UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

PROMOTION OF BAT AND BET TO REDUCE UPOPS RELEASES FROM WASTE OPEN BURNING IN THE PARTICIPATING AFRICAN COUNTRIES OF SADC SUB-REGION (Tanzania)

Baseline Assessment Report

Submitted to UNIDO and DOE – VPO, URT

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PART A: PRELIMINARY ASPECTS

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- Spokespersons and staff of recycling companies and other entities involved in recycling of resources from solid waste,
- Spokespersons and staff of companies and other entities involved in composting of solid waste organic fractions, and
- Members of communities with whom we interacted or got help from during the course of this assignment.

Even though its mention comes towards the end of the acknowledgement list, I owe a lot to Ardhi University for facilitating my execution of this assignment. Prof. Gabriel R. Kassenga, ARU Deputy Vice Chancellor for Academic Affairs, deserves a special mention on account of the sense of urgency and importance with which he handled the need for me to undertake this assignment.

A team of dedicated professional and non-professional members assisted the consultant during the execution of this assignment. Their contribution to the success of the assignment is highly acknowledged. Mr. Nickson and Mr. Eliud are specially singled out for their key roles.

Often reports say as much about the reporters as about what is reported on. By the same token, this report says something about me as a professional. I am grateful for the one of a kind moment in the sun that this assignment afforded me. I am very glad to have been given this opportunity to make use of my often underutilised expertise and long experience in waste management.

EXECUTIVE SUMMARY

ES1 INTRODUCTION

This report presents the outcome of the assignment in connection with the project on: ”PROMOTION OF BAT AND BET TO REDUCE UPOPS RELEASES FROM WASTE OPEN BURNING IN THE PARTICIPATING AFRICAN COUNTRIES OF SADC SUB-REGION” with a focus on the Tanzania component. It is meant to report on the final outcome of the assignment. The assignment was carried out under the auspices of both the United Nations Industrial Development Organisation (UNIDO) and the Division of the Environment in the Vice President’s Office (DoE VPO). However, UNIDO was the specific contracting party.

Specifically, the project spearheaded by UNIDO in collaboration with the Division of the Environment (VPO) is aimed at achieving continuing minimization of unintentionally produced POPs (u-POPS) release in the open burning sector through introduction of best available techniques and best environmental practice (BAT/BEP) measures at Kigamboni and Ubungo municipalities in Tanzania. The assignment which was carried out for this report avails baseline survey results which can be used in the next stage of the main project.

ES2 DATA AND INFORMATION ACQUISITION METHODS

The methods used to acquire and analyse the data and information for this assignment were selected on the basis of the required data and information. On the whole, the methods actually used were: brainstorming, reconnaissance surveys, review of various documentary sources of data and information, interviews, physical surveys and investigations, consultation for expert opinion, photography, and questionnaire surveys**.**

ES3 CURRENT STATUS OF SOLID WASTE MANAGEMENT

Kigamboni Municipality

Existing solid waste management system

Solid waste in Kigamboni municipality comes from various sources including residences, commercial premises, institutions and industries. Existing solid waste management options in the municipality include centralized and decentralized collection anddumping, burning, burying and recycling.

Solid waste generation in Kigamboni municipality

The average daily solid waste generation rate is 0.75 kg/c/day and the total quantity generated in the municipality is about 171 tons per day.

Solid waste characterization

Kitchen waste and other biodegradable organics are the main fractions in solid waste generated in the municipality. Solid waste composition at Kigamboni dump sites (TIPER and Mji Mwema) was almost the same as that obtained at generation points. Of all the waste fractions identified, the so called soft nylon was the most problematic to deal with since there are no recycling industries that accept these waste fractions in the region. In addition to the foregoing revelations, waste pickers are highly vulnerable to health and safety hazards because they do not use any protective gear.

Amount of recyclables generated

The total amount of recyclables generated in the municipality is 23.73 t/d and glass is the leading fraction accounting for 5.47 t/d (23%). Currently plastics, hard nylon, glass, aluminium and other metal items plus poly sacks are sorted and transported to processing industries available in Dar es Salaam. A large proportion is still left over. Some recyclables such as rubber, paper and textile are not recycled due to the absence of industries that are able and willing to recycle them.

Amount of biodegradable wastes generated

Biodegradable waste fractions (> 120 t/d) account for over 70% of the waste generated in Kigamboni municipality. These waste fractions are amenable to composting and the resulting compost can be used in urban agriculture.

Waste collection service fees and payment for contractors

Waste collection service fees range from TZS 3,000 to 170,000 per month for registered contractors while self-appointed contractors charge between TZS 1000 and 5000 per trip depending on the actual amount of solid waste to be transported. Payment of service fees by the beneficiaries is very problematic and is responsible for cessation of most contracts.

Size of the population served by waste collection systems

Based on our surveys and investigations for this assignment, 14,417 people equal to 7% of the municipality population are served by registered solid waste collection service providers, 36% equal to 74,147 residents are served by unregistered solid waste collectors and 57% of the population, which is equal to 117,400 people, is not served at all.

Collection systems

On the whole, the main waste collection system used in Kigamboni municipality is the door to door collection system.

Services carried out by non-registered companies

Solid waste collection

In most parts of Kigamboni municipality solid waste is collected by non-registered individuals and based on the surveys and investigations carried out for this assignment, 90% of the illegal dumping sites are caused by non-registered solid waste collectors.

Recyclables collection

Recyclable solid waste fractions (plastics, aluminium and ferrous metals) are collected by non-registered individuals (scavengers) to middle men who then transport them to the processing industries. Also, what is left of these materials in the waste stream is picked up at the dump sites.

Mode of collection for recyclables

Recyclables are scavenged at generation points, and their sources include residential premises, commercial areas and institutions. The collection usually involves three players, scavengers who pick recyclable waste fractions directly from generation points, the middle man who buys these recyclables from the scavengers and finally the processing industries that process the recyclables

Current recyclable materials

The main recyclable materials collected are plastics and ferrous and aluminium metal items. Plastics referred to here are mainly plastic bottles used for various drinks packaging.

Ongoing project for optimized collection system

The main project for optimization of solid waste management system in the municipality is the proposed Kisarawe landfill which is to cover 154 acres. It will reduce waste transportation round trip distances.

Solid waste sorting

In Kigamboni, Tungi and Somangila wards, sorting activities are conducted at the dump site where valuable materials including plastics, ferrous metals and aluminium items, and poly sacks are picked out and transported to processing industries for recycling. Segregation and sorting of solid waste at generation points is conducted by a small number of residents most of whom can be found in Kigamboni, Kimbiji and Somangila wards.

Burning practices

Burning practices were observed mostly in Kimbiji, Somangila, Kibada and Vijibweni wards. In most cases residents who burn their waste have enough land and are still conducting small scale farming.

Proposed final use of generated solid wastes

Reuse

Some of materials considered as waste can be reused in the community. Glass bottles, nylon bags, poly sacks and plastic bottles can be reused several times before being sent to recycling facilities.

Recycling

Plastics, ferrous and aluminium items are the materials that can easily be recycled in the municipality. There are also other waste fractions that can be recycled including paper and nylons but they are not all necessarily economical to recycle.

Composting

Biodegradable waste can be composted to produce an organic fertiliser that can be used for supporting the growth of crops. Diverting such materials from the waste stream will free up dumping space to accommodate waste materials that cannot be composted. It will also result in a reduction in solid waste collection costs.

Recyclable waste buyers

Currently, there two buyers of recyclables collected by different waste pickers from the municipality. The recycling companies are RAIDER Company Limited which is located in Kigamboni municipality and Fusun Investments Co United which is located in the nearby Kurasini area.

Number of contractors and type of collection contracts

There are various solid waste collection contractors registered within wards in Kigamboni municipality. The investigations for this assignment found that most of the contractors do operate during the early parts of their contracts but soon go out of operation depending on their ability to withstand the challenges that stand in their way, especially poor cost recovery.

Sites suitable for establishment of recyclable collection centres

A proposal for nine recyclable collection centres has been put forward to improve recyclable collection in the municipality. The centres they are suitable and convenient for both upstream and downstream stakeholders.

Ubungo Municipality

Existing solid waste management

Solid waste is generally collected at curbside from households, commercial establishments, institutions, markets, and street sweeping collection points. It is then taken directly to the Pugu-Kinyamwezi dump site.

Solid waste generation in Ubungo municipality

Based on physical surveys and investigations, the municipality generates 890.93 tons/day of solid waste most of which is organic fractions.

Solid waste composition in Ubungo municipality

Organic waste constitutes a large proportion (86%) of the solid waste stream in the municipality. The composition of waste at Pugu-Kinyamwezi did not differ much from the one determined for the corresponding generation points.

Waste collection

Solid waste collection in Ubungo municipality is carried out by both the municipal council, some private companies, community based organizations and the informal sector.

Waste transportation

Currently the transportation of solid waste is done by both the municipal council and the private sector (contractors). The municipal council has three trucks for transportation of solid waste from different areas of the municipality to the current dump site which is located 40 km from the centre of Ubungo municipality. This makes the round trip to be about 80 km long.

Solid waste disposal

Currently Ubungo Municipality does not have a sanitary landfill so the collected solid waste has to be transported to Pugu-Kinyamwezi dump site which is the only authorized site in Dar es Salaam. Furthermore, in areas where collection services are not available, burying, burning and illegal dumping are the main solid waste disposal practices.

Generation of recyclables

On the whole, the glass fraction accounts for a proportionately large share (24.67 tons/day w/w) of recyclables. Although there is a large proportion of soft nylon and textiles produced in the municipality, there is no market for these materials yet and as a result they end up in the dump sites, are burned or buried at home.

Collection of recyclables

Recyclables (plastics including both nylon and bottles, aluminium and ferrous items) are collected by non-registered individuals (scavengers) and taken to middle men who then transport them to processing industries which are located within the Ubungo municipality.

Generation of biodegradable materials

The generated biodegradable organics amount to 717.1 tons/day which accounts for 80.56% of all waste produced. Generated biodegradable waste is amenable to composting to produce compost

Main challenges facing waste management in Ubungo municipality

Challenges associated with solid waste management in the pilot project area include: 1) insufficient support to the private sector and community organizations dealing with solid waste collection, 2) a lack of suitable sanitary landfill, 3) unwillingness of the community to pay for refuse collection fees, 4) insufficient/limited SWM budget, 5) insufficient solid waste collection and transportation equipment, 6) long distance to the official disposal site whereby the round trip averages 80 km, and 7) informal settlements and informal business premises which make it difficult to carry out collection and transportation of the solid waste.

Solid waste management future plans in Ubungo municipality

Future plans meant to effect solid waste management improvement in Ubungo municipality are mainly: 1) purchase of additional waste collection vehicles, 2) purchase of land and development of a sanitary landfill, 3) increasing of involvement of the private sector in SWM, 4) development of a SWM master plan, and 5) step up efforts to prevent and control illegal solid waste dumping.

Size of population served by current waste collection services

The population that is served by the waste collection service is 360,972 which is 35% of the total population while the remaining 670,000 people (equal to 65% of the total) are not served by the municipal council waste collection system.

Waste collection and transportations

The waste collection and transportation services are provided by contractors appointed and approved by municipal council. The waste collection routes depend on the accessibility of the service areas. The routes are not designed mainly because of the informal nature of most parts of the municipality.

Waste collection service fees and payment for contractors

Solid waste collection service fees range from TZS 2,000 to TZS 200,000 per month. The payment for the services rendered by the contractors is determined on the basis of number of trips made and size of truck used. The payment per trip using a standard compactor truck is TZS 450,000 while that for a standard (Tata) tipper truck is TZS 350,000 per trip.

Burning practices

Burning is one of the solid waste management challenges in the municipality. It is currently used as the disposal method by some of the residents although it is prohibited and continuing education concerning its environmental impacts is given to residents. Burning practices are most rampant in Goba, Kwembe, Kimara, Mbezi, Mabibo, Sinza, Manzese, Ubungo, and Kibamba wards.

Ongoing projects for optimized solid waste collection system

The main project for optimization of solid waste management system in the municipality is the proposed construction of a sanitary landfill at Kisogwa (152 acres). The proposed landfill will provide for composting biodegradable waste fractions and sorting areas to remove recyclables so that they are not landfilled. The project will optimize solid waste management system in the municipality by reducing the transportation round trip and reduce the quantity of waste that needs to be disposed of.

Recyclable wastes buyers

Currently there four buyers of recyclables who are located in the municipality. These collectively handle between 95 and 120 tons of recyclables per week.

Number of contractors and types of collection contracts

There are several solid waste collection contractors who are registered within wards in Ubungo municipality but many of them are no longer operational due to being overwhelmed by challenges, especially due poor service fee payment by the service beneficiaries.

Recyclable collection centres in Ubungo municipality

The existing recyclable collection centres are owned by individuals and some of them are located far from the main road which increases transportation costs and causes transportation difficulties during the rainy season. As part of this assignment we have proposed a number of locations for establishment of recyclable collection centres which are suitable and convenient for both upstream and downstream stakeholders.

Additional Considerations Pertinent to Solid Waste Management

Major produce markets in Kigamboni and Ubungo municipalities

Produce markets are a special case of solid waste sources and therefore they are a special case of solid waste management needs. They receive a significant quantity of food packaging and container materials of agricultural or natural origin. Such packaging and containers include woven straw baskets, leaf based wrapping materials, and wooden boxes. Added to the foregoing list are non-edible parts of produce such as banana peduncles and pieces of twigs. Therefore, markets are a good candidate for resource recovery based on organic waste fractions.

Hazardous waste management in Kigamboni and Ubungo municipalities

Hazardous waste management is an important offshoot discussion issue relevant to this project. This is in part because hazardous waste management is related to solid waste management and in the absence of strict and meticulous segregation, municipal solid waste usually contains hazardous waste fractions.

Upstream management of hazardous waste in the project area is very poor. There is no organised system for segregation and separate storage and collection of the hazardous waste fractions. Downstream management of hazardous waste is also poor; there is no separate system for collection, transportation, treatment, and disposal of hazardous waste fractions from mainstream sources of waste.

Really large capacity for hazardous waste treatment by way of incineration or otherwise is still in short supply in the country. In spite of the foregoing, there may be change in the horizon because the hazardous waste management industry seems to be attracting investors. One of the investors is planning to install an incinerator in Kigamboni within one year.

ES4 AN EXTENDED ANALYSIS OF GENESIS AND STATUS OF OPEN BURNING OF SOLID WASTE

The Context of Open Burning of Solid Waste

Open burning of solid waste is specifically disallowed by law and is generally not expected to happen. More specifically, open burning of solid waste would not happen if 1) the law was complied with and 2) solid waste management service in the relevant areas was sufficiently good.

The greening of Dar es Salaam city has profound implications on SWM in general and on open burning of solid waste in particular. The green land cover is the source of yard waste of plant origin which contributes to open burning as well; it generates enormous quantities of solid waste most of which is not collected. The solid waste is consequently burned in the backyard and occasionally even in the front yard.

Major Cases of Illegal Disposal of Solid Waste

An inventory of the sites and premises where there are major cases of illegal disposal of solid waste revealed 3 sites in Kigamboni municipality and 3 in Ubungo municipality.

Major Cases of Open Burning of Solid Waste

Open burning of solid waste takes place mostly in the neighbourhood of residential premises, near markets and near other commercial premises. There are quite many open burning premises in the pilot project areas – 29 premises in Ubungo and 16 premises in Kigamboni, with Kibamba ward in Ubungo municipality leading with 14 premises.

ES5 AN EXTENDED ANALYSIS OF THE WASTE RESOURCE RECOVERY INDUSTRY

Scope and Context of the Waste Resource Recovery Industry

The most commonly retrieved and utilised waste resource materials in Dar es Salaam city including the project pilot areas are: assorted organic waste which is generally readily biodegradable and suitable for biogas production and composting, waste paper fractions, assorted plastics which are mainly used plastic bottles; metallic waste resources which are mainly ferrous and aluminium scrap metal and metal cans used as beverage containers; beverage industry waste food; food waste from restaurants, hotels, and institutions; and beverage glass bottles and broken glass bottles which are reused or recycled. Waste resource recovery takes place along the whole waste stream within each solid waste management functional elements.

Status and Viability of Composting Based on Organic Solid Waste Fractions

Small scale composting of solid waste has been in practice in Dar es Salaam city for a long time in part because of the influence of urban agriculture and greening efforts. Commercial producers of compost do exist but they face some formidable challenges. Some producers of compost who were in the market in the past had to close their business after failing to cope up with an apparent lack of market for the compost.

Waste Resource Reuse

The most outstanding case of waste resource reuse, is that of inter-industry practice involving glass beverage bottles. Glass beverage bottles for soft drinks and beer are reused over and over again until they are deemed to have developed defects such as cracks.

Waste Resource-Based Biogas Production

Biogas technology is quite prevalent in Dar es Salaam city, including the pilot project areas. Biogas plants are available at many different use levels, mainly household level and institutional levels. Extensive studies have been carried out at and by ARU on operational status of existing biogas plants and on suitability of different solid waste fractions for biogas production.

Waste Resource-Based Fuel Briquettes Production

Production of fuel briquettes using organic solid waste fractions can contribute to the enhancement of solid waste management while at the same time addressing the energy supply challenges. Use of yard waste in the production of fuel briquettes contributes directly to reductions in open burning of solid waste. One outstanding advantage of using solid waste to produce fuel briquettes is that production of fuel briquettes works even with solid waste fractions that would be unsuitable as biogas production feedstock. Such solid waste fractions would also be difficult to use for producing

compost. A lot of research and development work has been done at ARU regarding the feasibility of using solid waste fractions as main feedstock and alternative binders for fuel briquettes production.

ES6 CROSS-CUTTING SUPPLEMENTARY FINDINGS AND OBSERVATIONS

In connection with the cross-cutting supplementary findings and observations the following are noteworthy:

- The need to make use of existing quality research on waste management and resource recovery, including that on integrated waste management and resource recovery (IWM&RR), solid waste composting, solid waste-based biogas production, and production of fuel briquettes using solid waste fractions.
- The need for making use of waste management and waste resource recovery experts who are available and additional ones who are being trained locally instead of assuming that none exist.
- The need for companies involved in large scale resource recovery to involve academic or research institutions and relevant researchers and the need for waste resource recovery experts and researchers to collaborate in large scale waste resource recovery activities for complementary benefits. Currently, no such collaboration exists.

ES7 INTEGRATED WASTE MANAGEMENT AND RESOURCE RECOVERY CAPACITY

Noteworthy and potentially applicable IWM&RR capacity available at Ardhi University includes expertise and experience in the following:

- Solid and hazardous waste management and technology capacity dating back to 1980s.
- Solid waste recycling capacity dating back to 1980s with the kind of facilities only available at ARU.
- Waste composting technology capacity dating back to 1980s with the kind of facilities only available at ARU.
- Biogas production technology capacity dating back to the 1980s.
- Fuel briquettes technology with the feedstock and binder both being organic solid waste fractions.
- Integrated waste management and resource recovery (IWM&RR) capacity as applied to institutions and communities – a pioneering role in Tanzania.
- Obsolete pesticide management and clean-up of contaminated stores and sites – a pioneering feat in Tanzania.
- Integrated resource recovery and sanitary final disposal facilities for liquid, solid and semi-solid waste streams.
- Assessment of persistent solid waste fractions (PSFs) and their potential resource recovery options.

- Capacity and experience in training solid waste management practitioners.
- Experimental hall for IWM&RR research and training and technology research and development.

ES8 ANALYSIS OF IMPROVEMENT NEEDS AND OPTIONS

With respect to the analysis of improvement needs and options, the following have been borne in mind:

Strengths: All the features and characterised that have been identified as strengths need to be maintained and reinforced.

Weaknesses: Weaknesses are prime targets for improvement measures and they need to be rectified.

Opportunities: The characteristics identified as opportunities are opportunities for gaining strengths, which means they must be taken advantage of.

Threats: The features identified as threats have the potential to disrupt and weaken existing strengths, and reinforce existing weaknesses. They also need to be eliminated or deactivated.

ES9 CONCLUSION AND RECOMMENDATIONS

Concluding Remarks

This report has documented the output of the assignment in respect of the project on: ”PROMOTION OF BAT AND BET TO REDUCE UPOPS RELEASES FROM WASTE OPEN BURNING IN THE PARTICIPATING AFRICAN COUNTRIES OF SADC SUB-REGION” with a focus on the Tanzania component. The report presents baseline data and information on solid waste management and resource recovery as well as practices pertinent to open burning of solid waste in Dar es Salaam city with a focus on pilot project areas of Kigamboni and Ubungo municipalities. It has also covered integrated waste management and resource recovery capacity that can support the overall goal of the project. The following are some of the major concluding remarks pertinent to this report:

- Solid waste management in the pilot project areas as well as in the rest of Dar es Salaam city is poor both in terms of service provision and in terms of effectiveness.
- Open burning of solid waste is rampant in the project area. Both accidental and deliberate cases of open burning of solid waste have been observed in both Kigamboni and Ubungo municipalities. However, deliberate burning cases far outnumber accidental cases.
- Poor solid waste management contributes to open burning of solid waste in the pilot project areas. This is in part because, it gives rise to illegal disposal premises which turn into solid waste open burning premises.
- Waste resource recovery has the potential to contribute to the reduction in open burning of solid waste. It is thriving in the pilot project areas, but it needs to be improved.

- Biomass from utility and ornamental vegetation is a major component of yard waste which itself contributes greatly to open burning of solid waste.
- There is a considerable IWM&RR capacity within reach of the project in terms of technical expertise, practical experience, availability of research findings and development infrastructure and facilities, availability of training facilities and experience in such training, and IWM&RR technology demonstration capacity.

Recommendation

The report has indicated the need for a higher degree of professionalism in solid waste management and resource recovery practice and improved professionalism in enforcement of laws and regulations pertinent to solid waste management.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

Abbreviation	Long form/explanation
ABR:	Anaerobic baffled reactor
ARU:	Ardhi University
BAT:	Best available techniques
BEP:	Best environmental practices
CBOs:	Community based organizations
CEO:	Chief executive officer
DOE:	Division of the Environment (Vice President's Office)
GIS:	Geographic information systems
ILO:	International Labour Organisation
ILO:	International Labour Organisation
ISID:	Inclusive and Sustainable Industrial Development
IWM&RR:	Integrated waste management and resource recovery
MEO:	Mtaa Executive Officer
NGOs:	Non-Governmental Organizations
POSH:	Public and occupational safety and health
PSFs:	Persistent solid waste fractions
RRI:	Resource recovery industry
SADC:	Southern African Development Community
SEST:	School of Environmental Science and Technology
SW:	Solid waste

SWM:	Solid waste management
SWOT:	(Analysis of) Strengths, Weaknesses, Opportunities, and Threats
ToR:	Terms of Reference
ToR:	Terms of reference
UASB:	Upflow anaerobic sludge blanket
UNIDO:	United Nations Industrial Development Organization
U-POPS:	Unintentionally produced persistence organic pollutants
VPO:	Vice President's Office
WEO:	Ward Executive Officer
WM&RR:	Waste management and resource recovery
WRR:	Waste resource recovery

PART B: INTRODUCTORY ASPECTS

1.0 INTRODUCTION

1.1 Background Information

This report presents the outcome of the assignment in connection with the project on: ”PROMOTION OF BAT AND BET TO REDUCE UPOPS RELEASES FROM WASTE OPEN BURNING IN THE PARTICIPATING AFRICAN COUNTRIES OF SADC SUB-REGION” with a focus on the Tanzania component. It is meant to report on the final outcome of the assignment. The assignment was carried out under the auspices of both the United Nations Industrial Development Organisation (UNIDO) and the Division of the Environment in the Vice President’s Office (DoE VPO). However, UNIDO was the specific contracting party.

The United Nations Industrial Development Organization (UNIDO) is the specialized agency of the United Nations that promotes industrial development for poverty reduction, inclusive globalization and environmental sustainability. The mandate of UNIDO is to promote and accelerate inclusive and sustainable industrial development in developing countries and economies in transition.

The Department of Environment under the Directorate of Program Development and Technical Cooperation is responsible and accountable for providing technical cooperation services to enhance the capability of developing countries and economies in transition to promote Inclusive and Sustainable Industrial Development (ISID). It does so by promoting industrial resource efficiency to strengthen the green industry and improve the effective use of natural resources including water; by assisting developing countries and countries with economies in transition to achieve the objectives of and compliance with the Multilateral Environmental Agreements; and by working to reduce the release of industrial pollutants in the environment. Under the Department of the Environment the Stockholm Convection division (PTC/ENV/SCD) is responsible for supporting developing countries and countries with economies in transition to implement the economies the Stockholm convention (SC) on Persistence Organic Pollutants (POPs) and related industrial development aspects.

Specifically, the project spearheaded by UNIDO in collaboration with the Division of the Environment (VPO) is aimed at achieving continuing minimization of unintentionally produced POPs (u-POPS) releases in the open burning sector of participating African countries of SADC region through introduction of best available techniques and best environmental practices (BAT/BEP) measures at Kigamboni and Ubungo municipalities in Tanzania. The assignment which was carried out for this report was supposed to avail baseline survey results which can be used in the next stage of the main project.

1.2 Terms of Reference for the Assignment

The terms of reference for this assignment are clearly outlined in contract for the assignment. They are not reproduced here to avoid unnecessary repetition. However, they are well reflected in the main part of the report. This part of the report is presented in accordance with the flow of the ToR items. In addition, Table 2.1 in Chapter 3 outlines the ToR.

