic waste. Furthermore, there is big challenge of Tanzania there are no TBS standards for organic fertilizers which was a big hassle in registration of Hakika fertilizer. Katera fertilizer production is heavily affected by seasons of agriculture as during the non-farming seasons, they do not sell. Now Guavay base their efforts in creating fertilizers for export crops such as vanilla and cocoa.

4.5 Baobab School

Baobab Schools recycle organic waste generated within the school by channeling it to biogas plants in school therefore producing biogas. At the school we met Doctor Ainea Kimaro the creator and the supervisor of the biogas production project in Baobab schools. Doctor Ainea and associates provided us with the explanation on how the organic waste turned to biogas. All type of food waste is fed in the biogas plant inlet as a raw material. Furthermore, they use toilet waste water and feces produced by school occupants and chicken dung to feed into the system. Some materials such as paper, soap and lemons are not required as part of organic waste fed. Waste collected to the large tanks built in round concrete then methanogenosis takes place on the collected organic matter by the bacteria called methanogens. Methanogens (Bacteria) work best under high temperature of about 60 degrees.

The sludge coming from the biogas plant is taken to the treatment center consisting of various pools acting as different stages for purifying the sludge. They have managed to eliminate bad odor from the final sludge pools as they have put a layer of charcoal and other materials on top making the sludge to move underneath hence eliminating the smell. They use the final waste

water to water the vegetables they have planted in the area, in the cleaner waters at some of the pools, they have grown fish. They use the biogas produced to cook school meals every day although they use alternative sources such as natural gas or wood when the biogas runs out. The biogas plant produces enough gas to cook 210 kg of rice and other vegetables in exception of beans as it consumes much gas for heat generation. Dr. Ainea says the gas can be packed but will consist 35-40% of impurities such as carbon dioxide and other unwanted gases which means it can be packed but it will not be sustainable. As Dr. Ainea says, household level machine to produce biogas can be approximately 5 million to fabricate and install. For one system at Baobab which collects organic and sewage waste from about 1500 people costs approximately 70 million. Baobab school is having a new project of biogas for waste from primary schools intended to be high efficiency project as it increases route of digestion making final sludge more harmless.

CHAPTER FIVE
PROPOSED SOLUTION

5.1 Introduction

The gist of this chapter is to look at recommendations on solutions to be applied that can help alleviate the waste problem in Ubungo municipal.

5.2 Discussion & Proposed solution

From the findings of the researchers, it was observed by the researchers that there were existing methods of recycling and reusing of waste products autonomously generated by households and various businessmen and women. Practices such as reusing Nido milk powder can for storing sugar and plastic waste recycling system were found to be used and effective by the households. Recycling systems uncovered by researchers include paper recycling system, plastic recycling system and metal recycling system proven to be effective in promoting sorting at household level. Other systems such as plastic and paper systems provide no monetary rewards to the households while metal recycling system for various reasons provides monetary rewards per kilo of metal sorted.

The above observations and findings can be supported by random utility theory. From the economic theory, just as a consumer is faced with different consumption bundles to choose from, so is a household faced with a choice of whether or not to get involved in waste separation. This study supposes that household chooses whether or not to sort wastes before final disposal depending on the utility to be derived from such a choice. Since the choices are not ordered, an individual can randomly make a choice given his/her own reasoning. This gives rise to the use of random utility theory, which asserts that utility derived from a particular choice is a linear function of two components: observed component and unobserved component (Verbeek, 2004). Utility derived from whether or not separating waste before disposal is in this respect a function of household social-economic characteristics plus a random component.

Table 5.0: WASTE GENERATION.

No	Source of Waste	2016/17 Tons/day	Percentage
1.	Household waste	661	79.9%
2.	Commercial waste	12.4	1.5%
3.	Institutional waste	4.9	0.6%
4.	Market waste	16.5	1.9%
5.	Streets waste	0.74	0.09%
6.	Informal sector waste	131.6	15.9%
TOTAL		**827.4**	**100%**

Source: Ubungo Municipal Profile 2016

Table 5.1: WASTE COMPOSITION.