1.3 Practical Interpretation of the Terms of Reference

Although the side notes in the ToR for this assignment suggested that the assignment would not need any significant fieldwork other than site visits, the guide notes on the kind of data and information to be collected coupled with knowledge on the status of available data and information indicated clearly that extensive field surveys and investigations had to be done. As it turned out, the data and information in the custody of the authorities were not exactly sufficient or even reliable. In fact, even the relevant data and information in the custody of other institutions, including academic institutions, turned out to be unsuitable for the purpose at hand. The exception was data and information already in our custody, which nonetheless also needed to be updated to make them address squarely the needs of this assignment.

In order to address the quantity shortfall and quality deficiency in the available data and information, this assignment has involved extensive physical surveys and investigations. One aspect focused on quantification and characterisation of solid waste through field determination of

composition and generation rates of solid waste from all sources of solid waste in the project areas. It additionally involved quantification and characterisation of persistent solid waste fractions along the waste stream from the source all the way to the disposal sites including illegal ones.

Table 1.1 sums up important aspects and features of the practical interpretation of the ToR for this assignment which has added value to the originally envisaged output of the assignment.

Table 1.1: Important aspects and features of practical interpretation of the assignment's ToR

SN	Noteworthy practical interpretation the assignment ToR	Remarks and explanatory notes
1	Inventory and characterisation of illegal solid waste discharge sites in the project areas.	This task was partly indicated in the ToR, but it has been given more emphasis.
2	Inventory and characterisation of areas where open burning of solid waste is done in the project areas.	This task is indicated in the ToR; it is the heart of the assignment; but it has been done more comprehensively.
3	Field determination of solid waste composition and generation rates for all sources of solid waste in the project areas.	This task is an integral part of the ToR but the ToR indicated that it was meant to make use of secondary source data.
4	Field determination of persistent solid waste fractions along the solid waste stream from generation to disposal.	This task was not part of the ToR but was deemed necessary for the completeness of the assignment.
5	Inventory and characterisation of solid waste resource recovery practices all along the solid waste stream.	This was implied in the ToR but it has been done more comprehensively in this assignment
6	Field determination of persistent solid waste fractions within long deposited solid waste at solid waste disposal sites.	This task was not part of the ToR but was deemed necessary for the completeness of the assignment.

SN	Noteworthy practical interpretation the assignment ToR	Remarks and explanatory notes
7	Inventory and characterisation of solid waste composting activities and facilities in Dar es Salaam.	This task was indicated in the ToR and it has been accomplished accordingly.
8	Inventory and characterisation of the solid waste resource recycling industry including the resource collectors and industries that process and thrive on recovered solid waste resources.	This task was indicated in the ToR, however the ToR indicated use of secondary rather than first hand up to date data. The task was was partly accomplished comprehensively suing up to date first hand data.
9	Inventory and characterisation of activities and facilities involved in integrated waste management and resource recovery that encompass solid waste, faecal sludge, and wastewater and recovers both material and energy resources from waste.	This task was not part of the ToR but was included because it is very much in line with the objectives of the assignment and the assignment's report would be incomplete without it.
10	Inventory and characterisation of activities and facilities used to produce fuel briquettes using solid waste from the project area	This task was not part of the ToR but was included because it is very much in line with the objectives of the assignment and the assignment's report would be incomplete without it.
11	Inventory and characterisation of major infrastructure used in research and technology development pertinent to solid waste recycling and composting.	This task was not part of the ToR but was included because it is very much in line with the objectives of the assignment and the assignment's report would be incomplete without it.
12	Inventory and characterisation of biogas production facilities that use solid waste in the project area.	This task was included because it is very much in line with the objectives of the assignment and the assignment's report would be incomplete without it.

The entries in Table 1.1 are predominantly for tasks that were not specified in the ToR as required. However, not carrying them out would have affected the quality of the report and its eventual utility to the project. Therefore, they had to be done even though this ended up stretching the

assignment duration and increasing its cost beyond even the contract budget. Therein lies an important lesson in this respect.

1.4 Guidance on how the Report Addresses the Terms of Reference

Guidance on how the report has addressed the terms of reference is summed in Table 2.1 (Chapter 3). Table 2.1 shows how the methods used to acquire and generate the data and information for this assignment were derived from the terms of reference. Therefore, it shows clearly the connection between each of the terms of reference item and the corresponding data and information presented in the report.

PART C: DATA AND INFORMATION ACQUISITION METHODS

2.0 DATA AND INFORMATION ACQUISITION METHODS

2.1 Descriptions of Pilot Project Areas

2.1.1 Kigamboni municipality

Geographical location

Kigamboni Municipality was created from Temeke Municipality through the government gazette No. 462 of 2015 about the distribution of the district. Kigamboni covers 416 an area of square kilometres. Furthermore, Kigamboni district is adjacent to the Indian Ocean to the east, Mkuranga district to the south, Indian Ocean to the north and Temeke municipality to the west. The municipality has 9 wards (Kigamboni, Mji Mwema, Tungi, Kimbiji, Kibada, Vijibweni, Somangila, Pembamnazi and Kisarawe).

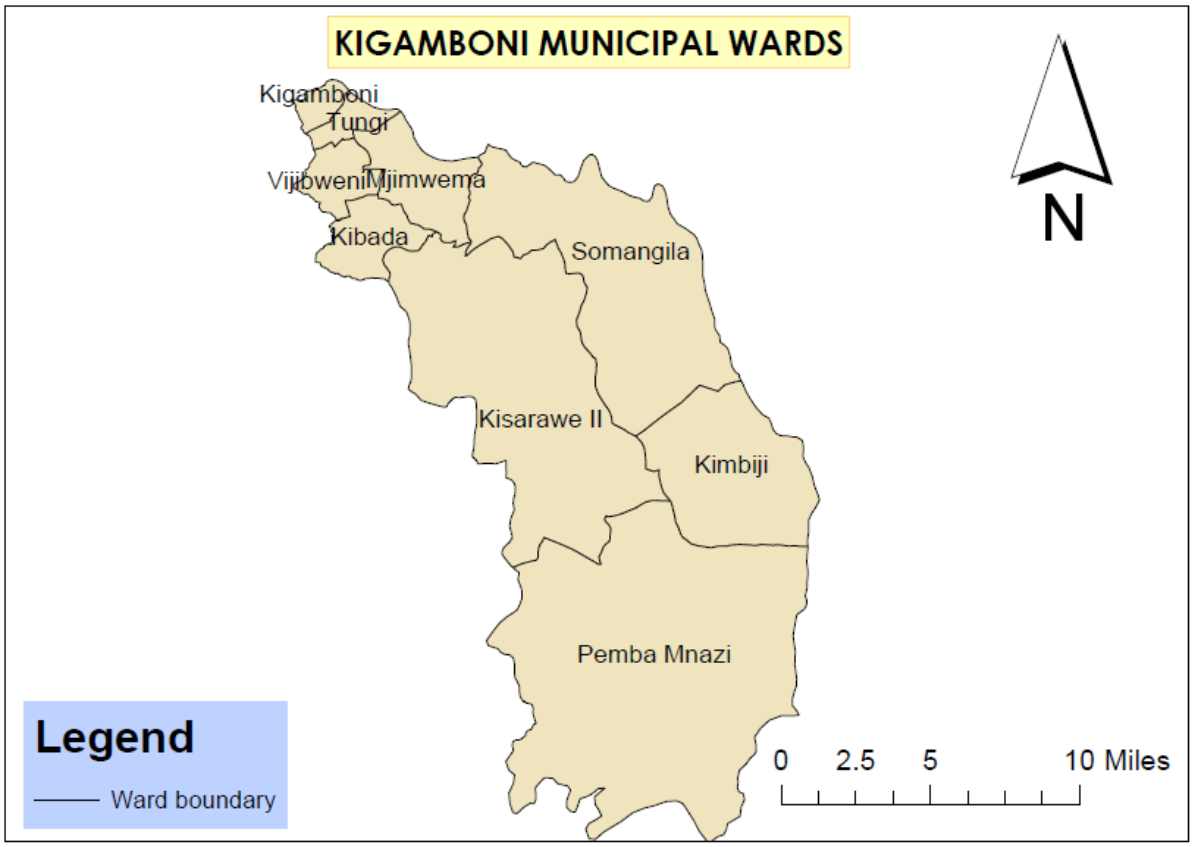

Figure 2.1: Kigamboni administrative map

Temperature and rainfall

Based on data and information from the Tanzania Meteorological Agency, the Municipality experiences a modified type of equatorial climate. It is generally hot and humid throughout the year with an average temperature of 29^0C .The hottest season is from October to March while it is relatively cool between May and August with temperature around 25^0C. There are two rain seasons, the short one is from October to December while the long one is between March and May. The average annual rainfall is 1300 mm.

Population size

Following the census in 2012, Kigamboni Municipality had a population of 162,932 and 40,133 households. Of these 81,199 were men and 81,733 were women. It has an estimated population increase of 5.6 percent per year. In 2017, the Municipality had an estimated population of 205,966 people and 48,043 households. Among the 205,966 people, 102,645 are men and 103,321 are women.

2.1.2 Ubungo municipality

Geographical location

The Municipality is bordered by the Kibaha district to the North, Kinondoni District to the South-East, and Kisarawe District to the West. The municipality is well linked by roads and other communication networks to the rest of the city and other parts of the country. Major road links are: Morogoro road, Mandela road and Sam Nujoma road. Ubungo Municipality has a total area of 260.40 square kilometres.

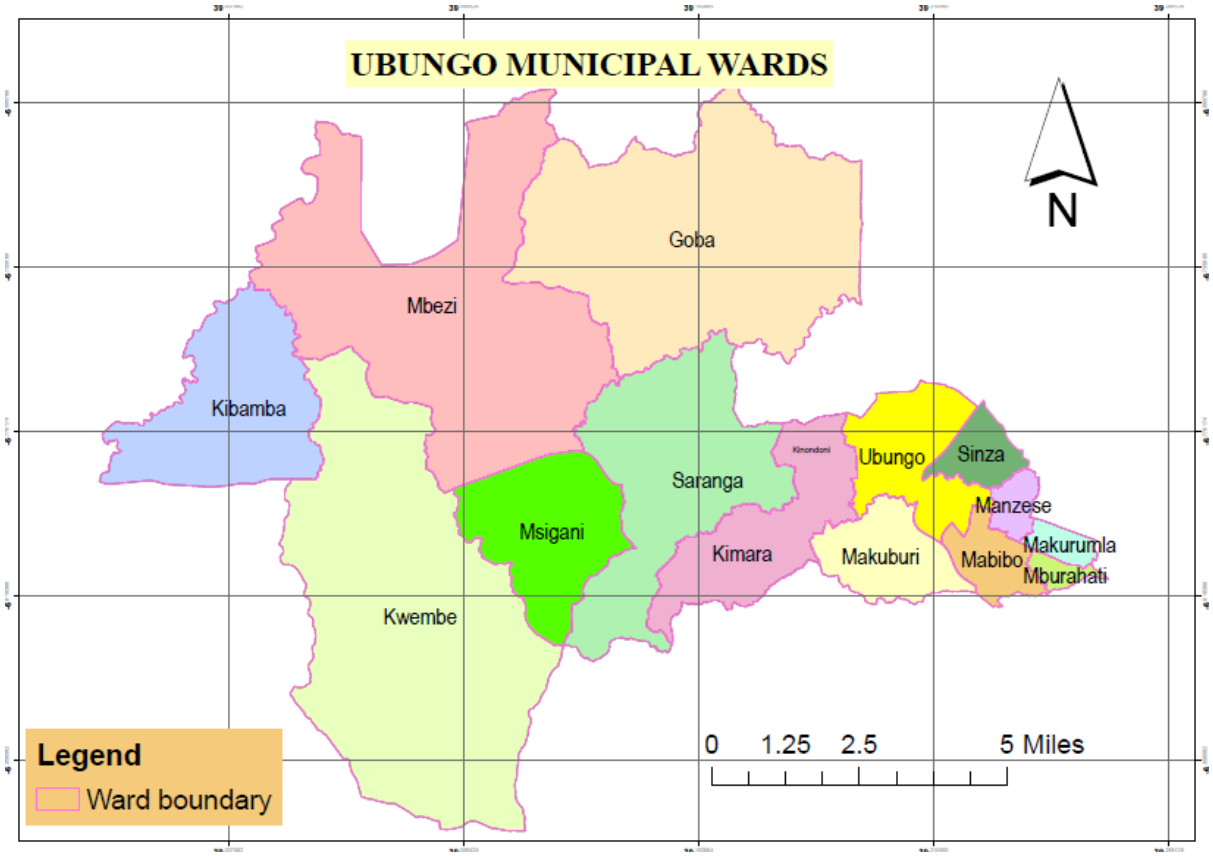

Figure 2.2: Ubungo administrative map

Temperature and rainfall

Based on data and information from the Tanzania Meteorological Agency, the Municipality experiences a modified type of equatorial climate. It is generally hot and humid throughout the year with an average temperature of 29^0C .The hottest season is from October to March while it is relatively cool between May and August with temperature around 25^0C. There are two rain seasons, the short one is from October to December while the long one is between March and May. The average annual rainfall is 1300 mm.

Population size

According to the 2012 population census (NBS, 2012), the municipality had a population of 845,368 where males were 409,149 and females were 436,219, but with the population projection

of 2016 Ubungo municipality had a total population of 1,031,349 where by males were 499,161 and females were 532,188. The population growth rate was 5.0% per annum with a population density 4,911 people per square kilometre. The municipality is estimated to have 257,837 households with an average of 4 persons per household.

Employment and economic activities

It is estimated that Ubungo has a population of 1,031,349, among of those 701,317 are able to work while the remainder are elders and children who are 20,626 and 309,404 respectively. Of the total workforce, 61% are engaged in the private sector, 35% are self-employed and 4% are employed in the public sector.

2.2 Data and Information Requirements

The data and information requirements for accomplishing this assignment were determined on the basis of the ToR for the assignment. However, as explained in great detail earlier (Section 1.3, Table 1.1), the ToR were subjected to a practical interpretation before the data and information requirements were derived.

2.3 Derivation of Data and Information Acquisition Methods

The methods used to accomplish the acquisition of data and information and their subsequent analysis for this assignment were selected on the basis of data and information requirement outlined earlier. The actual derivation was accomplished in three major stages as outlined next.

Stage 1: Determination of data and information required to address the objectives and specific terms of reference for the project.

Stage 2: Identification of actual and potential sources or custodians of the required data and information

Stage 3: determination of methods or suite of methods suitable for acquiring and processing the identified data and information in line with the needs of the assignment.

The descriptions of the three stages of the derivation of data and information acquisition and generation methods together with their results are summarised in Table 2.1.

Table 2.1: Derivation and selection of data and information acquisition and generation methods

RE	Data and information type	Data source/custodian	Acquisition methods
A.	Information on existing waste management plans	• Municipal and wards officers	• Check list guided interviews
B.	Size of population served by waste collection system and amount of waste generated;	• Municipal and wards officers • Wards officers • Residents • Contractors	• Check list guided interviews • Field survey and investigation • Observation
C.	Number of contractors; type of collection contracts; number of trucks and transport capacity for each contractor; type of collection (door to door, collection point and others); collection routes and periods; number of trips /routes to dump site	• Municipal Officers • Contractors • Wards	• Check list guided interviews • Field surveys and investigations
D.	Description of collection services carried out by	• Municipal Officers • Contractors • Wards	• Check list guided interviews

RE	Data and information type	Data source/custodian	Acquisition methods
	external (not appointed) companies		
E.	Waste fees and payment systems for different collectors	• Municipal Officers • Contractors • Wards	• Check list guided interviews
F.	Ongoing initiatives/project for new optimized collection system and related fee policies	• Municipal Officers • Contractors	• Check list guided interviews
G.	Size of served and non-served population by waste collection	• Municipal Officers • Contractors • Wards	• Check list guided interviews • Field surveys and investigations • Check list guided interviews
H.	Waste analysis characterization study at generations (household) and at dumpsite to assess the current recycling activities	• Municipal Officers • Contractors • Resident • Wards • Recyclable collectors and industries	• Check list guided interviews • Field surveys and investigations • Photography
I.	Estimate amount of recyclables from different sources (Household, commercial, institution)	• Municipal Officers • Contractors • Resident • Wards • Recycling collectors & industries	• Check list guided interviews • Field survey and investigations • Photographing • Sorting of waste at house hold and at dumpsite also

RE	Data and information type	Data source/custodian	Acquisition methods
			determining of generation rate
J.	Assessing ongoing activities on collection of recyclables from public and private companies /institution, locations of supermarkets, malls, commercial activities which produce recyclables and could be of reference for collection centres	• Municipal Officers • Contractors • Wards	• Check list guided interviews • Field surveys and investigations
K.	Assess current collection system from households and existing recycling activities	• Municipal Officers • Contractors • Wards	• Check list guided interviews • Field surveys and investigations
L.	Asses sites for CCs and number	• Municipal Officers • Contractors • Wards	• Check list guided interviews • Field surveys and investigations
M.	Identify potential private partner for CCs	• Municipal Officers • Contractors • Wards	• Check list guided interviews • Field surveys and investigations
N.	Identify buyers (local and international) of recyclables	• Municipal Officers • Contractors	• Check list guided interviews

RE	Data and information type	Data source/custodian	Acquisition methods
		• Wards	• Field surveys and investigations

2.4 Data and Information Acquisition Methods and Application

On the whole, the methods actually used for the acquisition and generation the information and data for this assignment were the ones outlined in Table 2.1 and explained in greater detail in the next discussion.

Brainstorming: All the other identified methods were preceded by and interspersed with brainstorming which was done to generate ideas and come up with data acquisition strategies throughout all the stages of the assignment.

Reconnaissance surveys: The reconnaissance surveys were the very first kind of surveys carried out in the field. They served to avail preliminary data and information for planning and designing the subsequent fieldwork. Reconnaissance surveys also encompassed field visits for fulfilling protocol requirements and for seeking permission as well as setting up appointment for interviews.

Review of various documentary sources of data and information: The documentary sources review covered research reports, consultancy reports, design reports and design drawings, journal papers, conference proceedings, and presentation slides for conferences and related events.

Interviews: All the interviews were guided by specific checklists. There was a specific checklist for guiding each kind of interview or interviewee. Interviews were conducted with municipal and other relevant officials and staff.

Field surveys and investigations: During the initial and early stages of the fieldwork, checklist guided field surveys and investigation enabled the understanding and characterisation of the project area itself as well as waste management and resource recovery strategies and practices in

the project area. Additionally, it enabled the identification and characterisation of illegal solid waste discharge premises as well as open burning sites.

In the later and final phases of the fieldwork, field surveys and investigations facilitated the achievement of the following:

- Field determination of solid waste composition and generation rates;
- Field determination of persistent solid waste fractions along the solid waste stream from generation to disposal;
- Inventory and characterisation of solid waste resource recovery practices all along the solid waste stream;
- Field determination of persistent solid waste fractions within long deposited solid waste at solid waste disposal sites;
- Inventory and characterisation of solid waste composting activities and facilities;
- Inventory and characterisation of solid waste recycling industry including the industries and resource collectors; and
- Inventory and characterisation of activities and facilities involved in integrated waste management and resource recovery that encompass solid waste, faecal sludge, and wastewater and recover both material and energy resources from waste.

Field determination of solid waste composition and generation rates and persistent solid waste fractions along the waste stream as well as at solid waste disposal sites was conducted in accordance with standard procedures and protocols. Exactly the same procedures and protocols were followed in Kigamboni and Ubungo municipalities.

Their contents of the samples were sorted and weighed to obtain the composition of the waste disposed of in these dump sites. Also solid waste characterization was done in ten generation areas in the Municipality to obtain composition of the waste generated. Samples of solid waste for the determination of composition and generation rates were collected from representative samples such as residential areas. A total of sixty samples was collected every day for a total of four days. Four additional samples were collected every day for four days from each of two dumpsites. The collected solid waste was sorted and weighed. The resulting data were accordingly processed abd analysed for solid waste composition and generation rates. The foregoing was done for sources of solid waste in both Kigamboni and Ubungo municipalities.

Additional samples were collected from Pugu Kinyamwezi disposal site in order to obtain data on composition and quantities of waste disposed of as well as composition of persisted of solid waste fractions at this disposal site. Pugu Kinyamwezi solid waste disposal site is special because it is the largest and the oldest formally operational solid waste disposal site in Dar es Salaam city. Therefore it is special in several ways and so are the data on and about it.

In order to determine area sizes, coordinates along all corners of areas of interest were taken and then entered into ArcGIS. Areas were computed using the produced polygons on the existing map scale, computed areas for collection centres have the accuracy of 10 ± 0.1.

Consultation: Consultation was done to obtain expert opinions and perspectives. It was used to obtain data regarding solid waste management and recycling from various stakeholders including municipal offices, local government offices, recyclable collectors, recycling industries and composting centres. Additional information on sample sources and sampling in connection with consultation is presented in Table 2.2.

Photography: Photography was used for acquiring the photographic images included in the report. The photographs captured and froze in time images of various scenes of interest for the reader to see and interpret independently. For most of the images, written descriptions would not have sufficed.

Questionnaire surveys: Question surveys were conducted among households and other main generators of solid wastes. Questionnaire surveys were used to gather information regarding solid waste management from residential areas, commercial areas and institutions such as schools churches, mosques. Table 2.2 shows sample sources and sampling in connection with the questionnaire surveys and consultation during the study.

Table 2.2: Sample sources and sampling for questionnaire surveys and consultation in Kigamboni and Ubungo municipalities

Ubungo municipality		
Data and information source/custodians	Number of samples	Description
Municipal offices	1	-
Ward	14	1 Per ward
Sub-ward	91	1 per sub ward
Residents & commercial	420	30 per ward
Institutions	Varied	At least 1 for each category(schools, churches and mosques)
Recycling industries	All	In and outside the municipality
Recyclable collectors	All	Covered those collecting more than 1 ton/week.
SW collection contractors	All	Some were not available during the study
Kigamboni municipality		
Custodian	Number of samples	Description
Municipal offices		-
Ward	1	1 Per ward
Sub-ward	34	1 per sub ward
Residents & commercial	270	30 per ward
Institutions	Varied	At least 1 for each category (schools, churches and mosques)
Recycling industries	All	In and outside the municipality
Recyclable collectors	All	Covered those collecting more than 1 ton/week.

SW collection contractors	All	Some were not available during the study

Computer software tools: MS Excel was used to organise, analyse, perform mathematical manipulations, and process data for producing charts for presentation. GIS software tools were used were used to process, analyse, and manipulate geo-referenced data and information.

Challenges in data acquisition in the field

Several direct and indirect challenges got in the way of acquiring the data and information during the fieldwork for this assignment, resulting in unplanned and unanticipated delays. The following are the main challenges that were encountered during data acquisition efforts in the field:

- Insufficient cooperation in some wards and sub-wards: Some of WEOs and MEOs were not sufficiently cooperative in connection with such things as introducing the study team to residents and other stakeholders in this projects. Also, there cases in which some people seemed to anticipate financial inducements in return for their cooperation.
- Hesitation in giving information for fear of self-incrimination: Some of residents and stakeholders were afraid in giving out full information regarding solid waste management including information on causes of illegal dumping, their solid waste collection service providers, and fees they pay for the collection service. Also, many of contractors refused to provide information on their collection vehicles that are actually working assuming that the study team may be government officials.
- Some of residents in Kimbiji and Somangila were not sufficiently cooperative because they were reluctant to let their solid waste collection service provision to be handled by the local government. They preferred to handle their solid wastes themselves by burning and burying arguing that the have enough land to accommodate this practice.

PART D: STATUS OF SOLID WASTE MANAGEMENT AND OPEN BURNING OF SOLID WASTE

3.0 CURRENT STATUS OF SOLID WASTE MANAGEMENT

3.1 Kigamboni Municipality

3.1.1 Existing solid waste management system

Solid waste in Kigamboni municipality comes from various sources including residential, commercial, institutions and industries. Existing solid waste management options in the municipality include centralized and decentralized dumping, burning, burying and recycling. In three wards (Kigamboni, Tungi, Vijibweni), generated solid wastes are dumped in centralized dump site located 20m from Tanzania international Petroleum Reserves Limited (TIPER) (to the Southern side). Some of the residents in these wards bury and burn their wastes due affordability challenges regarding service fees. On other hand, most of areas in these wards are unplanned and not accessible even for small collection vehicles.

Figure 3.1: Uncontrolled dumping at south of TIPER. The photo was taken on 16 November 2018 at coordinates 534552.01, 9244166.12 WGS 1984 UTM Zone 37S, facing TIPER fence.

Most of solid waste generated in Mji Mwema ward is dumped in borrow pits located in the southern part of the ward. In Kimbiji ward a small portion of generated waste mainly from market and areas located at the centre of the ward are collected by individuals and dumped in the northern part of Kizito Street. The rest of the areas in this ward manage their waste themselves usually by burning and burning.

In the remaining wards, most of residents still have enough land to conduct small scale farming, and as the result most of biodegradable solid waste ends up on the farms while the non-biodegradable portion is burned or buried.

3.1.2 Solid waste generation in Kigamboni municipality

Based on field surveys and investigations which generated original and up to date solid waste generation and composition data, the average daily solid waste generation rate is 0.75 kg/c/day. Since solid waste generation depends on the population in a given area, Kigamboni, Mji Mwema, Vijibweni and Tungi wards produce considerably high amounts of waste compared to other wards. Most of the areas in these wards have high housing densities with consequent high population density and high solid waste generation rate. The total solid waste generation in each wards was calculated using the generation rate obtained from field surveys and investigations in line with the usual practice in this respect. The outcome of the computation is presented in Table 3.1.

Table 3.1: Solid waste generation rates in different wards of Kigamboni municipality

SN	Ward	Population	Total solid waste generation (t/day)
1	Kigamboni	46137	34.60
2	Kibada	12988	9.74
3	Mji Mwema	37701	28.28
4	Somangila	26161	19.62
5	Pembamnazi	13122	9.84

SN	Ward	Population	Total solid waste generation (t/day)
6	Kimbiji	8698	6.52
7	Vijibweni	39358	29.52
8	Tungi	31720	23.79
9	Kisarawe II	12566	9.42
Total			171.34

3.1.3 Solid waste characterization

Kitchen wastes and other biodegradable organics are the main contents in solid waste generated in the municipality. This also indicates that a large percent of the waste generated comes from residential areas. Other constituents of the waste include plastics, boxes and paper, poly sacks and glass. These have considerably low bulk density. Solid waste characterization was conducted at generation and disposal points; some waste fractions accounted for higher proportions at generation points but lower proportions further down in the waste stream because since some of recyclables are removed from waste streams at disposal sites. Figures 3.2 and 3.3 present data on the composition of solid waste at generation and disposal points in Kigamboni municipality.

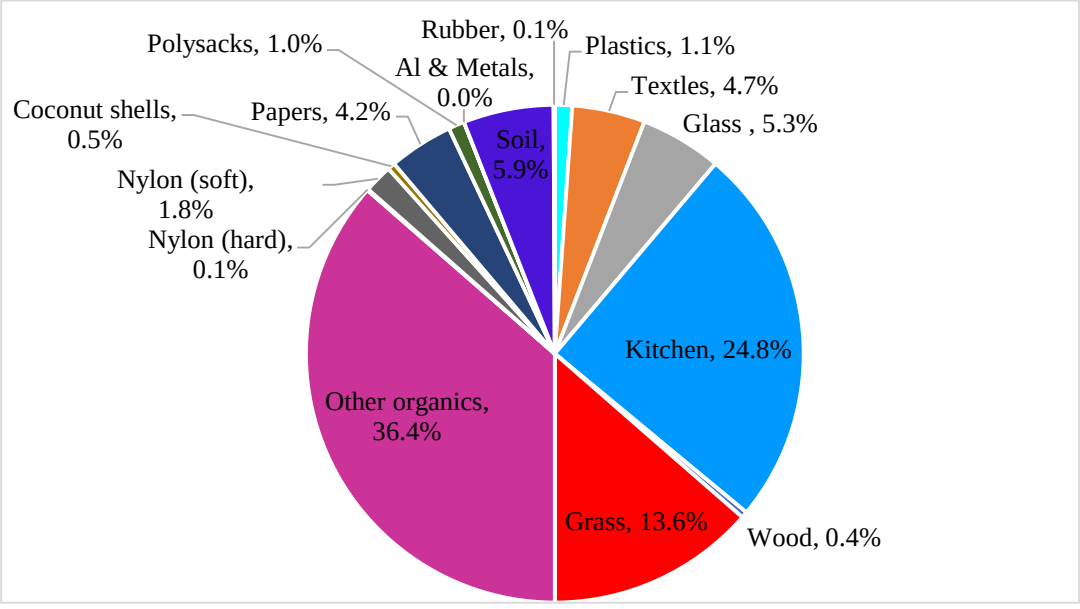

Figure 3.2: Solid waste composition at generation points in Kigamboni Municipality

Solid waste composition at Kigamboni dump sites (TIPER and Mji Mwema) was almost the same as that obtained at generation points. Of all the waste fractions identified, the so called soft nylon was the most problematic to deal with since there are no recycling industries that accept these waste fractions in the region. The surveys and investigations for this assignment also revealed that this and other similar materials are not economical to recycle. Furthermore, since most of valuable materials are being scavenged at disposal sites, most of them are being left in the waste stream because the waste pickers lack suitable techniques and tools for removing potentially recyclable materials from the waste stream individuals participating in these activities. It can further be argued that some materials are left in the waste stream because they do not have a market within and outside the country.

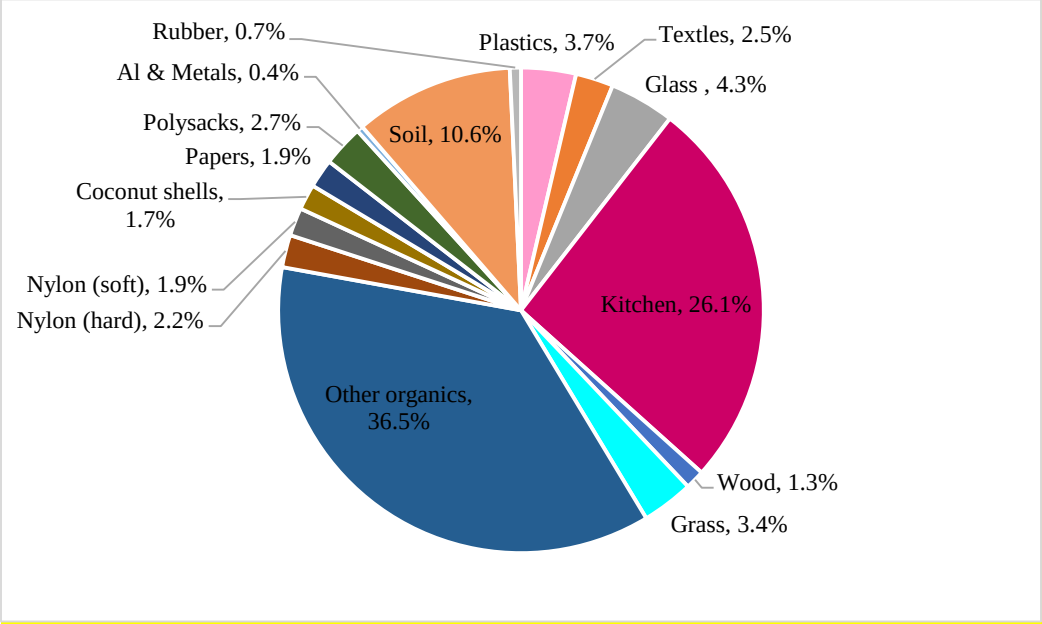

Figure 3.3: Solid waste composition at Kigamboni dump site

Solid waste fractions which persist (literally refuse to be amenable to resource recovery) from generation point, through storage, collection, and transportation to the disposal point are the ones which, in the context of waste management and resource recovery we refer to as persistent solid

waste fractions (PSFs). We have pioneered detailed determination of PSFs for Dar es Salaam city and Moshi municipality. Therefore, a pretty good picture is available for comparative analysis

In addition to the foregoing revelations, it is noteworthy that waste pickers are highly vulnerable to diseases because they do not use any protective gear when on the job. This implies that improvement in waste resource recovery needs to take this into consideration.

3.1.4 Amount of recyclables generated

The total amount of recyclable generated in the municipality has been computed from solid waste composition data presented earlier. Figure 3.4 presents data on quantities of recyclables generated in the municipality.

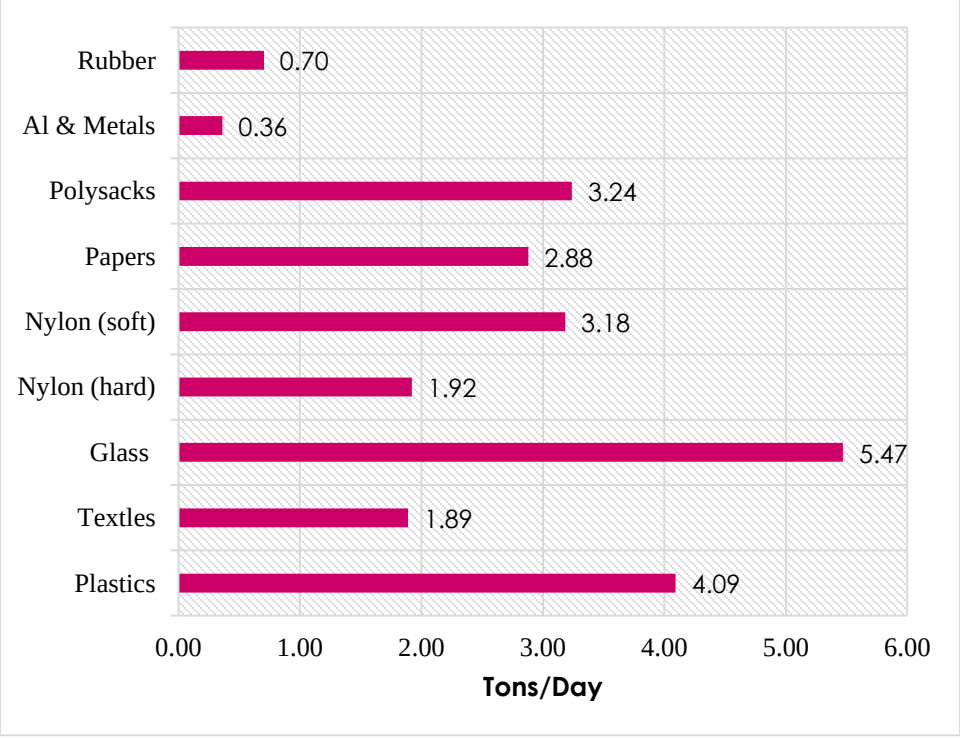

Figure 3.4: Amount of recyclables generated in Kigamboni Municipality

Currently plastics, hard nylon, glass, aluminium and other metal items plus poly sacks are being sorted and transported to processing industries available in the Dar es Salaam region. Regardless of many individuals who participate in recyclables collection in the municipality, a large proportion is still left over due to inadequate systems for collection of these recyclables. Furthermore, some recyclables such as rubber, paper and textile are not recycled due to the absence of industries that are able and willing to recycle them. This qualifies these materials as PSFs.

3.1.5 Amount of biodegradable wastes generated

Surveys and investigations revealed that biodegradable waste fractions account for a large percent of the waste generated in Kigamboni municipality in terms of weight. These waste fractions can be subjected to composting and the resulting compost can be used as fertilizer on farm lots for various food crops in urban agriculture. This is especially applicable in peripheral areas of municipality and adjacent areas such as Kisarawe District which have a potential market for compost.

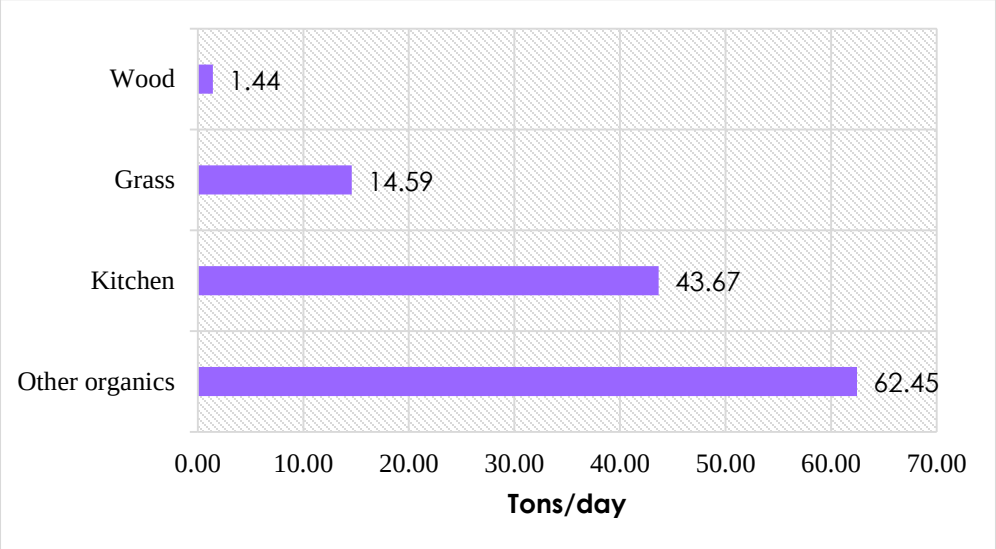

Figure 3.5: Amount of organic waste generated in Kigamboni Municipality

3.1.6 Waste fees and payment for contractors

The provision of solid waste management service in Kigamboni municipality is vested to local authorities. They designate and allocate solid waste collection contracts for different parts of their jurisdiction in line with needs. MEO's offices assist contractors in obtaining waste collection service fees from residents whereby 10% of the collected money is retained by local government office to cover the fees collection cost. Waste collection service fees are set by the municipal council and are outlined in the Municipal by-laws. They range from TZS 3,000 to TZS 170,000 per month. Table 3.2 shows the waste collection service fees for various categories of solid waste generators in the municipality.

Table 3.2: Solid waste collection service fees in Kigamboni Municipality as per Bylaws

S/N	Generator	Monthly fees (TZS)
1	Residential	3,000
2	Restaurant	30,000
3	Guest house	20,000
4	Dispensary	20,000
5	Ice selling place	50,000
6	Health centre	20,000
7	Industry (non-hazardous)	100,000
8	Industry (hazardous)	170,000
9	Hospital	40,000
10	Whole sales shops	20,000
11	Retail stores	10,000

S/N	Generator	Monthly fees (TZS)
12	Private school (day)	20,000
13	Private school (boarding)	25,000
14	Day care	14,000
15	Whole sales store(food)	20,000
16	Bar	50,000
17	Butcher	12,000
18	Pharmacy	15,000
19	Bus terminal	120,000
20	Machinga	2,000
21	Carpenter	60,000
22	Super market	60,000
23	Market (per table)	4,000
24	Electronic repairs	6,000
25	Saloon	10,000
26	Registered tailor	10,000
27	Charcoal store	20,000
28	Warehouse	50,000
30	Petrol Station	60,000
31	Hotel: 01-10 rooms	20,000

S/N	Generator	Monthly fees (TZS)
	11-15 rooms	40,000
	16 - 25 rooms	50,000
	26 - 50 rooms	60,000
	51 -7 5 rooms	70,000
	76-100 rooms	80,000
	100 and above rooms	100,000

Source: Kigamboni municipal office

Due to challenges faced during fees collection one of which being the awareness of residents on the importance of solid waste collection, the contractors do operate for long once assigned a service area. As result, in most parts of the project areas solid waste is collected by unregistered individuals who are paid by solid waste generators to transport their waste to the dumping sites. The payment for the service depends on a negotiated agreement between the pseudo contractor and the service beneficiary. The usual rates paid are often based on waste quantity and trip cost, and between TZS 1000 and TZS 5000 depending on actual amount of solid waste to be transported. The average cost per trip can be taken to be TZS 2500 per trip.

3.1.7 Size of the population served by waste collection systems

The formal solid waste collection service covers a small percent of the municipality population. There no documented data in the municipal office pointing out the size of the population served by solid waste collection system. In fact, based on the field survey and investigations conducted no wards have collection services that serve the whole population.

Based on our surveys and investigations for this assignment, 14,417 people equal to 7% of the municipality population are served by registered solid waste collection service providers, 36% equal to 74,147 residents are served by unregistered solid waste collectors and 57% of the population which is equal to 117,400 people are not served at all. It can justifiably be concluded from the foregoing discussion that, the solid waste generated by the unserved population ends up in open burning, illegal dumping and burying.

3.1.8 Collection systems

All of the collectors (registered and non-registered) in Kigamboni municipality use the door to door collection system. In markets waste is collected and temporarily stored in one place from where it is transported to the dump sites. Residents living near dump sites transport their waste for disposal themselves.

3.1.9 Services carried out by non-registered companies

3.1.9.1 Solid waste collection

Solid waste in most of the areas in Kigamboni municipality is collected by non-registered individuals. For most of interviewed collectors, transporting waste to nearby dump sites from residents is the main source of their income. On the other hand, non-registered collectors do not have appropriate equipment and vehicles for solid collection. Instead, they use rather crude or improvised and inappropriate transportation vehicles such as handcarts, non-motorised tricycles (commonly referred to as guta), and motorised tricycle (commonly known as toyo). These can transport considerably small amounts of waste ranging from 50 kg to 200 kg. The payment for collection varies depending on the agreement between the residents and these collectors. The solid waste collected by non-registered individuals is often dumped in inappropriate premises due to the fact that they take advantage of the situation to cut corners.

Based on our surveys and investigations carried out for this assignment, 90% of the illegal dumping sites are caused by non-registered solid waste collectors. Therefore, solving the illegal solid waste collection challenge is key to solving the illegal solid waste disposal problem.

Figure 3.6: Uncontrolled dumping at Mji Mwema borrow pits.

The photo was taken on 15 November 2018 at coordinates 538569.43, 9242226.50 WGS 1984 UTM Zone 37S, facing North West.

3.1.9.2 Recyclables collection

Recyclable solid waste fractions (plastics, aluminium and ferrous metals) are collected by non-registered individuals (scavengers) to the middle men who then transport them to the processing industries (RAIDER Company Limited which is located in Kigamboni municipality) and Fusun Investments Co United which is located in Kurasini. The middle man pays TZS 150 per kilogram for plastics and sells them for TZS 300 at processing industries. For that amount of money, these collectors depend on collecting recyclables as their main source of income. On the whole, a large proportion of plastics, aluminium and ferrous metals are picked up at generation points and hence

their availability in the disposal areas is low. Also, what is left of these materials in the waste stream from generation points is picked up at the dump sites.

Figure 3.7: Recyclable collection centre at Kigamboni ward

The photo was taken on 14 November 2018 at coordinates 533760.13, 9245728.17 WGS 1984 UTM Zone 37S, facing East.

3.1.10 Mode of collection for recyclables

Recyclables are scavenged at generation points, and the sources include residential premises, commercial areas and institutions. The collection usually involves three players, scavengers who pick recyclable wastes directly from generation points, the middle man who buys these recyclables waste from the scavengers and finally the processing industries that process the recyclables. All individuals participating in recyclables collection are not registered by authorities and hence they do not pay any kind of fee. Furthermore, there are various recyclable collection centres within the municipality which are owned by individuals. In some cases residential premises are used to accommodate temporary storage facilities for the recyclables.

3.1.11 Current recyclable materials

3.1.11.1 Plastics

Plastics referred to here are mainly plastic bottles used for various drinks packaging. Most of these materials are generated in commercial areas including bars, shops and markets. Also, a small proportion is generated by institutions and residential areas. Figure 3.8 presents data on quantities of plastics collected by various recyclable collectors in each ward in the municipality.

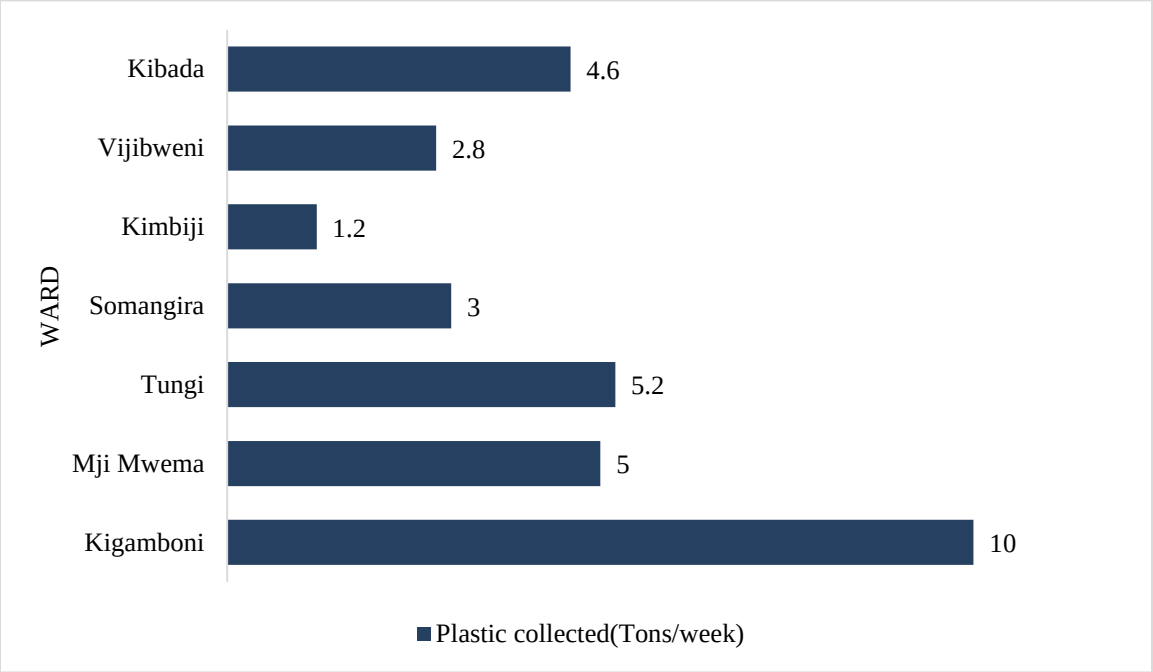

Figure 3.8: Amount of plastics collected in Kigamboni municipality per week

3.1.11.2 Ferrous and aluminium

Surveys and investigations for this assignment revealed that two collectors of ferrous metals and aluminium are located in Kigamboni and Kibada wards. These collectors all together collect about 14 tons per week and deliver the lot to a larger collector located in Kurasini who in turn transports these recyclables to processing industries. Although the study found three collection sites in the municipality, many of the collection sites for these materials are located outside the municipality which suggests that amount of ferrous and aluminium collected is more than 14 tons per week.

3.1.12 Ongoing project for optimized collection system

The main project for optimization of solid waste management system in the municipality is the proposed Kisarawe landfill which 154 acres. As the part of the project, the proposed landfill will have compositing centres for biodegradable waste management and sorting areas to remove recyclable materials to keep them from being landfilled. The project will optimize solid waste collection in the Municipality since the current transportation distance to Pugu-Kinyamwezi where the current disposal site is located is too long and not economical for solid waste collectors. The long transportation distance to the disposal site is a likely contributing factor to an increase in illegal solid waste dumping within the municipality.

Apart from landfill construction plans, which according to the Municipality office is in the final stage of implementation, there are several initiatives for solid waste collection optimization which includes:

- Raising awareness among the community concerning solid waste management; the efforts encompass prohibition and education on burning practices, education on impacts of illegal dumping and burying to the environment.
- Removing all kind of burdens on recyclables collectors as well as plans for provision of collection centres for recyclables in some wards including Kigamboni, Kimbiji and Kibada wards.

3.1.13 Solid waste sorting

Sorting as the key to waste recycling is being conducted at generation points and disposal sites. In Kigamboni, Tungi and Somangila wards, sorting activities are conducted at the dump site where valuable materials including plastics, ferrous metals and aluminium items, and poly sacks are picked out and transported to processing industries for recycling. The study found that about 2 tons/week of plastics are sorted and picked out of solid waste at TIPER dump site. Figure 3.9

shows the sorted plastics ready to be transported to recycling industry (RAIDER) located in the eastern side of the municipality.

Figure 3.9: Solid waste sorting at TIPER dump site. The sorted and picked out plastic recyclables can be seen in bags towards the background

The photo was taken on 16 November 2018 at coordinates 534723.27, 9244103.27 WGS 1984 UTM Zone 37S, facing TIPER fence.

Segregation and sorting of solid waste at generation points is conducted by a small number of residents most of them can be found in Kigamboni, Kimbiji and Somangila wards. Sorted waste include biodegradable waste which is used as manure, kitchen waste for animal feeding and non-biodegradable waste is either buried or burned.

Figure 3.10: An example of segregation and sorting practices at generation points in Kigamboni ward.

The photo was taken on 14 November 2018 at coordinates 534046.23, 9245799.66 WGS 1984 UTM Zone 37S, facing Western side.

3.1.14 Burning practices

Burning is the one of the solid waste management challenges in the municipality as it is currently used as the disposal method to some of residents. Although it is prohibited and continuous education concerning its environmental impacts is given to residents, most of them use burning as an economical method for disposal of wastes. The efforts for this assignment found burning practices being mostly conducted in Kimbiji, Somangila, Kibada and Vijibweni wards. In most cases residents burning their waste have enough land and are still conducting small scale farming. Apart from burning the waste as the disposal method, residents in these wards still burns their farms during cultivation season to clear their land. Figure 3.11 shows one of the farms cleared by burning which is located in Kimbiji ward.

Figure 3.11: Burning practice for land clearance in Kimbiji ward.

The photo was taken on 19 November 2018 at coordinates 557928.38, 9227979.23 WGS 1984 UTM Zone 37S, along Kimbiji Road.

3.1.15 Proposed final use of generated solid wastes

3.1.15.1 Reuse

Some of materials considered as waste can be reused in the community. Glass bottles, nylon bags, poly sacks and plastic bottles can be reused several times before being sent to recycling facilities. Reuse is considered the most economical in waste management hierarchy as it does not incur much cost. The investigations for this assignment determined that 90% of the population do not practice reuse although they are aware of its advantages. This indicates that if more effort is expended on raising reuse awareness in the community a significant amount of waste can be removed from the waste stream.

3.1.15.2 Recycling

Recycling differs from reuse because it includes the processing step. Recycling programs rely on separation of recyclable materials before they are mixed with the rest of the waste. This choice obviously depends on collection costs and other projected activities of recovery. Thus, although it is a simple concept, recycling can be performed effectively when the series of different aspects such as economics, social, training and technological are defined in details and their work is integrated and harmonized. Recycling can be can be promoted by encouraging waste separation at source. Separation at source can be achieved through financial incentives stimulation, legislation and raising of environmental awareness in the municipality.

Plastics, ferrous and aluminium items are the materials that can easily be economically recycled in the municipality. There are also other waste fractions that can be recycled including paper and nylons but they are not all necessarily economical to recycle. Furthermore, an apparent lack of markets for such materials is also the challenge. It is important to point out that Tanpack Paper Industry, which is located in Mikocheni light industrial area (outside the municipality) is known to recycle different fractions of waste paper. Moreover, our studies carried out in the past on the recycling industry indicate that the market for waste paper is available within and outside the country. It is quite possible that quality issues hamper efforts in respect of recycling of waste paper. Additional efforts are being expended to sort out the situation in order to establish the absolute truth.