TYPE OF WASTE	JICA 1997 (%)	ERC 2004 (%)
Kitchen waste	45	39
Textile	17	6
Grass and wood	24	10
Metal	2	5
Ceramic and stone	1	5
Paper	4	8
Plastic	2	16
Leather and rubber	1	6
Grass	3	2
Other	1	3
TOTAL	**100**	**100**

Source: Ubungo Municipal Profile 2016

From Table 5.0 above, it can be observed that the households produce approximately 79.9% of all waste in Ubungo Municipality. From Table 5.1, it can be observed that organic waste (kitchen waste) makes up 39% of the total waste produced by the households. It was observed by the researchers that when all the recycled waste (plastic, paper, metal and organic waste) is added up, a total of 58% percent is eliminated from the household level. This reduction of waste collected from households to 42% makes it easier for the municipal to do waste collection effectively leading to reduction of unwillingness to pay for garbage collection and improper household/garbage collection. However, the researchers took time and observed first the existing systems of paper, metal and plastics in order to come up with an efficient solution for the recycling of organic waste from the households. The researchers propose the following waste management models:

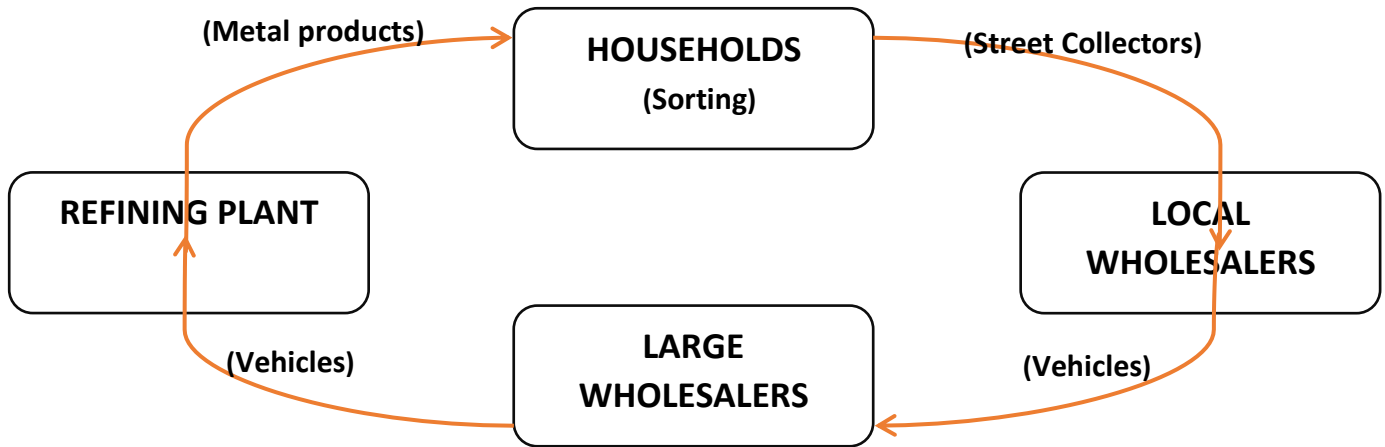## 5.1 Plastic waste collection system
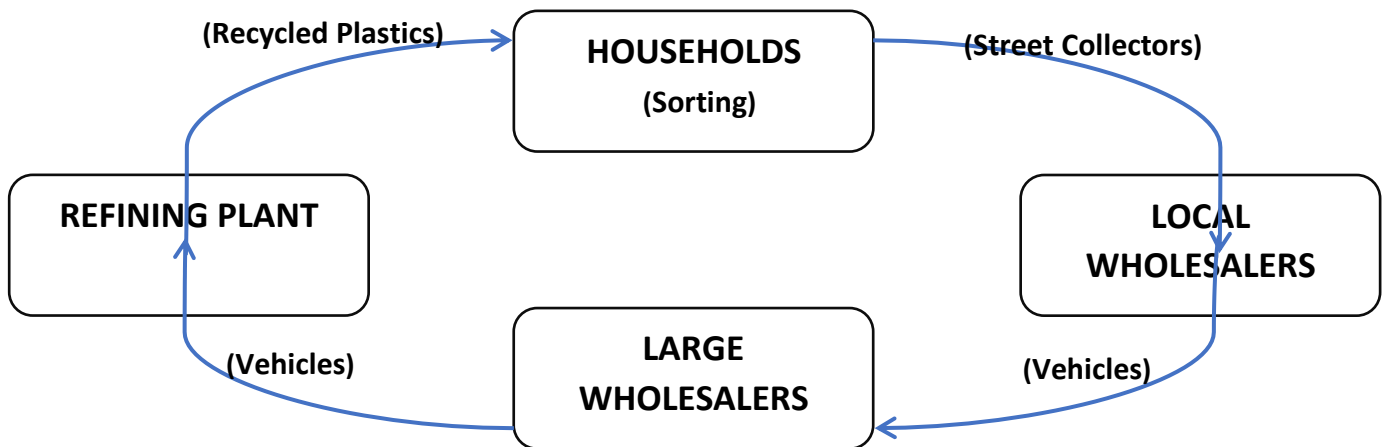
Model 5.0: Plastic waste refining model

Source: Researchers' Construct

As observed from model 5.0 above, plastic waste collection system is shaped by plastic waste refining process. Sorting of plastic waste is done at household level and collected by street collectors. The street collectors are usually youth and women who have found employment by selling collected plastic waste per kilograms to the local wholesalers. The local wholesalers then either transport to large wholesalers or sell from their storage area to the large wholesalers who bring their trucks to the storage area. From there, plastic waste is taken to the wholesalers' area

ready to be taken to the refining plant. The price of the plastic waste is usually dictated by the refining plant and autonomously the final price to be paid to the street collectors is generated throughout the process. In this system, the household is not rewarded monetarily but willingly sort out plastic waste to be given to the street collectors when passing by the household area.
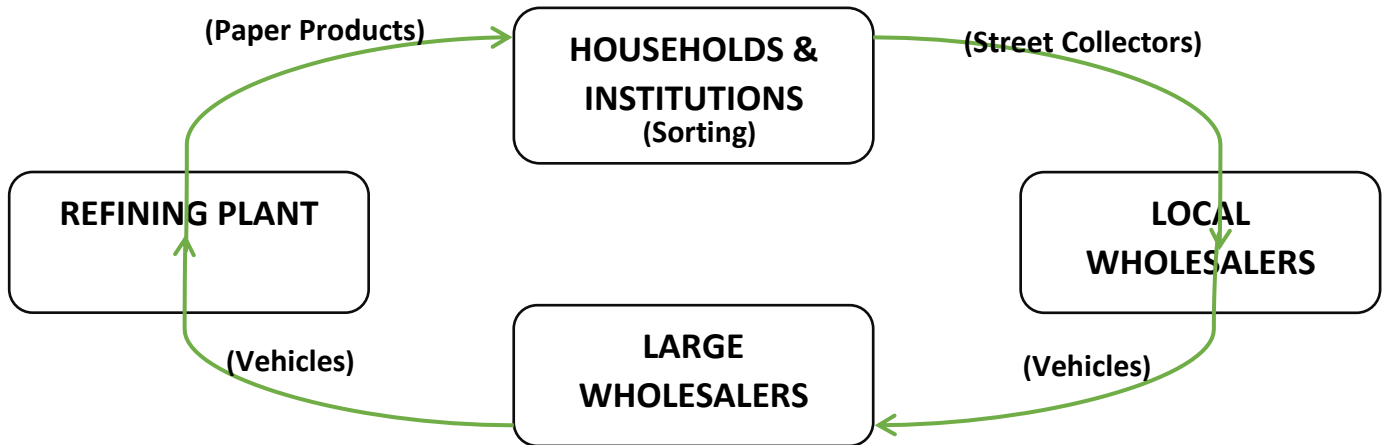
5.2 Metal waste collection system

(Metal products) → HOUSEHOLDS (Sorting) (Street Collectors)
REFINING PLANT   LOCAL WHOLESALERS
(Vehicles)   LARGE WHOLESALERS   (Vehicles)