3.1.15.3 Composting

Biodegradable waste can be composited to produce an organic fertiliser that can be used for supporting the growth of crops. Diverting such materials from the waste stream will free up dumping space to accommodate waste materials that cannot be composted. It will also result in a reduction in solid waste collection costs. Furthermore, there is a potential market for compost in Kigamboni municipality as some of the wards still conduct small scale farming. Also, Kisarawe district in which farming is the main activity is adjacent to Kigamboni municipality, which means the transportation cost for the produced compost will not be prohibitive.

3.1.16 Recyclable wastes buyers

Currently, there two buyers of recyclables collected by different waste pickers from the municipality. The recycling companies are RAIDER Company Limited which is located in Kigamboni municipality and Fusun Investments Co United which is located in the nearby Kurasini area. Table 3.5 presents data on quantities of recyclables processed by these industries per month.

Table 3.3: Recycling companies which handle recyclables collected from Kigamboni Municipality

Company	Recyclable material	Amount (tons/week)
RAIDER Company Limited	Plastics	-
Fusun Investments Co United	Plastics	55

Apart from these two companies which process recyclables collected from the municipality, there are other potential buyers of recyclables who are located in rest of the Dar es Salaam region. Table 3.4 presents a list of potential recyclable waste buyers who are located within the Dar es Salaam region.

Table 3.4: Recycling companies outside located Kigamboni municipality that can potentially process recyclables from Kigamboni municipality

Company	Input materials	Capacity (tons/week)	Location (municipality)
TANFOUR Company Limited	Plastics	30-40	Ubungo
TASIPA Company Limited	Poly sacks	25-40	Ubungo
SAMAKI Company limited	Poly sacks	40	Ubungo

HEGJI	Poly sacks	-	Ubungo

Apparently, all of the companies that can recycle recyclables collected from Kigamboni municipality are located in Ubungo municipality, which is the other pilot project area. The location of the industries in Ubungo area makes sense because there is a huge long dedicated industrial area in Ubungo municipality. It can be noted that the list of materials that can be accepted by the industries is limited to poly sacks and plastics.

3.1.17 Number of contractors and type of collection contracts

There are various solid waste collection contractors registered within wards in Kigamboni municipality. The investigations for this assignment found that most of the contractors do operate during the early parts of their contracts but soon go out of operation as depending on their ability to withstand the challenges that stand in their way. Based on consultation with the affected contractors, one of the contributing factors to situation is poor response of the community towards paying collection service fees. Another challenge, is the apparent fact the waste collection service fee charged is does not cover fully cost-recovery and business growth needs. As a result of this, the contractors do not make the anticipated profit and consequently fail.

The number of registered contractors per ward varies depending on the size of the ward or sub-ward. Also, some wards have no registered solid waste collection contractors at all, and these include Kimbiji and Somangila. In these wards non-registered individuals fill in the vacuum by providing the missing but essential service. They are directly paid by residents depending a negotiated agreement between. Table 3.5 below presents data on the number of contractors in each wards and correspond data on number of vehicles and their collection capacity.

Table 3.5: Number of contractors and their collection capacity in Kigamboni Municipality

Ward	Name of contractor	Number of vehicles	Capacity(tons /day)
Kigamboni	UMAWA	4	15
	MATEWA	3	7
Mji Mwema	-		
	-		
Tungi	MATEWA	3	8
	UMAWA	-	-
Vijibweni	MATEWA	2	7
	UMAWA	-	-
Kimbiji	-		
	-		
Somangila	UMAWA	2	7
	-		
Kibada	UMAWA	1	9
	-		
Kisarawe II	-		
	-		

3.1.18 Strengths and weaknesses of the current collection system

The investigations for this assignment found that the current collection system serves only 7% of the municipality population. The rest of the areas are either served by non-registered collectors or are not served at all. As a result, there is increase rampant illegal dumping and burning of generated wastes. Table 3.6 shows the strengths and weaknesses of the current waste collection system.

Table 3.6: Strengths and weakness of current solid waste collection system in Kigamboni municipality

Current collection system	
Strengths	Weaknesses
• Residents can choose either to use registered or non-registered collectors	• Illegal exists because service providers take advantage of the situation to reduce operation costs

• No delays in solid waste collection since non-registered collectors are available when their service is required	• Poor and inadequate collection vehicles and facilities for contactors. • Long transportation distance to disposal site (Pugu-Kinyamwezi) • The system does not favour the separation of recyclables at generation points • Lack of residents' awareness on importance of waste collection

3.1.19 Sites suitable for establishment of recyclable collection centres

The surveys and investigations conducted for this assignment revealed that all of the existing recyclable collection centres are owned or leased by individuals participating in recyclables collection. Some of the collection centres are located in residential areas which owners claimed are in use temporarily. In most cases, the collection centres were located along the main road for easy access of vehicles.

As part of this assignment, we have proposed potential areas for establishment of collection centres for recyclables. Most of proposed areas are owned by the local government but a few are owned by individual who were also consulted to find out the possibility of providing their land. All of consulted land owners were willing to rent their land for the use of recyclable collectors or the local governments.

During selection of the areas that can be used as collection centres, a specific set of criteria was applied to pre-screened candidate sites. The criteria were the following:

- Amount of recyclables which may be generated in the neighbourhood of the proposed site,
- Presence of market, commercial areas and markets, and
- Absence of existing privately held collection centres.

Figure 3.12 shows the location of existing and proposed recyclable collection centres in the municipality. Table 3.17 provides additional data on the centres, including coordinates.

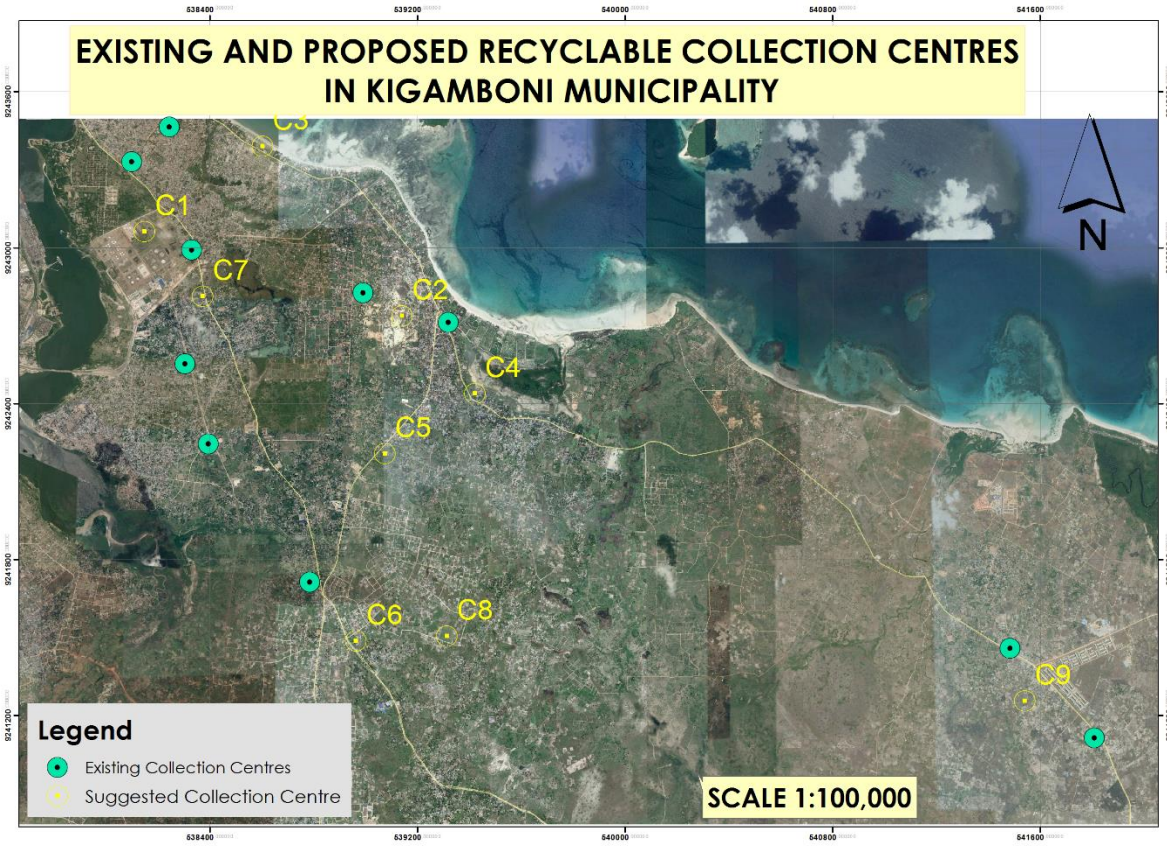

Figure 3.12: Existing and proposed recyclable collection centres in Kigamboni Municipality

Table 3.7: Locations of proposed recyclable collection centres

ID	Ward	Coordinates (UTM Zone 37M)		Area (m^2)	Ownership
		X	Y		
C1	Tungi	534912.98	9243926.89	1024	Local government
C2	Mji Mwema	538896.10	9242601.50	1120	Private
C3	Kigamboni	535139.77	9245094.45	676	Private
C4	Mji Mwema	539200.45	9241282.20	940.6	Private
C5	Mji Mwema	539774.93	9241461.10	777.2	Private
C6	Kibada	536813.28	9240552.89	1288	Private

C7	Vijibweni	534405.04	9241642.54	1564.7	Private
C8	Kibada	537220.06	9237984.17	2016	Local government
C9	Somangira	548348.23	9237220.82	1295	Private

3.2 Ubungo Municipality

3.2.1 Existing solid waste management

Waste management in Tanzania is liable directly to the local authority's responsibility. The local Government (Urban authorities) Act 1982 imposes under urban authorities the responsibility "to remove refuse and filth from any public or private place" (sect. 55 (g, k, i) and to provide and maintain public refuse containers for the temporary deposit and collection of rubbish. The municipal council plays an important role in the financing, planning and providing waste collection and disposal services. Under the Ubungo Municipal Council, waste management belongs to the structure of the Waste management Department, but other departments such as Works, Health and urban planning carry out part of its operation.

A reliable Municipal solid waste collection and transportation system is a cornerstone for good quality waste management services. The responsibilities for Municipal cleaning, waste collection and transportation are distributed between Ubungo Council and the fourteen Local Authorities or wards or ninety one sub-wards. In the Municipal Council under its office of Environment and Solid Waste Management Department are responsible for cleaning, waste collection, transportation and fee collection at the public areas i.e. markets, hospitals, schools, and open spaces. However, the sub ward are responsible for cleaning, waste collection, transportation and fee collection at the households, private sectors, commercial centers and institutions.

3.2.2 Generation of solid waste

3.2.2.1 As per Municipality office records

Ubungo municipality is estimated to generate about **828** tonnes of waste per day (which gives 302,001 tonnes per year) according to the current generation projections .The waste generation in all wards of the municipality is shown in Table 3.7.

Table 3.7: Estimated amounts of solid waste generated per ward in 2016/2017

No	Ward	Number of sub-wards (mitaa)	Population (2012)	Solid waste generation (t/day)
1.	Makurumla	6	63,352	114
2.	Mburahati	3	34,123	70.5
3.	Sinza	5	40,546	105
4.	Manzese	10	70,507	132
5.	Mabibo	6	85,735	85
6.	Makuburi	5	57,408	42
7.	Ubungo	5	56,015	85
8.	Kimara	6	76,577	41
9.	Mbezi	8	73,414	18.5
10.	Msigani	5	55,111	12
11.	Kwembe	10	56,899	10
12.	Kibamba	5	28,885	15
13.	Goba	8	42,669	18
14.	Saranga	9	104,127	60
TOTAL		91	845,368	828

Source: Environments and Solid Waste Management Department

Further to the data presented in Table 3.7, the waste generation at different sources in the municipality are categorised as indicated in Table 3.8.

Table 3.8: Solid waste generation Sources in Ubungo Municipality in 2016/2017

SN	Source of Waste	Tons/day
1.	Household waste	661
2.	Commercial waste	12.4
3.	Institutional waste	4.9
4.	Market waste	16.5
5.	Streets waste	1.6
6.	Informal sector waste	131.6
TOTAL		828

Source: Environments and Solid Waste Management Department

3.2.2.2 Solid waste generation rates based on field determination

The solid waste generation rate and composition data presented earlier are based on estimates extrapolated from old data collected for other places and which are not directly applicable to Kigamboni municipality. Our data which are presented here are based on field determination conducted during the surveys and investigations conducted for this assignment. Population used in identification of total SW was from 2012 census projected to 2018 at 5.6 growth rate as it was proposed in 2012 census report. Wards with large populations such as Mabibo, Kimara Mbezi, Manzese and Saranga have considerably larger amounts of solid waste compared to others. This also suggests that considerable quantities of resources need to be devoted to these wards to manage the large amounts of solid waste generated. Overall, the municipality produces 890.93tons/day which translated into 325,188.19 tons of solid waste per year. Table 3.9 present data on solid waste generated in the municipality.

Table 3.9: Solid waste generation in Kigamboni Municipality (based on field determination for this assignment)

No.	Ward	Population	Total solid waste generation (tons/day)
1	Makurumla	87850	66.77

No.	Ward	Population	Total solid waste generation (tons/day)
2	Mburahati	47318	35.96
3	Sinza	56225	42.73
4	Manzese	97772	74.31
5	Mabibo	118889	90.36
6	Makuburi	79608	60.50
7	Ubungo	77676	59.03
8	Kimara	106189	80.70
9	Mbezi	101803	77.37
10	Msigani	76422	58.08
11	Kwembe	78902	59.97
12	Kibamba	40055	30.44
13	Goba	59169	44.97
14	Saranga	144393	109.74
Total			890.93

3.2.3 Solid waste composition in Ubungo municipality

Organic waste constitute a large proportion of the solid waste stream in the Municipality. The solid waste composition and generation data presented in Figure 3.13 are based on detailed field surveys and investigations carried out in the pilot project areas. Specifically, the data presented in Figure 3.13 refer to the generation rates and composition of the solid waste as close as practicable to their respective sources. Therefore, there are directly applicable to the assignment at hand.

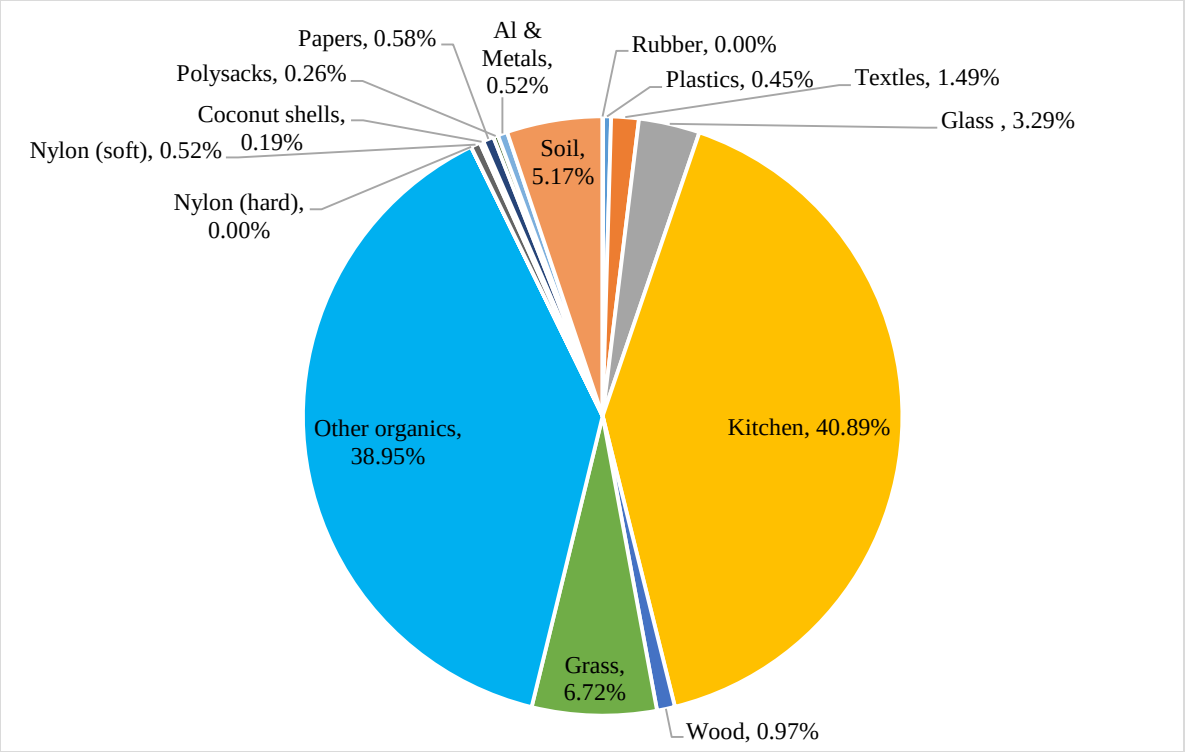

Figure 3.13: Solid waste composition as determined at generation points in Ubungo municipality

In addition to the detailed surveys and investigations carried out to determine the generation rates and composition of the solid waste at the sources, surveys and investigations were carried out to characterise the solid waste that is disposed of at Pugu-Kinyamwezi dump site. This facility is the only formal solid waste disposal premise used by all municipalities in Dar es Salaam region. Figure 3.14 shows data on the composition of solid waste as determined at Pugu-Kinyamwezi dump site.

The surveys and investigations carried out at the dump site were carried out during the same period as the ones carried out at the generation points. So the corresponding sets of data are directly comparable. The composition of waste at Pugu-Kinyamwezi did not differ much from the ones determined for the corresponding generation points.

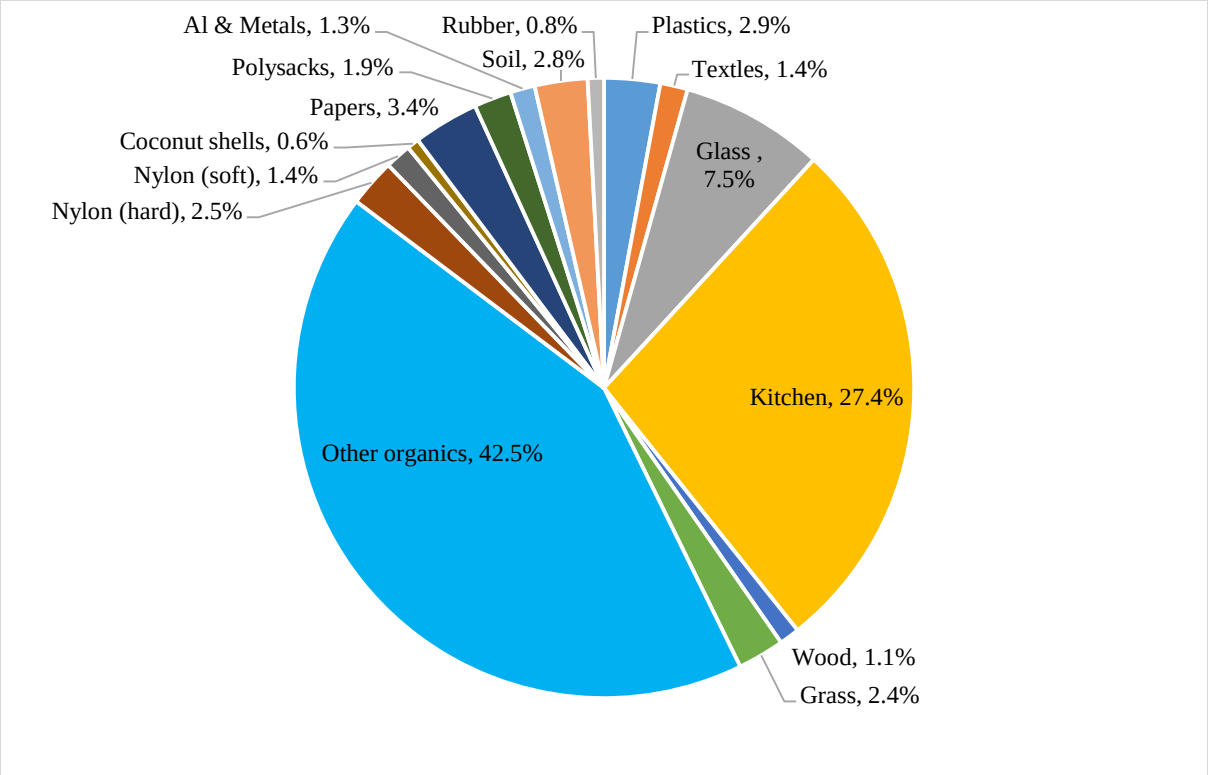

Figure 3.14: Solid waste composition at the disposal site (Pugu-Kinyamwezi) from Ubungo municipality

3.2.4 Waste collection

Solid waste collection in Ubungo municipality is carried out by both the municipal council, some private companies, community based organizations and the informal sector. Solid waste is generally collected at curbside from households, commercial establishments, institutions, markets, and street sweeping collection points. It is then taken directly to the Pugu-Kinyamwezi dump site. Where access by collection vehicle is impractical, collected waste from these areas is taken initially to neighbourhood collection sites by handcarts for secondary storage before transportation to the dumpsite. In planned and unplanned areas of the municipality where the populations are less affluent and the neighbourhoods more congested, waste is collected using handcarts for delivery to neighbourhood collection sites or taken directly to these sites by householders. The municipal council and the contractors subsequently pick up the accumulated waste from the neighbourhood collection sites for transportation to the Pugu dumpsite. In unplanned areas of the city where wards or CBOs have not taken the initiative to collect waste or in areas where collection service is poor, individuals commonly dump their waste into drainage ditches, streams and by the roadside. Effectively, burying, burning and open dumping are all practiced.

The amount of solid waste that the municipal council and contractors collected and transported to Pugu-Kinyamwezi dump site in the year 2016/2017 is summarized in Table 3.10.

Table 3.10: Amount of solid waste collected in Ubungo municipality and disposed of at Pugu dumpsite in 2016/2017

SW collector	Amount (tons/day)
Municipality	200
Contractors	222
Total SW collection	422

Source: Environment and Solid Waste Management Department

Furthermore to the data and information presented in Table 3.10, there are various waste management options that are available in the municipality. Table 3.11 summarises the options relating them to the proportion of waste handled through each option.

Table 3.11: Solid waste management options in Ubungo municipality

SN	Waste Management options	Average (tons/day)	Proportion (%) by volume
1.	Amount of solid waste transported and disposed to the Pugu dumpsite	422	51
2.	Amount recycled or re-used	157	19
3.	Amount controlled with on-site disposal (burned, buried)	142	17
4.	Amount remaining without control	108	13
Total		828	100

Source: Environment and Solid Waste Management Department

3.2.5 Waste transportation

Currently the transportation of solid waste is done by both the municipal council and the private sector (contractors). The municipal council has three trucks for transportation of solid waste from different areas of the municipality to the current dump site which is located 40 km from the centre of Ubungo municipality which makes the round trip to cover about 80 km. Other trucks are owned by the private sector including contractors, community groups and NGO's. Some other equipment which are used to collect and transport waste is hired by municipal council from private sectors. Table 3.12 summarises the data on equipment owned and used by the municipal council.

Table 3.12: Solid waste collection equipment owned by Ubungo municipality council

SN	Equipment	Quantity
1	Cesspit emptier	1
2	Tipper trucks (TATA)	2
3	Tractors	1
4	Excavator machine	1

Source: Environment and Solid Waste Management Department

3.2.6 Solid waste disposal

Currently Ubungo Municipality does not have a sanitary landfill so the collected solid waste has to be transported to Pugu-Kinyamwezi dump site which is the only authorized site in Dar es Salaam for the receipt of non-hazardous solid wastes. Furthermore, in areas where collection services are not available burying, burning and illegal dumping are the main ways for solid waste disposal.

Figure 3.15: Open dumping and burning of solid waste in Kibamba ward in Ubungo municipality.

The photo was taken on 14 November 2018 at coordinate 561129.68, 9247721.66 UTM Zone 37M, facing western side.

3.2.7 Generation of recyclables

The amount of recyclable generated in Ubungo municipality was computed using the composition data obtained at generation points and disposal site (Pugu-Kinyamwezi). On the whole, the glass fraction accounts for a proportionately large share in terms of mass (24.67 tons/day) but occupies a considerably small volume compared to other components such as nylon, paper, plastic and textiles. Although there is a large proportion of soft nylon and textiles produced in the municipality, there is no market for these materials yet and as a result they end up in the dump sites, are burned or buried at home. Dumping or burning nylon and textiles pose environmental and public health risks. This is especially the case because the materials they are persistence in nature, thus their presence and effects on the environment occur over a long period of time. Figure 3.16 presents solid waste composition data.