Model 5.1: Metal waste refining model
Source: Researcher's Construct

As observed from model 5.1 above, just like the plastic waste collection system also the metal waste collection system is shaped by the metal waste refining process. Sorting of metal waste is done at household level and collected by street collectors. The street collectors are usually youth who have found employment by selling collected metal waste per kilogram to the local wholesalers. The local wholesalers then either transport to large wholesalers or sell from their storage area to the large wholesalers who bring their trucks to the storage area if the metal waste is big enough. From there, metal waste is taken to the wholesalers' area ready to be taken to the refining plant or exported for refining. The price of the metal waste is usually dictated by the refining plant and autonomously the final price to be paid to the street collectors is generated throughout the process. In this system, the households are rewarded monetarily so they are willingly sort out metal waste to be given to the street collectors when passing by the household area. Different types of metal have different prices due to their scarcity and mineral components available in the particular type of metal. According to the Random utility Theory, utility in this model to the households is found in the monetary reward available through selling of the metal to

street collectors. That is why it is so hard to find metal waste lying in the compound or the streets compared to plastic waste or any type of waste.

5.3 Paper waste collection system

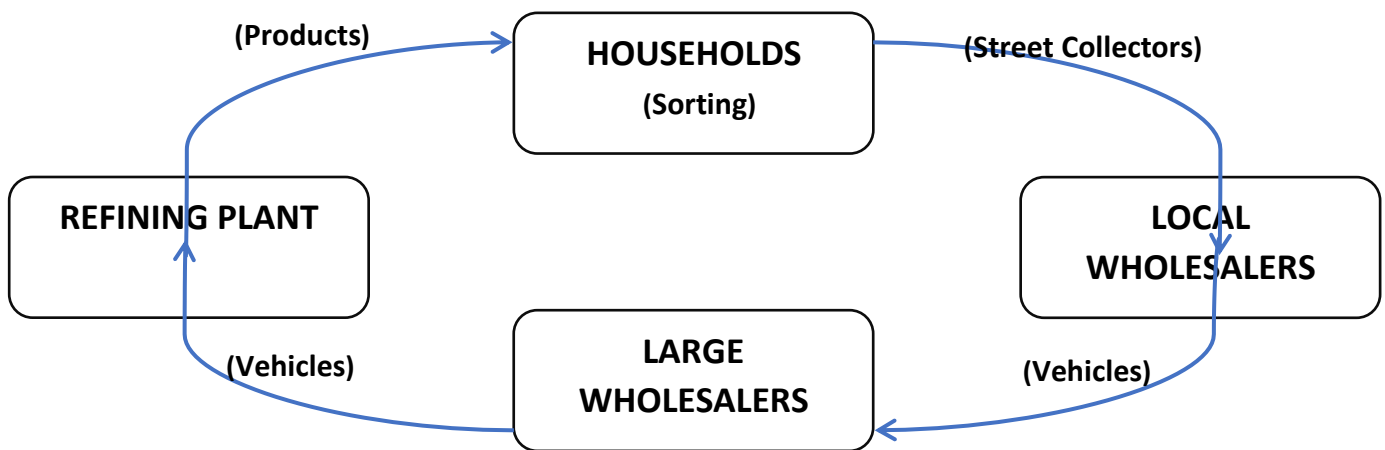**Model 5.2: Paper waste refining model**

Source: Researcher's Construct

As observed from model 5.2 and all the models above, paper waste collection system is shaped by paper waste refining process. Sorting of paper waste is done at household and institutional level and collected by street collectors. The street collectors are usually youth and women who have found employment by selling collected paper waste per kilograms to the local wholesalers who Zaidi recyclers refer as agents. There are agents owned by companies such as Zaidi recyclers and other independent agents who sell their paper waste independently. The local wholesalers then transport their waste paper to Zaidi recyclers. From there, paper waste is carefully sorted, packed and taken to the refining plant. The price of the paper waste is usually dictated by the refining plants such as Mufindi papers and Tanpack and autonomously the final price to be paid to the street collectors is generated throughout the process. In this system, the household and is not rewarded monetarily but willingly sort out paper waste to be given to the street collectors when passing by the household area. Most of paper waste from households does not make it to the refining plants due to less volume generated by households and scarcity of local wholesalers makes street collectors scarce and end up picking most paper waste from institutions. However, paper waste at households is mostly burned for waste papers like

magazines and papers or reused for waste paper like boxes into other household uses such as storing things.

5.4 Proposed model for Organic waste collection

After researchers took time to observe and study various successful models of waste collection, they came up with a model and solution they think will fit best for the largest composition of waste, the organic waste. The organic waste from households (Table 4.1) makes up 39% of all collected waste from households. The models proposed are as follows;

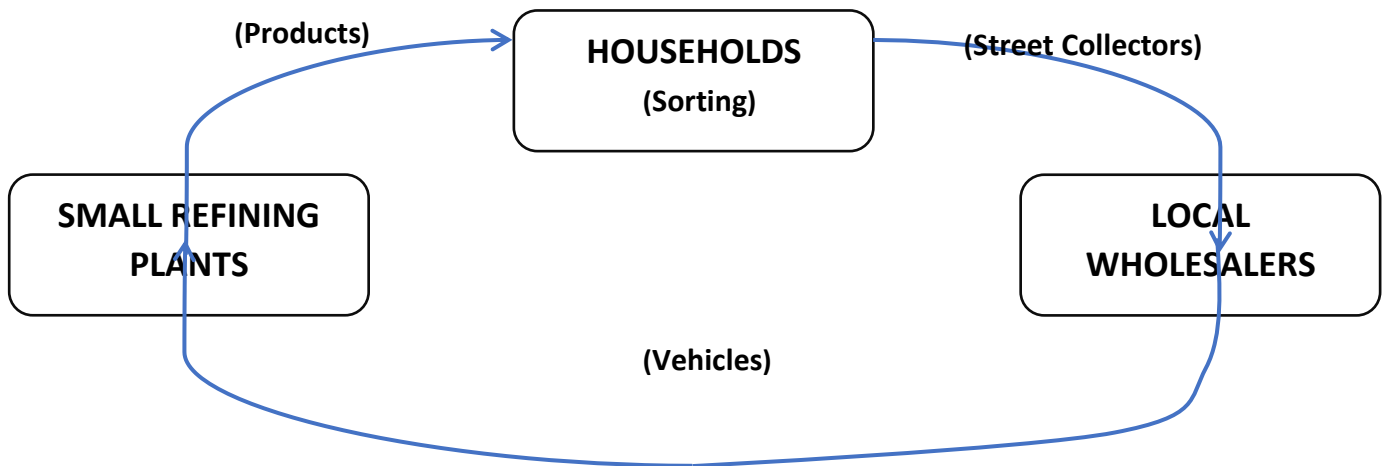**Model 5.3: Proposed organic waste refining model**

Source: Researcher's Construct

The above proposed model 5.3 is aimed at minimizing the problems of unwillingness to pay and improper household waste disposal. Through this model, organic waste is to be treated of value and as a product which provides employment. Organic waste is supposed to be generated and sorted at home. The street collectors pass by the homes and collect the organic waste sorted in special collection bags. The street collectors then sell to the local wholesalers of organic waste who then sell to the large wholesalers and then transported to the refining plant. At the refining plant, various products can be generated mainly biogas and digestate which can be fertilizer and soil amendments.

The model is not as easy as it seems due to the nature of waste carried around having expiration period to be well enough fit for creation of products such as biogas. As explained by one of the personnel at Guavay Company, the organic waste should be half fresh for maximum efficiency

not brought in at a rotten state. The above model is for a huge refining plant that will be able to cater for organic waste in the whole municipal of Ubungo or city of Dar es Salaam. However, due to the complexity of the type of waste carried having certain expensive way of handling it, by having various stakeholders in the way, the model can be refined by having small refining plants in various areas tuning the model to be as follows;

5.5 Second proposed organic waste collection system

Model 5.4: Proposed organic waste refining model 2
 Source: Researcher's Construct