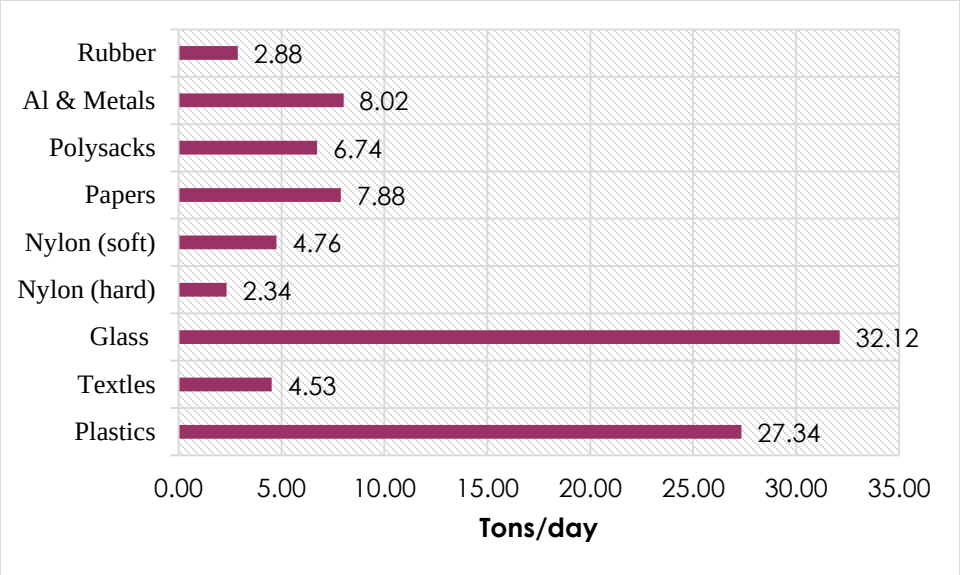

Figure 3.16: Amount of recyclable generated in Ubungo Municipality

3.2.8 Collection of recyclables

Recyclables solid wastes (plastics including both nylon and bottles, aluminium and ferrous items) are collected by non-registered individuals (scavengers) and taken to the middle men who then transport it to processing industries (TASIPA Company Ltd, TANFOR Company Ltd and SAMAKI PLASTIC Investment) which are located within the Ubungo municipality. The middle men pays TZS 150 per kilogram for plastics and sell them for TZS 200. Poly sacks are bought at TZS 400 and sold for TZS 500. Glass bottle are bought at TZS 20 and sold at TZS 30 to processing industries.

Most of collection centres visited during the field surveys are for recyclable materials including plastic bottles, poly sacks, PVC and HDPE pipes, plastic buckets, glass bottles and ferrous metal items. Figure 3.17 give a visual impression of the situation painted by the foregoing explanations.

Figure 3.17: Recyclable collection centre in Kibamba ward.

Photo was taken on 14 November 2018 at coordinates 505855.37, 9249413.53 UTM Zone 37M, facing Northern side.

3.2.9 Generation of biodegradable materials

Since a large proportion of waste stream comes from residential areas, most of the waste produced in the municipality is organic waste which can further be classified as kitchen waste, wood, grass and others which due to their being rather decomposed, could not easily be categorised.

The generated biodegradable organics amount to 717.1 tons/day which accounts for 80.56% of all waste produced. Generated biodegradable waste can be composted to produce compost but due to effects of urbanization, all of this waste is disposed of which exhausts the dumping space. Figure 3.8 shows the amount of organic waste generated in the municipality.

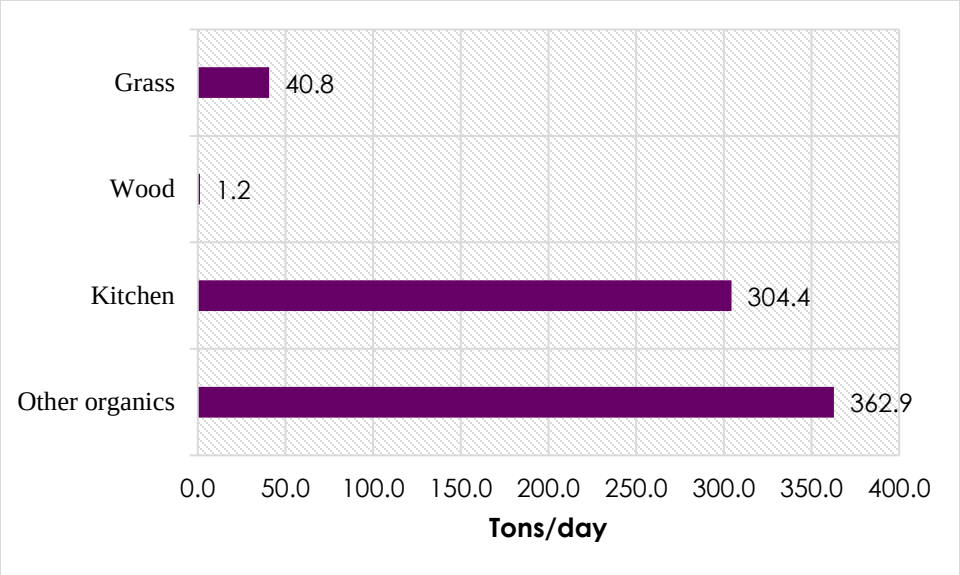

Figure 3.18: Quantities of different organics generated in Ubungo municipality

3.2.10 Street cleaning

To comply with the Local Government (Urban authorities) Act 1982, the municipal Council provides a cleaning service that is responsible for the following operations:

- Removal of rubbish, any unwanted solid waste on public land.
- Cleaning all streets, footways and open spaces that are in public ownership.
- Emptying of litter and bins on public areas.
- Removal of dead animals both domestic and wild.
- Collection of domestic bulky waste, which is a chargeable service in public areas.

Table 3.13 presents data on the coverage of the road cleaning service provided by Ubungo municipal council.

Table 3.13: Ubungo Municipal Council road cleaning coverage

SN	Service area	Distance (m)	Wards
1.	Sam Nujoma Road (5,200 Metres from Mlimani city Round About to Ubungo traffic light)	5,200	Sinza Ubungo
2.	Nelson Mandela road (8,400metres from Ubungo Trafic Light to Nida Textile area, Sungasunga Rd 900M and Makuburi/Majichumvi Rd 3,400M(From external traffic light to Makuburi/Majichumvi)	12,700	Makuburi Mabibo Ubungo
3.	Shekilango Rd (2,400M From Morogoro/Shekilango Rd junction to Mori Rd Junction and BRT Feeder Rd to Shekilango Markert 500M and Mori Rd 1,680M and Igesa Rd 900M	5,480	Sinza Ubungo
4.	Ubungo Maziwa road 4,500 Meters (From Kigogo Bridge to Morogoro roads junction), Mabibo NIT road 1,400 Meter (from Morogoro Rd Junction to Ubungo Maziwa Rd)	5,900	Ubungo Mabibo Mburahati
5.	Ubungo NHC Rd 1,000Meters from Shekilango Rd to Ubungo Plaza-Morogoro Rd Junction)	1,000	Ubungo
6.	Mlandizi road 1,600 Meters (From Muhalitan Primary School to Shekilango Rd Junction(Kijiweni) and Mbokomu Rd 900 Meters (From Morogoro road junction to Sweet Corner – Mlandizi Rd)	2,500	Sinza Manzese
7.	Kimamba road 1,800 Meters (From Morogoro Rd Junction to Kagera First Inn Junction), and Kagera First Inn 2,000 Meters(From Mlandizi road via Kagera First Inn to Maziwa road	3,800	Makurumla Mburahati
8.	Morogoro road 15,000Meters(From Kimara Temboni to Kiluvya Kibaha Bounder)	15,000	Kwembe Kibamba Msigani Mbezi

SN	Service area	Distance (m)	Wards
9.	Morogoro road 15,400 Meters (From Mikumi rd Junction to Ubungo Mataa Junction)	15,400	Manzese Makurumla Ubungo
10.	Morogoro road 20,000 Meters (From Ubungo Mataa Junction to Kimara Temboni)	20,000	Ubungo Saranga Kimara
11.	Mbezi/Goba Rd 12,000 Meters (From Mbezi Mwisho - Morogoro rd Junction to Goba Kunguru)	12,000	Goba Mbezi
12.	Mlimani Rd 4,000Meters (From Mlimani Roundabout to Sam Nujoma Junction)	4,000	Ubungo
13.	Riverside/ Mkoka Rd 700 Meters (From Mandela rd junction to Makoka)	700	Makuburi
Total distance		103,680m	

Source: Environments and Solid Waste Management Department

3.2.11 Community participation

The major stakeholders and their roles in the case of solid waste management in Ubungo municipality include:

- The Municipal council is responsible for managing the general waste, such as ensuring availability of sufficient services for refuse collection and night-soil removal from households.
- The government provides all necessary guidance (legislation and policy) to Municipal council and financial aid and other resources when available.

- Franchisees are required to promote more efficient wastes collections services to their respective areas as directed by the Mtaa Executive Officer, Ward Executive Officer and the Municipal council and as per contracts.
- Residents cooperate in the waste management programs and pay their refuse collection charges. Also, they will be required to keep their surroundings clean wherever they are.
- Supporting groups**;** Community groups (including NGOs, and CBOs), Academic institutions and donors also have their identified rolls to play. This includes financing, moral and promotional support, technological and marketing

3.2.12 Main challenges facing waste management in Ubungo Municipality

The following challenges have been identified to be associated with solid waste management in the pilot project area:

- There is insufficient support to the private sector and community organizations dealing with solid waste collection.
- There are no suitable sanitary landfills, and therefore some of the generated solid waste is disposed of in open dumping areas.
- A behavioural whereby the willingness of the community to pay for refuse collection fees they produce is poor and some of them do not seem to care about solid waste management practice.
- Insufficient/limited budget in which the Central government does not subside waste collection activities which consume a large proportion of municipal council's revenue. Added to this is the rather low priority accorded solid waste management in budgeting.
- There is insufficient solid waste collection and transportation equipment.
- Long distance to the official disposal site whereby the round trip averages 80 km, a considerable portion of which requires negotiating traffic congestion.
- Informal settlements and informal business premises whereby Sinza ward is the only planned ward, the rest being unplanned with poor road accessibility for some areas all of which make difficulty to carry out collection and transportation of the solid waste.
- There is no sorting of solid waste at the source which leads to large amounts of waste being transported to the dumpsite instead of being reused or recycled.

3.2.13 Solid waste management future plan in Ubungo municipality

Future plans meant to effect solid waste management improvement in Ubungo municipality are mainly the following:

- The municipality expects to Purchase 4 (four) trucks in 2018/19 for transportations of solid waste. Also Ubungo is in the process to acquire Kisopwa (152 acres) for a sanitary landfill.
- The municipality is planning on more involvement of the private sector in solid waste management and continuous community involvement and awareness.
- Continuing inspection and prevention of illegal dumping area and legal enforcement.
- Preparation of a solid waste management master plan.

3.2.14 Size of population served by current waste collection

The municipality has an estimated population of 1,031,349. Based on the surveys and investigations for this assignment, the population that is served by the waste collection service is 360,972 which is 35% of the total population while the remaining 670,000 people (equal to 65% of the total) are not served by the municipal council waste collection system.

3.2.15 Waste collection and transportations

The services are provided by contractors appointed and approved by municipal council. The solid waste collection contracts are awarded following publicly advertised tenders for collection and transportation of solid waste in the municipality in public areas, that is markets, hospitals, schools, and open spaces. At sub-ward level, the contractors are obtained in the same way through publicly advertised tenders after which the qualified contractor has to be approved by sub-ward committee and introduced to the sub ward general meeting. The contract has to be signed by contractor, the sub ward Executive Officer, Ward Executive Officer, Municipal Advocate, Municipal Mayor and finally the Municipal Executive Director.

The waste collection routes depend on the accessibility of roads but the complete route area is only achieved in Sinza ward which is planned and the services cover the whole ward. In Kibamba ward in which road accessibility is problematic, the collection route covers two sub-wards which are Kibamba and Gogoni. The rest of the sub-wards such as Kiluvya, Hondogo and Kibwegere are not covered by the service.

In Manzese ward the collection of solid waste are achieved in all sub wards but unplanned settlements and inaccessibility hamper the provision of the solid waste collection service. In Kimara ward only two sub wards have solid waste collection services. These are Baruti and Kimara while the rest bury and burn the waste as a form of waste disposal. In Mbezi ward only one sub ward Mbezi Luis has a collections service; the rest use open dumping, burying and burning. In Mabibo ward, collection services cover all sub-wards but some of its area are not accessible for solid waste collection which results in burning and burying of the waste. Finally, in Goba ward there is no collection service at all and this makes open dumping, burying and burning as the only options for solid waste disposal.

In all wards, the collection system employed is the door-to-door and usually collection vehicles make one trip to the dump site (Pugu-Kinyamwezi). Apart from the formal and authorises service providers, self-appointed service providers also take part in solid waste collection service and plus collection of recyclables which is eventually sold recycling industries.

3.2.16 Waste fees and payment for contractors

The whole of solid waste management service provision in Ubungo municipality is the responsibility of local authorities as described in detail with respect to Kigamboni municipality. MEO's assist contractors in obtaining collection fees from residents and 10% of the collected money is retained by the local government office to compensate for the costs incurred in assisting with payment fees collection. Collection fees are set by municipal council and are outlined in Municipal by-laws. They range from TZS 2,000 to TZS 200,000 per month. The payment for the

services rendered by the contractors is determined on the basis of number of trips made and size of truck used. The payment per trip using a standard compactor truck is TZS 450,000 while that for a standard (Tata) tipper truck is TZS 350,000 per trip.

Table 3.14 presents details on the solid waste collection fees for various waste generators in the Municipality.

Table 3.14: Solid waste collection fees in Ubungo Municipality

SN	**Generator**	**Monthly fees (TZS)**
1	Residential	3,000
2	Small shops	4,000
3	Restaurant	30,000
4	Guest house	10,000
5	Grocery	10,000
6	Night club	20,000
7	Stationary	5,000
8	Fruits vendor	3,000
9	Mama lishe	4,000
10	Vegetable vendor	500 every day
11	Garage	5,000
12	College	20,000
13	Shop for construction material	5,000
14	Small market	7,000

SN	Generator	Monthly fees (TZS)
15	Dispensary	5,000
16	Whole sales shops	7,000
17	Private school (day)	20,000
18	Private school (boarding)	25,000
19	Day care	14,000
20	Whole sales store(food)	20,000
21	Bar	10,000
22	Bar with kitchen	15,000
23	Butcher	5,000
24	Pharmacy	15,000
25	Machinga	2,000
26	Electronic repairs	6,000
27	Saloon	4,000

3.2.17 Burning practices

Burning is one of the solid waste management challenges in the municipality as it is currently used as the disposal method by some of the residents. Although it is prohibited and continuing education concerning its environmental impacts is given to residents, most of them use burning as the most economical method for disposal of wastes. The surveys and investigations for this assignment revealed that burning practices are rampant in Goba, Kwembe, Kimara, Mbezi, Mabibo, Sinza, Manzese, Ubungo, and Kibamba wards. Open burning of waste was observed even during the field surveys and investigations. The solid waste fractions involved in open burning were mostly plastic bottles, nylon, rubber such as tyres, perfume bottles, food and fruit remains, and grass as well as tree leaves. Figure 3.19 gives visual evidence of cases of open burning of solid waste observed in Ubungo municipality.

Figure 3.19: Open burning in Kibamba ward.

Photo was taken on 14 November 2018 at coordinates 506054.28, 9249505.26 UTM Zone 37M, facing North Western direction.

3.2.18 Ongoing projects for optimized solid waste collection system

The main project for optimization of solid waste management system in the municipality is the proposed construction of a sanitary landfill at Kisogwa (152 acres). As part of the project, the proposed landfill will have compositing centres for biodegradable waste management and sorting areas to remove valuable material and prevent them from being landfilled. The project will optimize solid waste collection in the municipality since the current transportation distance to Pugu-Kinyamwezi where the current disposal site is located is too long and not optimal for solid waste collection service providers. As a result of the long distance that the service providers have to transport the waste to the disposal site, there is an increase in illegal dumping and burning of solid waste within the municipality.

3.2.19 Recyclable wastes buyers

Currently there four buyers of recyclables who are located in the municipality. These are TANFOR, TASIPA Company Limited, SAMAKI Plastic Ltd and HEGJI Company. Table 3.15 presents data on the quantities of recyclables processed by these industries.

Table 3.15: Solid waste recycling companies in Ubungo municipality

Company	Input Materials	Amount (tons/week)	Location
TANFOUR Company Limited	Plastics	30-40	Ubungo
TASIPA Company Limited	Poly sacks	25-40	Ubungo
SAMAKI Company limited	Poly sacks	40	Ubungo
HEGJI	Poly sacks	-	Ubungo

Figure 3.20: Scavengers picking recyclables at Pugu-Kinyamwezi dump from waste generated in Sinza ward. The photo was taken on 13 December 2018 at coordinates 515104.96, 9234085.97 UTM zone 37M, facing North Western side.

3.2.20 Number of contractors and type of collection contracts

There are various solid waste collection contractors who are registered within wards in Ubungo municipality. The surveys and investigations for this assignment found that most of the contractors are only really operational during the early period of the contract. Later on they are overwhelmed by challenges, especially the ones that are caused by poor service fee payment by the service beneficiaries. Additional problems pertain to poor estimation of transportation costs and quantities of solid waste generated. All these result in unmet expectations and unmet development goals.

The number of contractors per ward varies depending on the size of the ward/Mtaa. Also some wards do not have registered solid waste collection contractors at all. These include Goba and Kwembe wards. In these wards self-appointed solid waste collection contractors are directly compensated by the service beneficiary residents depending on pre-negotiated payment agreement. Table 3.16 presents data on the number of contractors that provide the cleaning services in respect of various roads, plus those who provide solid waste collections and transportations services to the Pugu-Kinyamwezi dumping site.

Table 3.16: Solid waste collection contractors in Ubungo municipality

S/N	Name of company awarded	Collection capacity (t/day)
1	BAM WASTE MANAGEMENT	
2	SKY MARS SERVICE LTD	15-20
3	TOA TAKA MAKURUMLA CO LTD	15-25
4	JUHUDI CORPORATION	23-30
5	BGT ENVIRONMENT WATER AND SANITATION SERVICES	-
6	KANYAMADULA CO. Ltd	-
7	WASHAPAWA CO. Ltd	15
8	NIMA ENTERPRISES	-

S/N	Name of company awarded	Collection capacity (t/day)
9	S.G MSENGI ENTERPRISES CO. Ltd	-
10	KAMOA Company	20-30
11	NDUWILLU SMART ENTERPRISES CO. Ltd	-
12	MOREFORELESS ENVIRONMENT SOLUTION CO.	30-50

3.2.21 Current door to door collection system

The door to door collection system is the main method used for collection of solid waste in Ubungo municipality and in most of the areas in Dar es Salaam region. Although it seems to be considered as the best option for the collection of solid waste in urban areas, the method has its disadvantages which include:

- Lack of collection vehicles which leads to delay in collection services. This problem was raised almost in every ward in which surveys were conducted for this assignment.
- This method consumes a considerable amount of time during collection since drivers have to wait for home owners to get their waste outside their premises.
- Most of the areas in the municipality are unplanned hence are not easily accessible by solid waste collection vehicles. This results in partial transportation of the generated waste by generators themselves.
- The door to door collection system as practiced in the municipality does not easily accommodate the collection of recyclables since residents tend to mix their waste all together.

3.2.22 Improved door to door collection system

Due to its disadvantages and shortcomings as pointed out earlier, as currently practiced in the municipality, the door to door system of solid waste collection is not the best option for the municipality. To improve the system it is advised that the municipality encourage solid waste sorting and segregation at generation points. Since scavengers are present in almost in every sub-wards in the municipality it will be a lot easier for them if they pick segregated recyclables which

could end up motivating them more. Furthermore, the access roads in sub-wards must be improved so that the whole community is covered by the solid waste collection service. In addition, education should be provided to recyclable collectors to ensure that they cover all areas during collection. Provisional of collection centres in every sub-wards is also essential to motivate recyclable collectors to cover all areas.

3.2.23 Recyclable collection centres in Ubungo municipality

The surveys and investigations carried out for this assignment found that all of the existing collection centres are owned by individuals. It was also observed that some of the collection centres are located far from the main road which increases transportation costs and causes transportation difficulties during the rainy season.

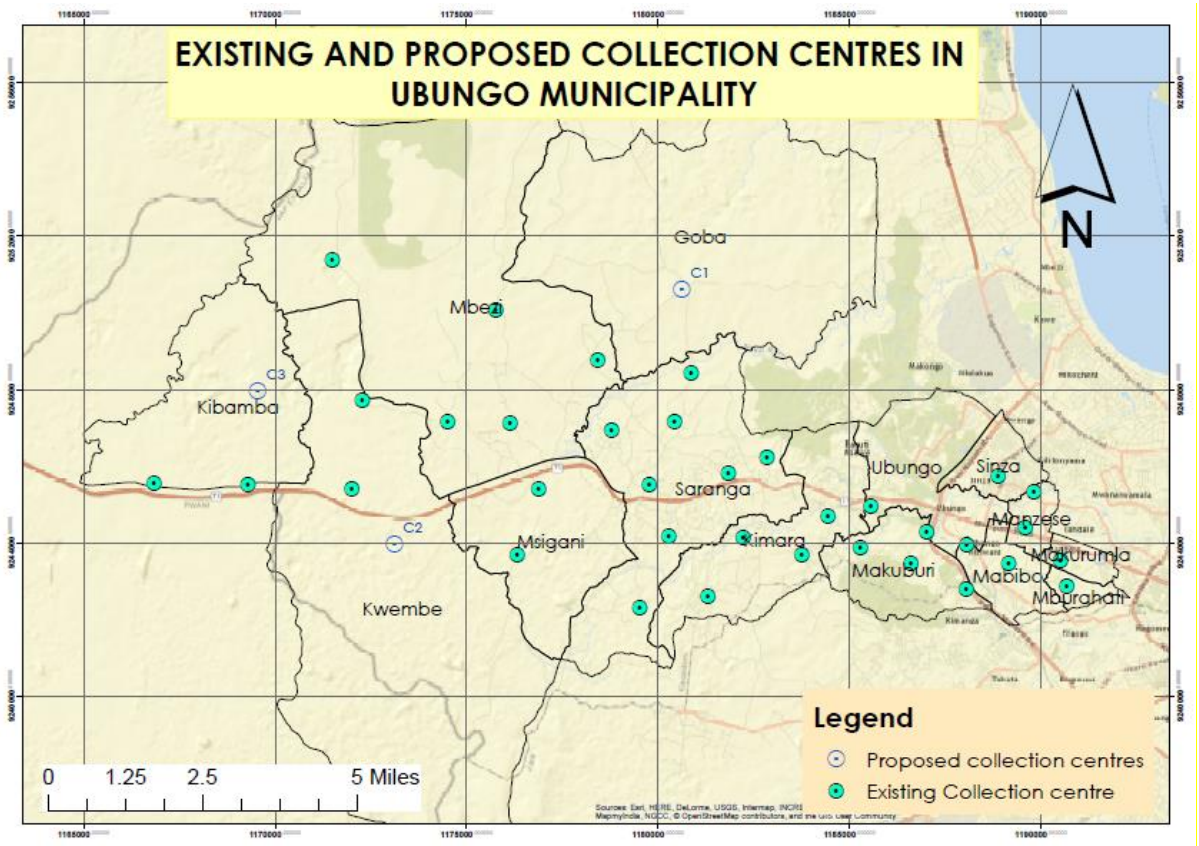

Figure 3.21: Location of existing and proposed recyclable collection centres in Ubungo Municipality

As part of this assignment we have proposed are number of locations for the establishment of recyclable collection centres as shown in Figure 3.21 and Table 3.17. The selection of the potential areas for recyclable collection was based on factors such as present land owners, distance from the main roads, and presence of markets, institutions and commercial areas for easy availability of recyclables. All land owners including private individuals and local governments were consulted during the selection of these areas.

Table 3.17: Locations of proposed recyclable collection centres in Ubungo municipality

ID	Ward	Coordinates (UTM Zone 37M)		Area (m^2)	Ownership
		X	Y		
C1	Goba	515893.25	9259852.30	2184	Private
C2	Kwembe	508492.73	9248225.73	1260	Private
C3	Kibamba	505649.17	9250884.01	2058	Private

Based on Figure 3.21, it is noteworthy that the existing collection centres for recyclables are generally clustered along the existing road network. This makes sense because the collected recyclables need to be transported. Therefore, the closeness to an all-weather road is an advantage that translates into cost savings. After all, poor road conditions increase transport cost rates.

3.3 Additional Considerations Pertinent to Solid Waste Management in Kigamboni and Ubungo Municipalities

3.3.1 Overview

This section presents a brief cross-municipality discussion on: 1) solid waste management aspects of produce markets and 2) hazardous waste management in both Kigamboni and Ubungo municipality. The idea of a cross-municipality rather than separate discussions dedicated to each of the municipalities is intended to serve a purpose. Both produce market solid waste and hazardous waste are special wastes even though in very different ways. Hazardous waste

management issues cross municipal boundaries and are handled across boundaries. On the other hand, markets serve beneficiaries across municipality boundaries and host operators who cross municipal boundaries. Most importantly, both produce markets and hazardous waste have management needs and implications that are best considered in a cross-sectional manner.

3.3.2 Major produce markets in Kigamboni and Ubungo municipalities

Produce markets are a special case of solid waste sources and therefore a special case of solid waste management needs. By the same token, they are a special case of solid waste management options amenability. The following features and characteristics set produce markets apart from other main sources of solid waste:

- They are a nutritional and socio-economic lifeline
- They form the main interface between consumers and the agricultural industry
- They generated large quantities of readily degradable solid wastes which have serious public health and aesthetic quality implications
- Although they are located in urban areas, they generate solid waste that contains significant agricultural fractions
- They have a huge resource recovery potential because of the organic solid waste fractions they generate and conducive physical and socio-economic environment.
- They have huge solid waste management improvement potential because of the fact that each market is under one management entity which can prescribe and enforce good solid waste management practices. Solid waste management matters can be handled in the same way as administrative and operational matters.
- At produce markets public and occupational safety and health (POSH) is exceptionally important because of vulnerability presented by unprotected food, huge human traffic, and an environment conducive to health and safety hazards.

Tables 3.18 and 3.19 present information on basic features and characteristics of major public produce markets in Kigamboni and Ubungo municipalities.

Table 3.18: Major public produce markets in Ubungo municipality

Ward	**Premise centre coordinates (UTM)**	**Occupied area (m^2)**	**Served neighbourhood**
Mabibo	524743.33, 9247748.34	12436.45	Residential, compact
Kibamba	505480.95, 9248322.81	9356.78	Residential, compact
Manzese	525988.18, 9248322.81	10956.43	Residential, compact
Kimara	516321.25, 9249273.53	7038.7	Residential, compact
Mbezi	512709.31, 9250013.76	11768.49	Residential, compact

Table 3.19: Major public produce markets in Kigamboni municipality

Ward	**Premise centre coordinates (UTM)**	**Occupied area (m^2)**	**Served neighbourhood**
Kimbiji	558443.63, 9227286.69	3875.8	Residential, dispersed
Kibada	537457.65, 9238200.53	4698.34	Residential, compact
Tungi	535273.23, 9243746.02	13479.91	Residential, compact
Kigamboni, Ferry	533342.93, 9245851.10	8456.06	Residential, compact
Kigamboni	534548,53, 9245305.28	11819.15	Residential, compact

It is apparent from Tables 3.18 and 3.19 that the number of major produce markets is the same in the two municipalities. However, this does not mean anything about the population and area sizes of the municipalities.

Major produce markets are a source of whole sale food supply. Retail sales are also conducted but most ordinary people would get their food supplies on retail from kiosks or smaller retail markets rather than from the major produce markets like the ones listed in Tables 3.18 and 3.19. The kiosk and small market retailers all get their food items from the produce markets.

Since they receive their supplies almost directly from the producing farms, the produce markets receive a significant quantity of food packaging and container materials of agricultural or natural origin. Such packaging and containers include woven straw baskets, leaf based wrapping materials, and wooden boxes. Added to the foregoing list are non-edible parts of produce such as banana peduncles, pieces of twigs and fruit and nut attachments.

Comparatively, kiosks and retail markets hand out thin film plastic bags more than produce markets because thin film plastic bags are devised to handle small quantities of supplies which are obviously associated with retail trade. This argument applies to all retail trade and all wholesale trade regardless of the goods sold.

Detailed information on types of waste and generation rates for market solid waste is covered elsewhere in this report. It is also covered in great detail in Mbuligwe and Kassenga (2004). All in all, market solid waste is dominated by organic solid waste fractions. Most of the organic solid waste fractions are amenable biological resource recovery by way of biogas production, composting, and fuel briquettes production. The foregoing is an important consideration with respect to improving solid waste management.

3.3.3 Hazardous waste management in Kigamboni and Ubungo municipalities

This assignment was not explicit on the need for any coverage on hazardous waste management *per se*. However, due to the general importance and relevance of hazardous waste management to this project, this report would be incomplete without some coverage on hazardous waste management. Further to the foregoing, any discussion on solid waste management warrants incorporation of a brief discussion on hazardous waste management because:

1) Hazardous waste management is related to solid waste management and in the absence of strict and meticulous segregation, municipal solid waste usually contains hazardous waste fractions,

2) In the literature and even in training, hazardous waste management is treated together or alongside solid waste management,
3) At the core of this project is hazardous air pollution management.

In addition to the above, hazardous waste management is important because it is associated with very serious public and occupation safety and health (POSH) issues. In this respect, POSH is important because of the health and safety hazards inherent in the hazardous wastes.

Literature on hazardous waste management in Tanzania is hard to come by. Nonetheless, Grasso et al. (2002), Kahn et al. (2002) and Kaseva and Mbuligwe (2002) have covered extensively all important aspects of hazardous waste management in Tanzania, which means the literature is relevant to the pilot project areas.

Major categories and subcategories of sources of hazardous waste and examples of the hazardous waste fractions they generate in the pilot project areas are outlined in Table 3.20.

Table 3.20: Major categories of sources of hazardous waste in the pilot project areas

SN	Hazardous waste source main category	Subcategories of hazardous waste sources	Hazardous waste fraction examples
1	Domestic source	Households, housing estates, apartment buildings	Household items of hazardous nature, pesticide residues, poisons, pressurised cans, expired drugs
2	Institutional sources	Academic institutions such as schools and colleges, hospitals, religious institutions such as	Expired laboratory chemicals and drugs, surplus utility chemicals,

		churches and mosques, prisons, and military barracks	excess and expired agrochemicals
3	Industrial sources	Industries of various scales (large, medium, and small scale)	Rejected chemical products, spoilt chemical products, pesticides, excess and obsolete utility chemicals
4	Commercial sources	Chemical stores, pharmacies, agrochemical stores, super markets, fuel filling stations	Expired chemicals, expired drugs, used chemical containers, used fuel containers
5	Informal sector activity sources	Backyard industries, street-side and backyard auto repair shops, backyard equipment repair shops, illicit chemical dealers	Spilled fuel and oils, expired drugs, toxic chemicals, corrosive cleaning agents, explosive materials, discarded pressurised cans
6	Seized and confiscated hazardous contraband destined for destruction	Law enforcement agencies, government agencies such as National Environment Management Council, and Tanzania Food and Drug Agency	Expired drugs, toxic beauty products, expired chemical products, spoilt food, contaminated food

Upstream management of hazardous waste is very poor and it is characterised by the fact that there is no organised system for linking all functional elements of hazardous waste management. There is no organised system for segregation and separate storage and collection of the hazardous waste fractions. Downstream management of hazardous waste is also poor and there is no separate system for collection, transportation, treatment, and disposal of hazardous waste fractions from the mainstream sources of the waste listed in Table 3.20.

There is no hazardous waste management system for mainstream sources of hazardous waste fractions. As such, hazardous waste from such sources is mixed with non-hazardous solid waste fractions, and consequently managed together with non-hazardous solid waste.

Special sources of hazardous wastes such as hospitals are supposed to have their own health care waste incinerators. However, small health care facilities and many of the larger ones do not have incinerators. Moreover, even for the health facilities which have incinerators, their incinerators are often out of operation for various reasons such as breakdown and a lack of fuel.

The main means of treatment for hazardous waste in Dar es Salaam is incineration and there are a number of operators and owners of incinerators. Even the Wazo Hill Cement Factory cement kiln has the capacity to carry out incineration of hazardous waste. The kiln has been used several times for special operations. Understandably, the facility is not available for treatment of small quantities of hazardous waste and even for larger quantities on *ad hoc* basis.

Really large capacity for hazardous waste treatment by way of incineration or otherwise is still in short supply in the country in the private as well as in the public sector. As a result of this, destruction of obsolete pesticides and decontamination of contaminated pesticide containers plus clean-up of 300 contaminated premises (pesticide stores and neighbourhood land) required the use of facilities available in the more developed countries. A country environmental and social assessment (CESA) report NIRAS (2012) provides details on this. The assignment, which the consultant and one of his colleagues carried out on behalf of NIRAS for NEMC (Tanzania), provides details on the hazardous waste treatment capacity in the country then (by 2012). This coverage is additional to the coverage on treatment and clean-up aspects of the obsolete pesticide problem.

In spite of the foregoing, there may be change in the horizon because the hazardous waste management industry seems to be attracting investors who are already in the country and from as far as South Africa. Among others, the Recycler Company, whose case is discussed in detail later in connection with composting of solid waste, is planning to install and incinerator in Kigamboni municipality within one year.

4.0 AN EXTENDED ANALYSIS OF GENESIS AND STATUS OF OPEN BURNING OF SOLID WASTE

4.1 Introductory Remarks

This section supplements the coverage presented earlier (Chapter 3) on the subject of open burning of solid waste. It is meant to collate information on and extend the discussion on open burning of solid waste across the pilot project areas. More specifically, it is intended to provide a more detailed analysis of the genesis, the context and status of the issue of open burning of solid waste. This is all done with a view to providing the most objective basis for developing solution options for the challenge. It is noteworthy that, the analysis presented in this section is relevant to not only the rest of Dar es Salaam city but also to the rest of urban areas in Tanzania.

4.2 The Context of Open Burning of Solid Waste

It is important to take note of the physical, administrative, and socio-economic environment in which open burning of solid waste takes place. An understanding of the pertinent context is paramount to understanding the root cause of the problem. It is also key to devising a cost-effective solution to the problem. Open burning of solid waste takes place in the following main contextual dimensions:

- The affected areas are characterised by relatively poor solid waste management service which leaves the generators of solid waste with almost no viable options for solid waste disposal.
- The solid waste management regime is characterised by poor enforcement of applicable laws and regulations, including the ones that regulate open burning of solid waste.
- Indiscriminate enforcement of sanitation regulations in an environment where there is ambiguity or poor understanding of what constitutes waste on the part of environmental sanitation officers. This is coupled with zealousness and erroneous enforcement regulations which does not differentiate what is waste from what is not waste and how what is not waste can be stored outdoors so that it is not confused with waste.

Open burning of solid waste is specifically disallowed by law and is generally not expected to happen. More specifically, open burning of solid waste was not supposed to happen if 1) the law

was complied with and 2) solid waste management service in the relevant areas was sufficiently good.

Further to the above, it is useful to take note of the essence and implications of the greening of Dar es Salaam city with respect to solid waste management in general and open burning of solid waste in particular.

The extent of green land cover over Dar es Salaam city is evident especially when one flies over the city on a low flying aeroplane. The sight gives an obvious impression of a lanscape dominated by vegetation cover especially in the outskirts of the city. The general impression is that the green cover accounts for a significant part of the land cover (though not necessarily in the same proportion as that of the land use). This impression is borne out by observational surveys even though there is no documented evidence on the proportion of vegetation cover of the city.

Use of vegetation is widespread in the city and some of the commonest uses include the following:

- Use of vegetation in dedicated gardens and recreational parks
- Use of vegetation in erosion control, wastewater treatment, and soil conservation
- Use of vegetation as shade trees
- Use of vegetation as ornamental trees
- Use of vegetation as property boundary marker and fencing material (typically Ashok trees)
- Use of vegetation as a source of medicinal products (typically Neem tree and Aloe vera)
- Use of vegetation as a source of food (mango trees, palm trees, baobab trees)
- Use of vegetation for multiple benefits (shade, ornamental function, medicinal use function, and source of food)
- Use of vegetation as lawn usually between trees
- Use of vegetation as tuff grass in sports arena, especially for football (soccer) pitches
- Use of vegetation as a source of animal fodder in urban livestock keeping which is widespread in Dar es Salaam city

Apart from the primary or originally planned benefits of the vegetation, there are spinoff benefits of existing vegetation during growth and after the term of the primary use of the benefit of the vegetation runs out. These are the following:

- Use of vegetation as a wind breaker
- Use of vegetation to reduce air pollution (as a dust trap)
- Use of vegetation to achieve natural space cooling
- Use of harvested vegetation as construction material and related products (wood for construction, grass and leaves for roofing, etc)
- Use of harvested vegetation products as fuel wood

Many city roads are lined with ornamental and shade trees plus clusters of growers and suppliers of ornamental and utility plants. As a result, many clusters of shade and ornamental trees have developed along the city roads, consequent to unsold overgrown seedlings growing into big trees and subsequent accidental though desirable greening of the city roadside.

The green land cover is the source of yard waste of plant origin which contributes to open burning as well; it generates enormous quantities of solid waste most of which is not collected. The solid waste is consequently burned in the backyard and occasionally even in the front yard.

In connection with the foregoing, a recent concerted solid waste management efforts initiated in Dar es Salaam city whereby groups of militia spearheaded environmental sanitation inspections did not conclude well. This is partly because in some cases, the real experts in environmental sanitation did not play the leading role as intended. In addition, there were cases where the responsible people made the whole campaign give the impression that the focus of the efforts was on extracting fines from defaulters rather than improving environmental sanitation. It did not proceed well and ended up being almost wholly unsuccessful.

- It was not designed or operated in a manner that would enable it to be sustainable – it came across as a one-time effort; the one time efforts eventually let the situation revert to where it originally was or be even worse.
- It gave the general impression of being confrontational and combative as if it was a military operation instead of the civilian inspection that it was; threats were thrown around as if to force subjects into accepting whatever the inspection party concluded.
- Neither did it provide room for reason or discussion nor avail opportunities for a second chance even for genuine accidental defaulters.
- As explained in greater detail later, the verdicts reached by the environmental sanitation inspection party were often wrong with respect to yard waste stored as a resource in the backyard.

The environmental sanitation inspection party designated any biomass accumulated and stored in the backyard as waste. Even collected and nicely stored tree leaves, branch pieces and twigs which practically do not rot or produce nuisance, or attract vermin when kept well, which were stored for composting were branded waste. Even partially mature compost prepared in the backyard was designated uncollected solid waste. This has an unintentional indirect effect of encouraging open burning of the yard waste, because generation rates of yard waste are very high while the collection service is infrequent and unreliable in most parts of Dar es Salaam city.

Based on the extensive fieldwork for this study and drawing on experience from numerous studies we have been carrying out in the city over the years, yard waste of biomass origin accounts for a significant proportion of uncollected solid waste that is eventually burnt. While tree branches and twigs may be used as fuel wood, tree leaves and grass as well as wilted flowers end up accumulating as they await collection.

Where the solid waste collection fee is paid as a function of the weight or volume of the waste collected from a particular source, yard waste may not be surrendered to the solid waste collection service provider if at all such a service provider shows up to collect the waste. This is done to reduce the cost of the service on the part of the service beneficiary. It is also often done in the hope that the uncollected yard waste may be composted. However, with the inspections described earlier taking place, composting is out of the question because composting feedstock and compost itself are both regarded as uncollected waste, which puts a premise out of compliance with environmental sanitation regulations.

The situation described in the foregoing discussion leaves open burning of the yard waste as the only viable and realistic option for those who cannot afford the relatively high solid waste collection fees charged by some service providers. Even for the people who would otherwise be able to afford the service and pay the requisite solid waste collection fee, the fate of their uncollected yard waste may end up in the same way as the one for those who cannot afford the service. If the solid waste collection service provider does not show up at the right time, what happens to the yard waste in this case is the same as what happens to the yard waste that is intentionally not handed over to the solid waste collection service provider on cost reduction basis.

4.3 Causes and Influencing Factors of Open Burning of Solid Waste

Analysis of the data and information acquired in the course of this assignment has revealed a number of causative and influencing factors of open burning of solid waste. The ones listed here are the most distinctly prominent and therefore must be considered when devising remedial measures.

The actual fires that result in open burning of solid waste can mainly be attributed to one or more of the following:

- Accidental ignition of the solid waste due to ignition sources such as amber in ash and cigarette butts together with solid waste or where solid waste is discharged.
- Deliberate setting on fire of the solid waste to reduce the volume of the solid waste or in an attempt to eliminate the waste altogether.
- Deliberate starting of the fire to use it as a form of treatment of solid waste that is considered to contain hazardous components or any components that are considered to be unsafe to be kept on the premises for long.
- Deliberately starting of the fire to kill vermin and pests which may breed, feed, or live within and around the solid waste storage premises in the backyard.
- Deliberately setting the solid waste on fire to obtain ash which is used as a mild form of pesticide in gardens and urban agriculture lots as well as an odour suppressant in latrines.
- Accidental ignition of the solid waste as a result of biogas generated following anaerobic digestion of organic fractions of the solid waste.
- Deliberate setting on fire of grass to clear vegetation from premises especially in the outskirts of municipalities where single properties occupy large pieces of land.

In addition to the above, it is important to note that there are many cases of open burning of solid waste that result from fire incidents that are neither planned nor deliberate and may continue to rage without deliberate effort to sustain them.

To a very great extent, poor solid waste management service and poor solid waste disposal contribute significantly to open burning of solid waste. Therefore, improved solid waste management service coupled with improved solid waste disposal can contribute to a significant reduction in open burning of solid waste even without improvements contributed by other measures.

Many of the solid waste fractions that end up burning in open burning of solid waste are to some extent currently recovered for reuse or recycling or have the potential to be recovered, have a current market or have a potential market. This implies that promotion of solid waste resource recovery and development of the local waste resource recovery industry can contribute to a significant and sustainable reduction in open burning of solid waste.

In line with the foregoing, there is a need for improving waste resource recovery from the most upstream stage in the waste stream to the most downstream stage – from the lowest end of the resource recovery chain to the highest end.

The full potential of the waste resource recovery industry can only be realised if there is close collaboration among all major stakeholders. Noteworthy among these are resource recovery practitioners on the one hand and trainers of experts, researchers and training as well as research institutions, on the other hand. Currently, the collaboration is between practitioners and researchers or trainers is shaky. Some practitioners have a disdain for researchers and trainers because they believe that entertaining them does not improve the bottom line of their business while it wastes valuable time.

Some practitioners do not cooperate and are not willing to share any valuable information concerning their businesses. These particular practitioners consider sharing their information is tantamount to sharing trade secrets and other proprietary information with potential competition and this is serious because it may end up compromising their competitiveness.

Apart from exchanging expertise and experiences and sharing information between the practitioners and trainer or researchers, the waste resource recovery industry can facilitate better training of future waste resource practitioners and researchers. One potential avenue for this endeavour is through providing industrial training and internship opportunities. On the other hand, the trainers, researchers and training institutions can provide continuing education and tailor-made training for the practitioners. If properly exploited, the two options stand a good chance of strengthening both the part of the practitioners and that of the trainers and researchers. They also constitute a self-reinforcing feedback loop that can potentially strengthen both parties.

4.4 Inventory of Major Cases of Illegal Disposal of Solid Waste

Table 4.1 and Table 4.2 present findings on an inventory of the sites and premises where major cases of illegal disposal of solid waste were observed in Kigamboni and Ubungo municipalities.

Table 4.1: Major cases of illegal dumping of solid waste in Ubungo municipality

Ward	Premise centre coordinates (UTM)	Area occupied by premise (m^2)	Served neighborhood
Kibamba	506154,89, 9249958.48	423.56	Residential, compact
Kibamba	506179.21, 9250057.97	142.00	Residential, compact
Goba	506111.74, 9249497.51	224.36	Residential, compact

Compact = neighbourhood housing density is high

Table 4.2: Major cases of illegal dumping sites for solid waste in Kigamboni municipality

Ward	Premise centre coordinates (UTM)	Area occupied by premise (m^2)	Served neighborhood
Mji Mwema	538569.43, 9242226.50	344.51	Residential, compact
Kimbiji	558431.72, 9227630.90	204.80	Residential, compact and dispersed
Tungi	534723.27, 9244103.27	30,592.94	Residential, compact

Compact = neighbourhood housing density is high; Compact and dispersed = neighbourhood housing density is a mixture of high and medium-to-low density

The following main observations can be made on the Tables 4.1 and 4.2 on major cases of illegal sites for solid waste in Kigamboni and Ubungo municipalities:

- Evidently, the list includes only main cases of illegal solid waste discharge premises; it does not include smaller cases, which do exist.
- Kigamboni and Ubungo municipalities have the same number of noteworthy illegal solid waste disposal premises.
- Illegal solid waste disposal premises are apparently mostly associated with residential premises or residential sources of solid waste.
- Ubungo municipality has a small size range (142 – 423 m^2) of illegal solid waste disposal sites while Kigamboni's sites have a large size range (204.8 – 30,592 m^2).
- The fact that the illegal solid waste disposal sites are close to residential premises magnifies the associated health and safety risks.

- The compact housing density in the neighbourhood of the illegal solid waste disposal sites magnifies the health risks even further because communicable diseases can spread easily among the residences.
- Tables 4.1 and 4.2 do not include at all backyard burning and burying of solid waste which is likely to take place wherever space is sufficiently large.
- The high housing density in the neighbourhood of the illegal solid waste disposal premises suggests that burying and burning of the waste would most likely be untenable because of space constraints. This would leave removal of the waste for disposal elsewhere as the only workable option for these areas. Therefore, improvement in solid waste management is likely to improve the situation.
- Illegal solid waste disposal premises are smaller than solid waste open burning premises (discussed later).
- Tables 4.1 and 4.2 pose the question as to who is responsible for dumping the solid waste in the illegal sites: is it the solid waste generators themselves or illegal solid waste collection service providers who normally use short range solid waste collection vehicles? In fact, both the waste generators and the self-appointed solid waste collection service providers are responsible. As such, both should be targeted in devising improvement measures.
- Overall, Tables 4.1 and 4.2 suggest that efforts on eliminating illegal solid waste disposal sites should give priority to residential sources of solid waste.

4.5 Inventory of Major Cases of Open Burning of Solid Waste

Table 4.3 and Table 4.4 present findings on an inventory of the sites and premises where open burning of solid waste takes place in Kigamboni and Ubungo municipalities.

Table 4.3: Premises where open burning of solid waste takes place in Ubungo municipality

Ward	Premise centre coordinates (UTM)	Premise size (m^2)	Premise neighborhood characteristics	No. of HH
Kibamba	506054.28, 9249505.26	2432.15	Residential, dispersed	1 house
Kibamba	506162.61, 9249794.88	1745.93	Residential, dispersed	1 house
Kibamba	561129.68, 9247721.66	4246.66	Residential, dispersed	1 house
Kibamba	506151.57, 9249887.73	2134.00	Residential, dispersed	1 house
Kibamba	505994.61, 9249510.79	9356.78	Market	
Kibamba	505962.57, 9249531.80	6913.88	Residential, dispersed	8 shops
Kibamba	505708.49, 9250922.10	4606.72	Residential, dispersed	2 houses
Kibamba	505193.18, 9253540.50	3962.11	Residential, dispersed	1 house

Ward	Premise centre coordinates (UTM)	Premise size (m^2)	Premise neighborhood characteristics	No. of HH
Kibamba	506487.15, 9253857.15	4348.68	Residential, dispersed	3 houses
Kibamba	503641.61, 9254375.81	3009.01	Residential, compact	2 houses
Kibamba	506258.50, 9247872.86	3512.63	Residential, dispersed	1 house
Kibamba	507325.15, 9247919.18	2878.77	Residential, dispersed	1 house
Kibamba	510754.41, 9247339.64	2708.11	Residential, dispersed	1 house
Kibamba	510967.21, 9251112.52	3672.02	Residential, dispersed	1 house
Goba	506111.74, 9249497.51	3607.78	Residential, dispersed	2 houses
Goba	514613.61, 9258559.80	3777.51	Residential, dispersed	1 house
Goba	517652.19, 9258464.31	2490.38	Residential, dispersed	1 house
Goba	511917.86, 9260627.55	2437.69	Residential, dispersed	1 house
Goba	519184.23, 9256656.73	3291.61	Residential, compact	4 houses
Kimara	514813.58, 9247190.85	4452.00	Residential, dispersed	3 houses
Kimara	516726.37, 9247610.90	3472.56	Residential, compact	1 house
Kimara	518671.65, 9246806.06	6096.96	Residential, dispersed	3 houses
Kimara	506054.28, 9249505.26	2184.46	Residential, dispersed	1 house
Kimara	520573.22, 9247425.82	1958.88	Residential and commercial	1 house
Kimara	515276.73, 9253700.50	4674.88	Residential, dispersed	
Kimara	518680.67, 9253429.68	1982.75	Residential, dispersed	1 house
Mbezi	507743.45, 9251649.00	3133.23	Residential, dispersed	3 houses
Mbezi	516334.29, 9253922.62	1945.20	Residential, compact	2 houses
Mbezi	512723.38, 9243704.05	2478.44	Residential, dispersed	2 houses

No. of HH = number of participating households

Table 4.4: Premises where open burning of solid waste is done in Kigamboni municipality

Ward	Premise centre coordinates (UTM)	Premise size (m^2)	Premise neighborhood characteristics	No. of HH
Mji Mwema	538985.89, 9242429.65	3480.51	Residential, dispersed	1 house
Mji Mwema	537889.13, 9242486.55	1994.56	Market	1 house
Mji Mwema	538107.97, 9240409.22	3680.00	Residential, dispersed	2 houses
Kibada	538749.54, 9235790.53	5699.95	Residential, dispersed	2 houses
Kibada	537037.85, 9239009.68	2965.91	Residential, compact	1 house
Kibada	539276.68, 9237932.84	3164.80	Residential, dispersed	1 house
Kibada	540094.29, 9237023.18	3560.40	Market	
Kibada	539802.08, 9235105.96	2369.20	Residential, dispersed	1 house
Kibada	538041.40, 9235912.79	4111.57	Residential, compact	2 houses

Somangira	551859.22, 9232627.11	2605.56	Residential, dispersed	3 houses
Somangira	548052.83, 9236818.70	3302.36	Commercial	4 shops
Somangira	549360.96, 9235330.77	1876.34	Residential, dispersed	1 house
Kimbiji	558878.61, 9227105.27	4258.04	Residential, dispersed	2 house
Vijibweni	535828.99, 9240038.31	2536.21	Residential, compact	1 house
Vijibweni	534585.08, 9244105.25	3563.34	Residential, dispersed	2 houses
Vijibweni	537255.19, 9244069.92	3948.13	Residential, dispersed	4 houses

No. of HH= number of participating households

Further to the findings presented in Tables 4.3 and 4.4, surveys and investigations for this assignment have revealed that, generally open burning of solid waste takes place at the following types of sites and premises:

- Open spaces
- Official solid waste disposal sites
- Illegal solid waste discharge sites
- Individual homes or private properties

The following main observations can be made on the Tables 4.3 and 4.4 on premises where open burning of solid waste takes place in Kigamboni and Ubungo municipalities:

- Open burning of solid waste takes place mostly in the neighbourhood of residential premises, near markets and other commercial premises.
- There are quite many open burning premises in the pilot project areas – 29 premises in Ubungo and 16 premises in Kigamboni, with Kibamba ward in Ubungo municipality leading with 14 premises.
- The open solid waste burning premises serve mostly residential premises, but eight shops (stores) in Kibamba are an exception.
- All open solid waste burning premises listed are located in areas where housing densities are low; where fire risks are relatively low, and where the potential for nuisance and the consequent complaints is also low.
- Each open solid waste burning premise case is a likely location for an illegal waste discharge premise.
- Where there is an illegal solid waste disposal premise, there is poor solid waste management service in the neighbourhood and the neighbourhood is likely to be an unplanned settlement.
- In these premises the low housing density would allow composting of solid waste to be practiced because the available space is sufficient.