This proposed model is for minimizing the complexities associated with taking the waste to the large recycling plant. Also, as observed from Kioko pastoralists in Kenya as they use animal waste produced during slaughter to produce packaged biogas which is cheaper than normal gas, the small refining plants can produce products of such type and supply to nearest households. This minimalist model is heavily supported by Dr. Ainea who has successfully created various biogas plants including the Baobab schools plants, Rwanda prisons plants and for his homes one at Arusha and another in Dar es Salaam. He recommends that if one household cannot be able to afford having such of a system, there can be a collective biogas plant which in this study we refer as small refining plants. However, Dr. Ainea discourages the packing of biogas as he calls the solution to be unsustainable due to presence of up to 40% of impurities.

5.6 Advantages of the proposed models

The proposed models to enable successful collection of organic wastes have various advantages such as; the model fits well with urban system in Ubungo. As observed in research done by Monella and Leyaro, Dar es Salaam city is comprised of 70% of unplanned households leading to inaccessibility of most areas for waste collection. The availability of street collectors who can use carts to pass through and collect organic waste from households just as metal waste street collectors which improves efficiency of waste collection.

Moreover, the proposed models provide alleviation of the burden of bulk waste collection from households imposed to the Municipal Council at the moment. By collaborating with various stakeholders in bringing the models to life, the municipal will only collect 42% of waste as compared to what they collect at the moment. This in turn shall lead to effective waste collection around the Ubungo municipal.

Furthermore, the proposed models shall provide employment at various stages of its implementation to people in the municipal. As a direct effect of the proposed models, employment shall be created from the level of street collectors to the level of people working in the refining plants. This is an added advantage making waste to create income and employment to Ubungo residents.

5.7 Drawbacks of the proposed models

The models proposed have various limitations in their implications caused by various reasons and constraints such as; expensive machines, tools and other processes needed in execution of particular models. The accompanying costs include collection vehicles, new bins, infrastructure costs, schooling the community about recycling and creating awareness programs which are very expensive. Also, much expertise is needed in creation, running and operations of particular machinery needed for organic waste refining. This is a challenge due to scarcity of professional people to carry on such activities.

Furthermore, this particular study could not provide estimated capital on starting projects on the presented models as the researchers were not exposed to big projects such as the organic recycling project in progress at Kenya or Kioko pastoralists. Data found on the internet could not serve as reliable data as it does not have affecting factors such that we have at Ubungo municipal and realistic figures.

25

CHAPTER SIX

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

6.1 Conclusion

With respect to other findings, it was established that a high amount of solid waste was found in unplanned settlements, markets places and along the streets and roads. Urbanization coupled with population increase is a challenge to solid waste found everywhere in the study area. Population increase leads to more production of solid waste since there are no areas designated for waste disposal. This study focused assessment of challenges associated with solid waste disposal management and proposed solutions. The research findings from other researchers and assessment of enterprises dealing with waste management show the viability of models developed in this study. The situation facing waste management and disposal in Ubungo at the moment is disastrous and shows more health and environmental dangers in the near future. Ubungo municipal should adopt modern ways of recycling and waste management so as to provide a cleaner and safer future for the coming generations

6.2 Recommendations

For the models proposed to be successful, various factors should be present as proposed by researchers as follows; privatization of the system of organic waste collection and refining system. Despite the existing challenges on waste management in Dar es Salaam, the privatization of waste management services has led to improved daily refuse collection of total generated waste from 12% in 1994 to 40% in 2007, creating employment and income opportunities to people engaged in collection and disposal of wastes, especially youths who would otherwise be unemployed (Kaseva & Mbuligwe, 2005). Privatization has proven to be effective years after the collection of waste was taken from the government. Researchers believe privatization shall lead to much effectiveness in the proposed models.

Moreover, incentives should be provided to households such as metal collection system so as to kick off organic waste sorting at household level. Supported by random utility theory, this new system should incentivize households so they can adapt sorting as a proper way of maintaining waste and also view it as an income source. In the study conducted by Monella and Leyaro

27

which included 450 respondents from households, when asked whether or not they are willing to participate in domestic waste separation, 70.67% of respondents were ready to participate in the programs, while 29.33% were not ready for different reasons. This study proves the viability of the model and ability of the public to participate especially when incentives shall be involved.

Furthermore, proper education should be provided to households on waste sorting at household level to ensure proper sorting avoiding of having unwanted materials such as lemons, papers and other indecomposable materials and harmful to the biogas plant. Waste sorting campaigns should also be put in place to make sure majority knows about waste separation.

Also, provision of tools for separation at household level for proper separation is crucial for the success of the particular model. As observed in the same study by Monella and Lerayo, 30% of participants who said they are not willing to participate in waste separation is because of inability to afford waste separation bins. With provision of such tools, it can be predicted with high accuracy that it shall contribute to effective operation of particular models.

6.3 Limitation of the Study

6.3.1 Corona Pandemic

When we were collecting data and continuing with the study, Corona virus pandemic came into existence which forced us to stop the study for a while.

6.3.2 Inaccessibility of Secondary data

When collecting secondary data, it was so difficult to find current documentation about solid waste management in Ubungo Municipal Council. That posed to us the difficult on determining the actual composition of waste generated in Ubungo. Very few studies were conducted in Ubungo Municipal we came across of only one that involved Manzese ward.

6.3.3 Time-demanding process

One of the drawbacks of this research is that it is a time demanding process. The process of setting up this research, organizing findings and analyzing them needed more time while we as finalist students we were time constrained.

6.3.4 Data Collection Process

Data was collected through face to face interviews to the respondents might have caused some of the respondents to give answers contrary to what they believe.

6.4 Areas for Further Studies

This study focused on assessment of challenges associated with solid waste disposal management and proposed solutions in Ubungo Municipal. The researchers propose other studies to continue research in other areas of Dar es Salaam and other studies on scientifically testing the viability of proposed models and cost of implementation.

REFERENCES

Abdel-shafy, H. I., & Mansour, M. S. M. (2018). Solid waste issue : Sources , composition , disposal , recycling , and valorization. *Egyptian Journal of Petroleum*, *27*(4), 1275–1290. https://doi.org/10.1016/j.ejpe.2018.07.003

Elisha Kaala (2016) *Critical Analysis of the Challenges of Solid Waste Management Initiatives in Keko Machungwa Informal Settlement, Dar es Salaam,* 1-12.

Joel Monella & Vincent Lerayo (2016). *Determinants of Households Willingness to Participate In Solid Waste Separation for Reduce, Reuse and Recycle: The Case of Dar es Salaam,* 1-26.

Kaseva, M. E. & S.E. Mbuligwe. (2005). Appraisal of Solid Waste Collection Following Private Sector Involvement In Dar es Salaam City, Tanzania, *Habitat International*, 29(2): 353–366.

Kumar & Pandey (2015). *Household participation in domestic waste disposal and recycling in the Tshwane Metropolitan area:* An environmental education perspective. MA thesis, University of South Africa.

Odonkor, S. T., Frimpong, K., & Kurantin, N. (2020). Heliyon *An assessment of house-hold solid waste management in a large Ghanaian district*. *Heliyon*, *6*(December 2019), e03040. https://doi.org/10.1016/j.heliyon.2019.e03040

Minghua, Z., Xiumin, F., Rovetta, A., Qichang, H., Vicentini, F., Bingkai, L., Giusti, A. and Yi, L. (2009) Municipal Solid Waste Management in Pudong New Area, China. *Journal of Waste Management*, **29**, 1227-1233. http://dx.doi.org/10.1016/j.wasman.2008.07.016

Oketola, A. (2018). *Solid Waste Management and Associated Environmental Solid Waste Management and Associated Environmental and Human Health Risks*. *May*.

Rushton, L. (2003). *Health hazards and waste management*. *68*, 183–197. https://doi.org/10.1093/bmb/ldg034

Verbeek, B. (2004). Justifying Rational Choice: The role of success, *GAPS*, (5), Bielefeld.

World Bank 2010. *Major Environmental Issues Facing 21st Century.* Prentice Hall, Upper Saddle River, New Jersey.