- If backyard composting of solid waste is implemented in these areas, the compost product is likely to find a ready use in urban agriculture, gardening and general vegetation enhanced aesthetic quality improvement. Such things are possible because of the low housing density.
- Illegal practices including open burning of solid waste can easily go unnoticed in these areas because the areas are practically out of sight

4.6 Impacts and Implications of Open Burning of Solid Waste

Impacts and implications of open burning of solid waste are basically known and generally well documented. Most importantly, they have been cited in connection with the genesis of this project. In fact they are the essence of the project itself; they are the essence of the project to which this assignment contributes. Therefore, a full treatment of the discussion on impacts and implications here is neither needed nor justifiable. Nonetheless, a discussion of specific noteworthy impacts and implications relevant to the pilot project areas is not only relevant but also required.

The impacts and implications of open burning of solid waste specifically observed and reported in connection with the pilot project areas are essentially the following:

- Fire risks to which passers-by, stray animals, children, and people as well as properties in the neighbourhood of the sites are vulnerable.
- Air pollution and smoke nuisance in the neighbourhood of the sites and directly downwind of the sites (in the direct line of the dominant wind direction).
- Air pollution due to ash resulting from burning solid waste which can occur onsite and offsite. The ash is transported offsite by natural wind and to a small extent by air disturbances created by vehicular traffic
- A reduction in visibility due to smoke in the neighbourhood of the sites and downwind of the sites (directly down the line of the dominant wind direction). Traffic accidents have been known to occur on road segments close to where open burning of solid waste takes place. For Dar es Salaam city, Tabata is a prominent reference case.
- Disruption of accessibility of areas in the neighbourhood of the sites and beyond which have to be reached by passing through or near the sites.
- Permanent destruction of some otherwise potentially recoverable solid waste resources especially those of biomass and plastic origin.
- Permanent and temporary degradation of aesthetic and scenic quality of properties in the neighbourhood of the sites due to smoke and soot associated with the smoke.

- Destruction of utility and ornamental vegetation such as landscape trees, shade trees, ornament trees, lawn grass, and flowers and other garden plants.

4.7 Current Prevention and Control Measures for Open Burning of Solid Waste

Any discussion on measures currently taken for the prevention and control of open burning of solid waste must take into consideration the levels at which the measures are taken as well as the contexts within which the measures are taken. The levels of prevention and control of open burning of solid waste identified below have been found to be the most relevant to this project.

National or central government level

This is the highest level and at this level the preventive and control measures are effected directly through the responsible ministries and departments or through agencies of the responsible ministries including ministries responsible for health, environment, and local government. The measures mainly pertain to policy and legislation aspects. Apparently, in the short term, only rare and exceptionally serious cases can be directly influenced by the measures taken at this level. However, in the long term, the measures are effective in part because the measures taken at the highest level also influence the implementation of the measures taken at lower levels. Where directives are involved, the influence of the measures taken at high level is magnified several folds.

Local government level

At this level the local government' authority and mandate as well as machinery are put to use to facilitate the prevention and control measures. At this level the measures are in the form of direct enforcement efforts, including routine inspection. When instituted, measures taken at this level are usually effective and their effects immediate even though not necessarily long lasting if not followed up or carried out regularly, which is unfortunately the case currently..

Community level

This level refers to the case whereby measures are undertaken by collective or coordinated efforts of members of a community. Members of a community identify themselves as belonging to that community because of one or more shared unifying factors. They include the place the people live in, the organisation the people work for, or the place the people come from. Many aspects discussed in connection with the institutional level below apply to the community level. However,

authority is not wielded as widely and as strongly and as effectively at community level as at institutional level.

Institutional level

In this context, institutions include academic institutions, religious institutions, military barracks, prisons, hospitals, housing estates, industrial estates, and other similarly organised establishments. At this level, decisions are made at high administrative echelons and are complied with even if the individual members of the institutions do not really understand the essence of the measures or personally support the measures themselves. Measures taken at this level have been found to work all the time. That is why it is not common to observe open burning of solid waste at institutional premises. Even during this assignment open burning of solid waste was not observed within the jurisdictions of institutions in the pilot project areas.

Family, household, or property level

This is the level where the preventive or control measures are undertaken at a level where the responsible people are related socially. In some cases, the responsible people are related through their landlord or landlady.

It has been observed that open burning of solid waste takes place quite frequently at family, household or property level. However, the waste being burnt may not be large in quantity and therefore the resulting fire may also be small and lasting only a relatively short time. Nonetheless, the short time is long enough to be a nuisance and cause other harmful effects. Besides, large premises are likely to produce large quantities of waste especially if there are ornamental and shade plants on the plot. At this level, the family or household head or property owner is the key to success and thus must be the prime target of any corrective measures.

Individual level

This is the level whereby a member of a community acts in his or her individual rather than collective capacity to prevent or control open burning of solid waste. It includes an individual's refrain from committing the offence herself or himself in the absence of other people or direct external pressure. It also encompasses measures undertaken by an individual to rein in actions of other people in this respect and this can be by way of reporting non-compliance cases, lodging complaints with the authorities, and educating the actual and potential culprits. The success of the measures taken at this level have been found to be highly dependent on:

- The general populace's awareness and appreciation of the essence of preventing and controlling open burning of solid waste. Thus, the higher the awareness and appreciation, the more likely the measures at this level are to work. Currently, many people appreciate the adverse effects of open burning of solid waste because of its obvious and easily discernible impacts such as the ones emanating from the smoke and ash produced and the associated fire risks. Therefore, action is likely to be taken only when the problem is close to home in consideration of the fire risks and when either smoke, ash or smell is observable from the burning waste. Education is needed to enhance awareness to a level higher than the current one.
- Boldness as well as willingness of the individual to take the right action even in the face of potential backlash or conflict. This is in part influenced by the trust people have in law enforcement authorities. With a trustworthy law enforcement authority, one knows that there is nothing to fear about. Trust in law enforcement authorities by ordinary people is fairly high nowadays and it is increasing especially with the current government in power. This was not the case not long ago.

5.0 AN EXTENDED ANALYSIS OF THE WASTE RESOURCE RECOVERY INDUSTRY

5.1 Scope and Context of the Waste Resource Recovery Industry

Aspects and practices

The waste resource recovery industry in the pilot project areas is linked to and interdependent with the waste resource recovery industry in the rest of Dar es Salaam city. In turn, the waste resource recovery industry in Dar es Salaam city is a good reflection of the waste resource industry in urban areas in the rest of the country. The waste resource recovery industry in Dar es Salaam city constitutes the practices as well as components and aspects pertinent to the following:

- Waste resource retrieval (retrieval of waste resources from the waste stream, which takes place at different stages of waste management),
- Waste resource reuse (putting the waste resources to use that is the same, similar or different from the original one),
- Waste resource industrial recycling (conversion of waste resources into new products),
- Waste resource based biogas production,
- Waste resource based fuel briquettes production, and
- Waste resource based composting.

To the above list can be added integrated waste management and resource recovery (IWM&RR) which incorporates two or more waste resource recovery practices identified above executed in parallel or in series. IWM&RR is discussed in greater detail in other parts of this report.

Common waste resource materials retrieved

The most commonly retrieved and utilised waste resource materials in Dar es Salaam city including the project pilot areas are:

- Assorted organic waste which is generally readily biodegradable and suitable for biogas production and composting.
- Waste paper fractions including packaging materials, printer paper and newsprint, which are currently used by the pulp and paper industry.

- Assorted plastics which are mainly used plastic bottles for beverages and bottled water plus other plastic items such as plastic furniture and plastic containers.
- Metallic waste resources which are mainly ferrous and aluminium scrap metal and metal cans used as beverage containers.
- Beverage industry waste food mainly from brewery industries for branded beer and unbranded local beers, which is reused as livestock feed.
- Food waste from restaurants, hotels, and institutions such as academic institutions, which is used as livestock feed.
- Beverage glass bottles and broken glass bottles which are reused or recycled for additional rounds of use.

The majority of the above listed cases of waste resource recovery involve resources which are retrieved for extra-industry or inter-industry resource recovery. The most outstanding intra-industry resource recovery involves beverage glass bottles which go through many cycles of post-use retrieval and collection followed by washing and reuse by the relevant industry.

Waste resource recovery operation and activity stages

The main waste resource recovery operation and activity stages exhibited in Dar es Salaam city including the pilot project areas are mainly the ones presented in Table 5.1.

Table 5.1: Waste resource recovery operation and activity stages

SN	WRR stage	WRR operation/activity	WRR participants
1	Upstream stage	Waste resource generation and discharge, waste resource retrieval, waste resource volume reduction, waste resource retail sale and retail purchase, waste resource collection	Waste resource generators, waste resource primary retrievers and retail sellers, waste resource primary collection
2	Mid-stream stage	Waste resource bulk buying and storage, volume and size reduction of bulky waste resources, waste resource transportation	Waste resource bulk buyers, waste resource transporters
3	Downstream stage	Waste resource bulk sale, waste resource recycling	Waste resource bulk sellers, waste resource industries

Solid waste management stages where waste resource retrieval takes place

Waste resource recovery takes place along the whole waste stream. More specifically, the solid waste management functional elements within which waste resource recovery takes place are:

- At generation and discharge
- At primary storage
- During primary collection
- At secondary storage or transfer
- During secondary collection
- During transportation
- At final disposal premises (at Pugu kinyamwezi dumpsite which is operational, at formally closed dumpsites, and at illegal disposal sites)

Even without considering any specific analysis or details for the case at hand, the greatest benefits of waste resource recovery can be achieved if waste resource retrieval takes place within the most upstream solid waste management functional element. The closer to the most upstream point the waste resource recovery efforts take place, the better. This is because the cost of solid waste management increases with the number of solid waste management functional elements included and therefore, the more of the solid waste management functional elements are excluded, the better. Implementing waste resource retrieval before storage facilitates the avoidance of waste management costs in respect of the waste resource except for pre-collection storage costs.

Pre-storage waste resource retrieval for waste resource recovery does take place in Dar es Salaam, but to a limited extent; it is neither formalised nor optimised. Also, because pre-collection waste segregation during storage is not formally practiced, waste resource recovery practice in Dar es Salaam has an added work and cost item of waste segregation. Furthermore, since waste resource retrieval takes place all along the waste stream without being designed into it, it interferes with and disrupts solid waste management service provision efforts. Again, the more the number of functional waste management elements involved, the greater the disruption.

5.2 Status and Viability of Composting Based on Organic Solid Waste Fractions

Small scale composting of solid waste has been in practice in Dar es Salaam city for a long time in part because of the influence of urban agriculture and greening efforts. Findings from our studies carried out long before this assignment, indicate that 55% of respondent urban agriculture practitioners had knowledge on compost, but only 36% of the respondents had used compost in urban agriculture. On the other hand, 93% of the respondents expressed willingness to try to use

compost in urban agriculture. The 7% of the respondents who were not willing to try using compost were discouraged by the possibility that compost would serve as a vector for new pests.

During the surveys and investigations carried out specifically for this assignment, it was revealed that commercial producers of compost do exist but they face some formidable challenges. It is noteworthy that some producers of compost who were in the market in the past had to close their business after failing to cope with challenges such as poor cost recovery. Table 5.2 presents a summary of the profile of the largest existing commercial producer of compost in the pilot project areas.

Table 5.2: Profile of the Recycler Company Limited

Key profile aspect	Corresponding details
Interviewee	Mattew Haden, Company founder and CEO
Office location	Kinondoni
Facilities location	• Mkuranga- plastic processing facility • Vijibweni –compost and protein insect processing facility
Mission and vision	Mission • Reduce waste which has to be disposed • Avoid the use of virgin materials • Provide employment
Vision	• Process 20 tons/day of plastic waste by end of 2019 • Construct hazardous waste incineration facility in Kigamboni
Facilities cost	• The company has invested more than 5.5 US dollars by total
Professional background of co-founders	• CEO-Environmental Engineering, University of Cambridge UK. • Second co-founder-University of Nairobi
Facility owners	• Shareholders
Land property owners	• The company owns the land in all facilities location
Facility operators	• Incineration plant will be partnership with NAC Consulting Company Limited • Other facilities are operated by the company employees.
Number of staffs	• 26 stuff by total, 20 unskilled, 6 skilled all these workers are permanent • 10 to 15 temporary employees per month.
Affiliation with academic institutions	None

Key profile aspect	Corresponding details
Source of technical support	• Company employees-CEO • Consulting companies such as NAC Consulting Company Limited for facility construction
Financial support	• From investors and partners • From product solid including compost, chicken feed, plastics
Composting facility description	• All facilities are constructed to fit intended purposes • The company were unable to provide further description for intellectual property issues.
Composting feedstock description	Capacity of operation • 1 ton per day of plastics • 5-8 tons of organic waste per day
	Constituents of organic waste were not described
	Sources of SW used • Embassies, • Breweries and other beverage industries
	Quality of feedstock was not described
Solid waste collection operation and procedures	Collection schedules • Once in week collection in residential and commercial areas • Once in a week collection in industries depending on availability
	Collection vehicles • Two collection vehicles 5tons each • Sometimes vehicles are hired depending on company needs
	SW onsite storage • The company provide collection beans in all collection areas
	SW sorting and segregation • Collection beans for each type of waste are provided in collection areas (non-biodegradable waste, and biodegradable waste) • Further segregation is conducted at company facilities • Size reduction is conducted at company facilities
	Rejected fraction management • Rejected solid waste is transported to Pugu-Kinyamwezi dump site
Composting operations and procedures	No description was provided reportedly due to intellectual property rights issues
Post composting operations and procedures	No description was provided reportedly due to intellectual property rights issues

Key profile aspect	Corresponding details
Composting and related products description and uses	Product lines • Compost for famers 3% N used as soil conditioner • Dried larvae 48.9% protein, 26% fat
Operation running costs	Hiring cost • Around 300,000/= TZS per month for each unskilled labour • 1,000,000 to 2,000,000/=TZS for each skilled staff
	Other cost were no disclosed but the company has invested more than 4 million USD dollar for its operations
	Financial sustainability challenges • The company faces financial challenges due to low demand of compost
Safety, health and environmental management issues	Workers safety and health consideration • All workers are provided with working PPE sets • The company make sure environmental safeguards are a priority across all operations.
	Environmental considerations • Environmental protection is given high priority in all areas where the company operates
	Hazardous waste management • In most cases the feedstock does not contain hazardous wastes. • The company is in the process to construct commercial incinerator near Vikindu. The construct will start in mid of 2019
Recognition and appreciation	• Sankalp Africa Award for providing best environmental solutions.

Table 5.2 reveals interesting findings on the potential benefits as well as challenges associated with commercial composting of solid waste in the pilot project areas. The following are noteworthy:

- It is not expected that intellectual property rights could be an issue with respect to composting because the basic composting technology itself is not proprietary knowledge. Nonetheless, it is conceivable that the company has added something on top of the basic composting technology which calls for IPR protection. In spite of the foregoing, IPR issues are not expected to affect applicability and promotion of composting as part of this project.
- The dried larvae (pointed out in Table 5.2), which serve as ingredients in livestock feedstock, is a spin-off product that can be promoted alongside composting of solid waste.

- Successful adoption and promotion of composting can achieve remarkable contributions to generation of employment opportunities and income.
- Despite the potential of compost market presented by urban agriculture and related activities, the actual current demand for compost is apparently low. This calls for the need to enhance the market for compost along with the promotion of composting.
- It is apparent that in most cases the feedstock for composting does not contain hazardous waste fractions. Nonetheless, it is important to consider what might happen if some batch of the feedstock happens to contain hazardous waste fractions. The main preventive measures against this eventuality is more vigorous pre-storage segregation of solid waste fractions meant for composting.

Apart from the companies and other entities that are currently involved in commercial composting of solid waste, a number of community based organisations (CBOs) used to be involved in composting activities in the past. Several CBOs which were conducting composting activities in Kigamboni and Ilala are no longer operational. The main reasons for their failure in continuing to conduct these activities were identified as:

- Apparent of unavailability of the market for the produced compost in Dar es Salaam region.
- A shortage of suitable land
- Changes in solid waste collection system in the city which requires the solid waste collectors to transport the collected waste all the way to the disposal site, which is a considerable distance. Previously the CBOs needed to collect the waste from its sources to collection centres from where municipal trucks transported the waste to the Pugu kinyamwezi disposal site. Most CBOs cannot afford the transportation means required to take part in the new solid waste management regime. Consequently, they cannot provide the solid waste collection service and as a result they no longer get the corresponding revenue which they used to spend on subsidising their composting activities. The composting activities in turn contributed to the reduction of the volume of waste needing further management.
- Furthermore, the changes in solid waste management system put an end to funds provided by the municipal council which were used to support composting activities.

Irrespective of the foregoing, Table 5.3 presents profiles of a selection of CBOs that were once active in solid waste composting and their corresponding reasons for not being able to continue to with solid waste composting.

Table 5.3: Profiles of a selection of now defunct CBOs and their failure to continue with solid waste composting

Profiles of CBOs	Reason for failure to continue with composting of solid waste
Kisiwani Environmental Group Location: Buguruni, Ilala Consulted person: Yahya Mkanga Services: • SW collection in Unplanned areas • SW Composting activities • Recyclables collection Years of operation: 2009-2014	• Financial challenges • Unavailability of compost market • Land availability challenges
MATEWA Location: Kigamboni Consulted person: Ferry MEOs office Services: • SW collection • Recyclable collection • SW composting Years of operation: 2007- present	The CBO is still conducting solid waste collection activities in 5 wards in Kigamboni municipality but stopped solid waste composting activities. Composting activities were stopped due to: • Unavailability of market for compost • Land availability • City council suspending the funding of solid waste collection groups
UMAWA Location: Kigamboni & Kurasini (Temeke) Consulted person: Hawa ally(member) Services:	The CBO is still conducting solid waste collection activities in 5 wards in Kigamboni municipality. Composting activities were stopped due to:

Profiles of CBOs	Reason for failure to continue with composting of solid waste
• SW collection • Recyclable collection • SW composting Years of operation: 2007-present	• Unavailability of market for compost • Land availability • Competition from MATEWA group at one time.
Songambele Environmental Group Location: Buguruni, Ilala Consulted person: Kisiwani MEO office Services: • SW collection in Unplanned areas • SW Composting activities • Recyclables collection Years of operation: Around 2010	• Financial challenges • Unavailability of compost market • Land availability challenges • City council suspension of funding for solid waste collection groups

Despite the discussion presented earlier which paints a grim picture, composting and its commercial viability can be related to urban agriculture (urban crop farming, urban gardening, and urban livestock keeping). To the foregoing list can be added, landscaping, soil conservation, and sale of ornamental and utility plants as discussed in detail elsewhere.

Animal manure has a huge market which, even without other evidence, suggests that there is a potential market for compost. Logically, there is a potential competition among different types of fertilizers (and soil conditioners). However, any competition between animal manure and industrial fertilisers seems not to affect the demand for animal manure. Most livestock keepers could sell their manure almost as soon as it is produced. Our studies show that chicken manure and cow manure sell like hot chocolate, literally. There may be a need for a dedicated study on use, market, and supply of animal manure in Dar es Salaam city, especially in urban agriculture (urban crop farming and urban livestock keeping). A market survey with respect to compost use has been carried out before, but there is a need to update it under the auspices of this project.

It is noteworthy that, a study on feasibility of solid waste composting as a strategy for solid waste management improvement is underway. The study encompasses coverage on needs and options for commercial viability of solid waste composting. However, it is a dissertation research project

which means its geographical scope is likely to be small. Moreover, its temporal scope may also be slightly out of step with the needs of the project.

As noted earlier, previous studies on solid waste compost market, which address the market aspect in Dar es Salaam city have not been fully released. They are also practically out of date as far as this project is concerned. Therefore, on the whole there is a need for another solid waste compost market survey under the auspices of this project. Alternatively, the project can support ongoing efforts that incorporate sufficient coverage on solid waste compost market survey. The market survey must cover, among other things, the reasons for the challenges observed with respect to commercial composting. Equally important, it should cover an analysis of needs and options for commercial viability of solid waste composting in Dar es Salaam city.

In addition to the need for enhancing the commercial viability of solid waste composting, significant emphasis should be put on backyard composting of solid waste especially where yard waste is involved. Therefore, backyard solid waste composting should be promoted alongside centralised and commercial solid waste composting. Backyard composting has the greatest positive impact on solid waste management in general and solid waste open burning in particular. This is the case because backyard composting can greatly reduce quantities of solid waste that need further attention. Consequently, the unit cost of solid waste management will go down.

A detailed discussion on research and development work done with respect to solid waste composting is presented later. Many studies have been carried out on composting of different fractions of solid waste. In addition, there is a dedicated facility for composting and recycling of solid waste. The wealth of knowledge and experience in the custody of ARU can be mined for the benefit of this project.

5.3 Waste Resource Reuse

As discussed earlier, the most outstanding case of waste resource reuse, is that of inter-industry practice involving glass beverage bottles. Glass beverage bottles for soft drinks and beer are reused over and over again and they are not taken out of service unless they are deemed to have developed a defect upon scrutiny to which every returned bottle is subjected. One cycle of reuse begins with the used beverage bottles being returned after use. The returned bottles undergo thorough washing. The bottles that pass the inspection are the ones that are refilled with a fresh batch of drink ready for another round of reuse.

5.4 Waste Resource Industrial Recycling

Waste resource industrial recycling is practiced extensively in the pilot project areas as well as in the rest of Dar es Salaam city. Industrial waste resource recycling is purposely and clearly differentiated from such resource recovery practices as production of fuel briquettes which are technically also a form of recycling.

Apart from the improvements discussed earlier as well as later with respect to general resource recovery, industrial waste resource recycling needs almost no interventions. The main waste resource materials recycled are:

- Ferrous items and ferrous metal scraps
- Aluminium cans and aluminium metal scrap
- Plastic furniture, containers, and other plastic items
- Miscellaneous scrap metal

5.5 Waste Resource-Based Biogas Production

Biogas technology is quite prevalent in Dar es Salaam city, including the pilot project areas. Biogas plants are available at many different use levels, mainly household and institutional levels. The institutions. The most noteworthy institutional user of the biogas technology in Dar es Salaam city, is Segerea Seminary, which makes extensive use of biogas. Most biogas plants in Dar es Salaam city use livestock manure as the main feedstock, but a small number use solid waste fractions. An almost negligible number of biogas plants use a mixture of livestock manure and solid waste fractions as the main feedstock.

Extensive studies have been carried out at and by ARU on operational status of existing biogas plants and on suitability of different solid waste fractions for biogas production. Most importantly, studies have been carried out on operation and maintenance challenges pertinent to different designs of existing biogas plants. The resulting wealth of knowledge and information can be mined for the benefit of this project. An additional discussion on biogas technology is presented in connection with other aspects of integrated solid waste management and resource recovery.

5.6 Waste Resource-Based Fuel Briquettes Production

As discussed in greater detail later, production of fuel briquettes using organic solid waste fractions can contribute to the enhancement of solid waste management while at the same time addressing

energy supply challenges. It will offset the use of fuel wood (charcoal and firewood) and consequently play a key role in the protection of the environment by way of contributing to the conservation of forests that would otherwise be harvested for firewood and charcoal. As discussed earlier, use of yard waste in the production of fuel briquettes contributes directly to reductions in open burning of solid waste.

One outstanding advantage of using solid waste to produce fuel briquettes is that production of fuel briquettes works even with solid waste fractions that would be difficult to use as biogas production feedstock. Such solid waste fractions would also be difficult to use for producing compost.

It is noteworthy that the capacity for local production of fuel briquettes using solid waste fractions as the main feedstock exists. The currently produced fuel briquettes are even stocked by reputable supermarkets, which suggests that there is a robust market for the briquettes, including the ones made using solid waste fractions. In fact, even though no systematic effort has been expended on identifying and characterising companies involved in fuel briquettes production using solid waste, our experience indicates that there are several companies involved.

A considerable amount of research and development work has been done at ARU regarding the feasibility of using solid waste fractions as main feedstock and alternative binders for fuel briquettes production. Therefore, there is a wealth of related knowledge that can be mined for the benefit of the project. In spite of the foregoing, there may still be a need for systematically gauging the viability of commercial production of fuel briquettes using solid waste fractions in the pilot project areas.

6.0 CROSS-CUTTING SUPPLEMENTARY FINDINGS AND OBSERVATIONS

6.1 On the need to make use of existing quality research on resource recovery

It has been observed that several studies on composting and on other aspects of waste resource recovery which have already been carried out by qualified and recognised experts are put to full use. On the other hand, the surveys and investigations for this assignment revealed that there are some people who are involved in resource recovery who make false claims that they have carried out research in some aspects of solid waste management or resource recovery. They go so far as to give out made up data to support their claims. In addition to establishing beyond doubt that their claims are false, we additionally established that they could not have carried out the said research because:

- They lacked the background academic capacity and experience to undertake the research
- They lacked material and financial resources to undertake the research
- Irrespective of the preceding arguments, apart from the verbal claims themselves, there is no collaborating evidence to back the claims

False claims to the effect that some research has been carried out and the accompanying tossing around of baseless statistics, should be discouraged because false data are misleading and may form the basis for bad decisions. False research claims may mask data poverty and lead to preclusion of genuine research efforts that would otherwise help to plug real knowledge gaps. False research claims and the accompanying false data may give rise to a false sense of accomplishment.

6.2 The need for making use of waste management and waste resource recovery experts

There are many Tanzanians who are specially trained in what is required for effective waste resource recovery, but in the current efforts they are apparently not involved. At best, they feature only sparingly, if at all. On the hand, the people who feature prominently even in positions that require expertise are least qualified for the jobs.

6.3 Other cross-cutting supplementary findings and observations

There are a number of cross-cutting findings and observations that are relevant to the project and as such worth of being put on the record. They include:

- Quality research findings are not utilised or are simply underutilised while at the same time blatant claims of lack of research are made
- Some studies carried out in an inferior way in areas and issues for which applicable, relevant and up-to-date quality research exists; are given prominence at the expense of the quality research.
- Valuable ongoing efforts on solid waste management and waste resource recovery are apparently ignored while potentially unsustainable new efforts are given attention as if they are the first of their kind.
- False claims are made by some people especially solid waste management service providers and resource recovery practitioners that they have carried out citywide or nationwide research on solid waste management on which their practice is based. This is done while not only the claims are untrue but also such people lack the ability to carry out such research.
- Trailblazer research is not acknowledged while copycat though more recent research is not only glorified but also treated as if it is ground-breaking and original.
- Some real solid waste management experts are underutilised while at the same time claims of a lack of expertise are being made by those who need the expertise.
- A wealth of information and data on solid waste management and waste resource recovery is sitting in the custody of experts while potential users go elsewhere to look for the data and information.
- Some high cadre solid waste management and waste resource recovery experts may sit idle while their potential service beneficiaries look elsewhere for expertise and occasionally end up with pretending experts rather than real experts.
- Most companies involved in solid waste management and waste resource recovery do not involve academic institutions which have expertise and experience in solid waste management and waste resource recovery. On the other hand, academic and research institutions deeply involved and highly experienced in solid waste management and waste resource recovery do not get opportunities to get involved in activities undertaken by the companies involved in solid waste management and resource recovery. This denies both the academic and research institutions and the companies of the benefits of synergistic cooperation. This would be research-informed improvements in performance on the part of the companies and practice- and challenge- informed improvements in teaching, research and public service provision on the part of the academic and research institutions.
- For some waste resources, the ultimate market is outside Tanzania. While this is generally acceptable and even encouraged in the short term, an industry that is wholly dependent on some external market is deemed to be unsuitable for the long term because sustainability is not assured. It is advisable to develop the internal industrial capacity in this respect. This will fit in well with the country's expressed desire to industrialise. Notably, this is also in line with UNIDO's function and mission.

7.0 INTEGRATED WASTE MANAGEMENT AND RESOURCES RECOVERY CAPACITY

7.1 Introductory Remarks

Without appearing to be biased or prejudiced in favour of Ardhi University, it is important to project a realistic and reprehensive image of integrated waste management and resource recovery (IWM&RR) capacity in Dar es Salaam city. While there are several practitioners of one or another aspect of IWM&RR as discussed in this report, evidence-supported full-fledged capacity in terms of technical expertise, infrastructure and facilities, and practical experience in IWM&RR under one roof is only available at the School of Environmental Science and Technology (SEST) at Ardhi University.

Some universities and research institutions have been found to undertake occasional research in some aspects of IWM&RR. However, none have the coverage of IWM&RR, long term continuity in IWM&RR research, permanent full scale IWM&RR research and development infrastructure and facilities, and IWM&RR engagement that is even remotely close to that of ARU SEST. On the other hand, the practitioners, lack the extensive and comprehensive IWM&RR coverage, long term practice track record and technical support that ARU SEST possesses.

As such, a separate detailed discussion on IWM&RR capacity available at ARU SEST is not only warranted but also required for completeness of the discussion in this section. The discussion is also useful because it also reveals opportunities for beneficial mining of the wealth of IWM&RR data and information as well as expertise and experience. The opportunities can come in handy in the later stages of the project at hand.

7.2 Integrated Waste Management and Resource Recovery Capacity at Ardhi University

Surveys and investigations for this assignment revealed enormous integrated waste management and resource recovery capacity at Ardhi University. It deserves a mention and coverage here because: 1) it is clearly incomparable to any other found elsewhere and 2) it presents a potential

that can be tapped for beneficial use in the later stages of this project. For convenience of presentation and reference, the capacity is summed up in tabular form (Table 7.1).

Table 7.1: Noteworthy and potentially applicable IWM&RR capacity available at Ardhi University

SN	IWM&RR capacity aspects	Explanatory notes and details
1	Solid and hazardous waste management and technology capacity dating back to 1980s and continually maintained and updated.	- Undergraduate and postgraduate teaching capacity - Tailor made training capacity (for example for practitioners, solid waste collection contractors) - Solid waste management and technology research capacity - Solid waste management and technology literature wealth – a wealth of research findings including data repository dating back to the early eighties
2	Solid waste recycling capacity dating back to 1980s with facilities only available at ARU continually maintained and updated.	- Research expertise and experience - Practice skills and experience - Training expertise and experience - Training facilities - Technology demonstration and practice facilities - A wealth of research findings including data repository dating back to the early eighties
3	Waste composting technology capacity dating back to 1980s with facilities only available at ARU continually maintained and updated.	- Research expertise and experience - Practice skills and experience - Training expertise and experience - Training facilities - Technology demonstration and practice facilities - A wealth of research findings including data repository dating back to the early eighties
4	Biogas production technology capacity dating back to the 1980s and continually maintained and updated.	- Research expertise and experience - Practice skills and experience - Training expertise and experience - Training facilities - Technology demonstration and practice facilities

SN	IWM&RR capacity aspects	Explanatory notes and details
		- A wealth of research findings including data repository dating back to the early eighties
5	Fuel briquettes technology with the feedstock and binder both being organic solid waste fractions	- Research expertise and experience - Practice skills and experience - Training expertise and experience - Training facilities - Technology demonstration and practice facilities - A wealth of research findings including data repository
6	Campus based - integrated waste management and resource recovery (IWM&RR) capacity – a pioneering role in Tanzania	- IWM&RR research and development expertise and experience - Practice skills and experience - IWM&RR training expertise and experience - Training facilities - IWM&RR technology demonstration infrastructure and facilities - A wealth of research findings including data repository
7	Community based (Segerea) Campus based - Integrated waste management and resource recovery (IWM&RR) capacity – a pioneering role in Tanzania	- IWM&RR research and development expertise and experience - Practice skills and experience - IWM&RR training expertise and experience - Training facilities - IWM&RR technology demonstration infrastructure and facilities - A wealth of research findings including data repository
8	Obsolete pesticide management and clean-up of contaminated stores and sites – a pioneering feat in Tanzania	- Quantification and characterisation of the obsolete pesticides - Assessment of extent contaminated stores and sites - Development of treatment options for the pesticides and pesticide containers and clean-up options for the contaminated stores and sites (soil and water)

SN	IWM&RR capacity aspects	Explanatory notes and details
9	Integrated resource recovery and sanitary final disposal facilities	- Development of an alternative direction for resource recovery which integrates resource recovery functions with sanitary final disposal functions especially for land-constrained urban areas that desire sanitary landfills - One such facility designed for Moshi municipality (which is critically land-constrained) has had the tender for its implementation already advertised
10	Innovative health care waste incineration with thermal energy recovery provision	- Incorporates use of innovative green resources for pre-treating health care waste and make its incineration a potential source rather than a sink for thermal energy
11	Assessment of persistent solid waste fractions (PSFs) and resource recovery options	- This is a new waste resource recovery development thrust area which focuses on understanding and developing beneficial uses for waste constituents which are currently not amenable to recovery but whose removal from the waste stream would have a great impact on waste management especially in terms of disposal facility size reduction. PSFs include fractions that are set on fire in open burning - Extensive work on characterisation and quantification of PSFs and development of use options has been done in Moshi municipality and Dar es Salaam city
12	Experimental hall for IWM&RR research and training and technology research	- Purpose built hall with 25 m x 40 m space with adjoining lab facilities specially intended for IWM&RR research and development plus training
13	Capacity and experience in training solid waste management practitioners	- ARU has conducted ILO sponsored training on solid waste management and resource recovery (composting and recycling) and hazardous waste management for more than 70 contractors, CBOs, and other entities involved in solid waste management. The training was conducted under

SN	IWM&RR capacity aspects	Explanatory notes and details
		the auspices of the International Labour Organisation.
14	Use and post-use management of plastic bags	- Management and technology aspects of plastic bags from issuance during shopping to the disposal site and on into the environment - Replacement options for plastic bags and recycling options for plastic bag material

The solid waste and hazardous waste management and technology capacity covers all functional elements of waste management and all solid and hazardous waste types and sources. For example, health care (medical) waste is covered in all the aspects listed in Table 8.1under the corresponding explanatory notes in this respect.

In connection with undergraduate and postgraduate academic programmes which train professional experts in IWM&RR, the following programmes offered by ARU are relevant: BSc. Environmental Engineering, BSc. Municipal and Industrial Services Engineering, BSc. Environmental Science and Management, and MSc. Degree and PhD degree in Environmental Technology and Management. These programmes both train the professionals and produce research outputs pertinent to IWM&RR.

The recycling and composting technology capacity has a number of highlights that are worth mentioning. For one thing, ARU carried out the first ever full scale recycling and composting demonstration twin projects in Tanzania way back in 1995 – 1998. The nearby residential areas of Sinza served as sources of the solid waste for recycling and composting. Full scale facilities for composting and recycling infrastructure and facilities which were first used for the demonstration twin projects are still operational to date. At any one time there are ongoing composting operations. At the time of this assignment they were being used to compost yard waste. The facilities can be used to address actual composting needs as was the case then. In addition, they can be used for technology research and development demonstration, training of practitioners, and demonstration of design, construction and operation of composting and recycling facilities.

Regarding biogas technology capacity, efforts have covered investigation on different options for feedstock materials, suitable plant feeding rates, optimisation of substrate utilisation, and

enhancement of performance of biogas plants for improved biogas production. In addition, it has included analysing of the needs and options for bringing down barriers to the adoption and sustainability of the technology.

With respect to fuel briquettes technology research and development, capacity encompasses the applicability of almost all organic waste fractions as main feedstock in the production of fuel briquettes based on organic solid waste. It also encompasses use of selected solid waste fractions as briquette binder options. Elsewhere heretofore, starch and related valuable food sourced materials were used binders. Therefore, new grounds have been broken in this respect as well.

Noteworthy things about the IWM&RR infrastructure and facilities mentioned in Table 7.1 are: 1) they are really for integrated waste management in that they are for handling mixtures of solid waste, faecal sludge from onsite sanitation systems, and wastewater, 2) they are indeed for waste resource in that they recover energy resources (biogas) and material resources (treated wastewater and organic fertilisers), 3) they cater for institutional and community IWM&RR needs, and 4) they serve actual institutional and community IWM&RR utility needs while also being available for technology demonstration and research as well as training. On top of the foregoing, the infrastructure and facilities and the technology they represent are truly one of a kind; they break new grounds as far as the field of waste management and resource recovery is concerned. Figure 7.1 – 7.3 show examples of the IWM&RR infrastructure available at ARU.

The capacity for management (including treatment and disposal) of obsoleted pesticides and their containers and clean-up of storage premises (storage rooms and buildings) and contaminated premises (soil and water) is one of a kind that no other in Tanzanian can boast of. Even in Africa, such capacity is available in only a few countries.

The experimental hall described in Table 7.1 constitutes custom - built hall with more than 8 m of headroom with adjoining laboratory facilities, lab chemical stores, accommodation for essential amenities, office space, seminar and meeting room, and tools and equipment stores. Although it can and it does accommodate other needs, it was specially and specifically designed and constructed to cater for research and development as well as training in IWM&RR. At the time of this assignment, the experimental hall was hosting several IWM&RR research and development projects, among others.

Figure 7.1: A view of the IWM&RR constructed on ARU campus in Dar es Salaam. In the middle right side of the picture is an anaerobic baffled reactor (ABR) while a biogas digester is to the left of the ABR. An underground tank for treated waste is right behind the ABR while an elevated tank for treated wastewater is to the left of the underground tank. A unit for biogas storage is located right behind the biogas digester. A sludge and slurry processing unit is located behind the biogas storage unit to the left of the treated water elevated storage tank. In the background the fencing poles which are visible demarcate and physically separate the irrigation plots from the rest of the IWM&RR system units which can be seen in the middle of the picture.

Figure 7.2: Another view of the IWM&RR constructed on ARU campus in Dar es Salaam. In the foreground towards the right hand side corner of the picture can be seen a faecal sludge receiving unit which is connected to a flow equalisation unit towards the middle of the picture. A covered channel for delivering the faecal sludge extends between the sludge flow equalisation unit and the biogas digester towards the middle of the picture slightly towards the left edge of the picture. An elevated water storage tank is to the right of the biogas digester behind which can be seen the sludge and slurry processing unit. Slightly behind and to the right of the elevated water storage tank can be seen a biogas storage unit. Further to the right of the elevated water storage tank towards the right top corner of the picture can be seem a solid waste pre-digestion processing unit (for size reduction and homogenisation)

Figure 7.3: Another view of the IWM&RR constructed on ARU campus in Dar es Salaam. In the middle ground towards the left edge of the picture can be seen an upflow anaerobic sludge blanket (UASB) reactor. The two pipes that are visible on the right and left sides of the UASB reactor are for delivery of influent from the chamber which is right in front of the UASB reactor. The chamber receives effluents from a hydrolysis reactor (partially visible in the picture) which processes effluents from a solid waste size reduction and homogenisation unit (not visible in the picture).

The first ever training of solid waste management contractors and community groups involved in solid waste management and resource recovery following privatisation of solid waste management in Dar es Salaam city around 1994, was conducted at and by ARU in 2000 under the auspices of ILO. ARU developed and run the pertinent training programmes which involved the use of the recycling and composting facilities for training and technology demonstration. ARU could provide similar training in connection with enhancing the overall goal of the project in future.

ARU has the longest trail of studies and the richest repository of home-grown literature on solid and hazardous waste management in general and integrated waste management and resource recovery in particular, among others. Apart from journal and book chapter publications, there are published and unpublished conference papers, manuals, research reports, and published as well as unpublished dissertations and theses. Worthy additions to the preceding list are relevant project reports, and public service and consultancy reports.

The capacity with respect to use and post-use management of plastic bags addresses the menace posed by plastics with a focus on plastic bags whose proliferation in the environment in Tanzania is directly linked to shopping and the subsequent indiscriminate disposal. It traces the plastic bag from the shopping premise to the disposal sites, and on into the environment. Moreover, it looks at the options for replacing the plastic bag and options for beneficial reuse and recycling of plastic bags. It even looks at the options for slowing down the journey of plastic bags from shopping premises into the environment.

7.3 Integrated Waste Management and Resource Recovery Capacity Elsewhere

Extensive surveys and investigations for this assignment in the pilot project areas plus in areas in the rest of Dar es Salaam city revealed that capacity in respect of IWM&RR per se (not just one aspect of IWM&RR) was not available anywhere other than in connection with ARU activities. However, as discussed elsewhere in this report, various WRR activities take place in the pilot project areas and in the rest of the city. Solid waste composting, operation of biogas digesters fed with solid waste, and production of fuel briquettes using solid waste do all take place. The recycling industry is also vigorous even though it is not perfect. In spite of the foregoing, capacity in IWM&RR has not yet made significant inroads into the core of waste management in Dar es Salaam city.

PART E: ANALYSIS OF IMPROVEMENT NEEDS AND OPTIONS

8.0 ANALYSIS OF IMPROVEMENT NEEDS

8.1 Essence and Rationale of Improvement Needs Analysis

The required improvements with respect to reduction of open burning of solid waste are deliberately identified and characterised using the improvement needs analysis approach in order to capture the full spectrum of needs and consider the full depth of each need. The actual analysis of the improvement needs is initiated by way of performing a SWOT (strengths, weakness, opportunities, and threats) analysis. This is deliberately done in order to come up with an objective basis for comprehensively and cost-effectively addressing the issue at hand. Other approaches have been put aside because they are known to have a great likelihood of addressing major problems only. The other approaches are also known for not taking full advantage of available opportunities and failing to address some existing threats. Moreover, they are associated with failing to put in place measures for ensuring sustainability of existing strategies and practices that work.

It is very important to note that in conventional approaches to deriving bases for improving things, only problems – deficiencies are dealt with. As such, weaknesses would be the only target of the improvement efforts. Under such circumstances threats posed to the status quo are not given attention; the same thing happens to opportunities for enhancing the status quo. Strengths inherent in the status quo are not considered to be worthy of any attention because it is not appreciated that they too provided room for improvement. It is not recognised as well that the sustainability of the strengths is not automatic and that the strengths are not fool proof. The rationale for the use of the SWOT analysis results is partly that it circumvents the challenges discussed in the foregoing discussion.

8.2 Derivation of the Improvement Needs

Details of the SWOT analysis performed to systematically derive the specific needs for improving the situation regarding open burning of solid waste in the pilot project areas are summarised in Table 8.1. Noteworthy observations and explanatory notes on the contents of the Table are also discussed. Moreover, discussions to qualify or clarify specific issues raised in the tabulated SWOT analysis results are also presented.

Table 8.1: Summary of SWOT analysis performed for deriving improvement needs with respect to prevention and control of open burning of solid waste in Kigamboni and Ubungo municipalities

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
	Solid waste management				
	- Prevention and control of open burning of solid waste per se	- Laws and regulations against open burning exist - Ad hoc inspections against open burning are done - Affected people lodge complaints against effects of open burning of solid waste such as smoke nuisance and fire risks	- Enforcement of the laws and regulations is poor - Awareness on the laws and regulations is poor - There are no dedicated efforts to deal with the problem of open burning of solid waste - Use of fuel wood whereby charcoal containing burning amber is discharged with other solid waste and becomes an ignition source - Failure to include in WRR the combustible fraction of solid waste which is significant - Biomass yard waste which is highly ignitable and whose quantity is very high is collected with other waste rather than being composted -	- Improvements in SWM will reduce fuel for open burning - Improvement in WRR will reduce fuel for open burning - Compliance with laws and regulations is improving across the board	- Dominance of informal settlements presents a challenge - Misinterpreted enforcement of SWM laws and regulations - Small and diffuse backyard open burning premises are difficult to monitor - Poor, infrequent, and unpredictable waste collection service - Rapid accumulation of biomass yard waste and the need for volume reduction or elimination of uncollected loads - Relatively high fees of waste collection
	- Solid waste management system	- It is implicitly provided for by law	- A formally designed SWM system is non-existent	- Willingness to improve and passion for improvement	- Potential policy changes

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
		- It provides for diversity of service providers - It provides for potentially healthy competition	- Some areas are not covered by SWM service - Disposal aspect of the system is poor - POSH is not considered - The informal sector contributes a lot of solid waste but hardly contributes to SWM - Ergonomic considerations are ignored throughout	- Private sector involvement increases options	- Well-intentioned but disruptive political actions - Resource recovery tends to disrupt SWM system operation
	- Solid waste management strategies and practices	- There are some good strategies and established good practices in place - In some cases, collection service is separated from long range transport	- Resource recovery is not integrated into the SWM system - Monitoring of service provision is inadequate - POSH is not considered - Street sweeping is done in unsafe ways - Too many levels of governance are involved in SWM - SWM vehicles are generally old and prone to frequent breakdowns which are disruptive - Poor screening of SWM contractors - Poor quality and commitment of SWM contractors	- Planned improvements in SWM will provide for better practices and strategies	- Resource recovery tends to disrupt SWM - Diversity of service providers complicates strategies and practices
	- Primary storage	- Many premises have primary storage facilities	- Many sources do not have appropriate storage	- Resource recovery reduces storage needs	- Organic waste stored within premises for long

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
		- Pre-collection retrieval of waste resources is done in some places	facilities in terms of size, configuration, construction materials, and other ergonomic considerations - POSH is not considered - Litter storage is not provided for in most areas - Open areas and public areas have no provision for litter storage	- Availability of cheap plastic container materials	attracts vermin and vandalising animals. - Resource retrieval efforts may disrupt good storage practices
	- Collection	- Many parts of the pilot project areas are covered by some solid waste collection service	- Collection frequencies are low - Inappropriate vehicles are used in waste collection	- Road improvement will improve accessibility	- Poor roads make some premises inaccessible - Traffic jams disrupt waste collection
	- Transfer	- Some provision for transfer of waste from short to long range vehicles exists	Transfer facilities and practices are poor in terms of design and operation	- Improvement in SWM in the city includes appropriate transfer facilities.	- Poorly operated transfer points are vulnerable to environmental, health, aesthetic, and safety risks
	- Transportation	- Some collection vehicles are suitable for long range transportation	- Inappropriate vehicles are used in waste transportation	- Road network improvement will improve transportation	- Many roads make transportation difficulty - Traffic jams especially during the day disrupt waste transportation
	- Treatment	- Treatment of a portion of hazardous waste done - Indirect treatment by way of WRR operations and processes is done	- Waste treatment other than size reduction is not done except for incineration of some hazardous waste	- Incinerators suitable for treating hazardous waste fractions are planned	- The interested investors may pull out before implementing the facilities

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
				- Planned new disposal facilities are likely to incorporate treatment	- Cost recovery in waste treatment has not been established -
	- Disposal	- Land of sufficiently large size for new and better disposal facilities is available	Existing disposal facilities not sanitary by design and practice Illegal disposal is practiced Disposal site's distant location contributes to illegal waste discharge WRR activities at disposal facility disrupt operations	- New sanitary disposal facilities are planned	- Development of planned facilities may take too long
	Waste resource recovery				
	- Waste resource recovery system	- An informal WRR system does exist - Does not support open burning of solid waste	- A formally designed unifying WRR system does not exist	- Improvement in SWM system will provide room for a WRR system	- Improvement in SWM may take too long
	- Waste resource recovery strategies and practices	- They discourage open burning of solid waste - Some companies and individual practitioners implement good practices and have good strategies	- Formal unifying strategies and vetted good practices are sporadically applied	- Improvement in SWM will provide room for better strategies and practices	- Improvement in SWM may take too long - WRR is not a formal SWM priority
	- Waste resource retrieval o Pre-storage o Post-storage	- They discourage open burning of solid waste - Many premises encourage waste resource retrieval and waste resource practitioners	- Facilities used in resource retrieval, storage, and transportation are crude - Waste retrieval tends to disrupt solid waste management	- Increase in awareness on WRR benefits and potential provides room for pre- and post-storage resource retrieval	- Sporadic enforcement of SWM laws and regulations usually fail to consider WRR needs

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
	- The recycling industry	- It discourages open burning of solid waste - A robust recycling industry is well established - Local capacity (training, practice and research) is available	- The downstream end of the industry is mostly export-dependent - The local capacity (training, research and practice) is not fully used - Different components and aspects of the industry are not formally coordinated - POSH among resource retrieval practitioners is poor - IWM&RR is not practised. - Many potentially recoverable resources end up at the disposal site - Enforcement of some SWM laws and regulations disrupt WRR efforts - The current recycling feedstock range is limited to a few resources - Most WRR is done on the post-storage and post-collection side of SWM system	- There is a strong industrialisation drive - There is strong support from the government - Many investors express interest in WRR - Locally trained - WRR can facilitate income and employment generation while solving SWM problems	- Undefined SWM - Potential changes in SWM policies and legislation - Increasing dependence on foreigners - Increasing tendency to depend on export market
	- Composting	- It discourages open burning of solid waste - The composting technology is available and composting is practiced - Some actual large scale composting facilities exist	- Awareness among some potential users of compost is still low - The existing local capacity (training, research and	- Urban agriculture and gardening provide a market for compost - The green and greening of the city provides feedstock for	- Competition with the livestock industry for the same market - Potential policy changes could be disruptive

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
		- Some market for compost exists	practice) is not well utilised	composting and market for compost - Many waste fractions are suitable for composting - Local capacity (training, research, and practice) is available	- Well-intentioned but disruptive political actions
	- Biogas production	- It discourages open burning of solid waste - The biogas technology is available and operational biogas digesters do exist - A huge market for biogas exists	- Some existing biogas digesters do not operate well and do not produce biogas as intended and expected - Experts are not used and available capacity is not used	- There is a huge unmet demand for energy - Many waste fractions are suitable for biogas production - Huge local capacity (training, research, and practice) is available	- Potential policy changes could be disruptive - Well-intentioned but disruptive political actions
	- Fuel briquettes production	- Fuel briquettes production technology is available and is used - The market for fuel briquettes exists	- Experts are not used and available capacity is not used	- There is a huge unmet demand for energy - Huge local capacity (training, research, and practice) is available - Many waste fractions are suitable for biogas production	- Potential policy changes could be disruptive - Well-intentioned but disruptive political actions
	- Miscellaneous resources and miscellaneous recovery practices (based on persistent solid waste fractions, PSFs)	- To a small scale there are a myriad of miscellaneous resource recovery practices based non-conventional materials	- Segregation of waste is not done and where it is done PSFs are not segregated - Many PSFs have not found reuse or recycling options and thus contribute to filling disposal facilities	- Copycat culture among entrepreneurs can disseminate WRR based on PSFs	- Potential policy changes could disruptive - Well-intentioned but disruptive political actions

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
	Crosscutting aspects and considerations				
	- Crosscutting issues regarding SWM, WRR, IWM&RR and prevention and control of open burning of solid waste per se	- Appropriate SWM policy, laws and regulations exist - Enforcement of sanitation laws and regulations is occasionally done - WRR efforts allowed to take place within the SWM system reduce quantities of solid waste that need to be disposed of - WRR by way of composting, biogas production, fuel briquettes production, and recycling which makes use of solid waste fractions is booming - There are many efforts that benefit SWM and WRR including campaigns against plastic waste - SWM and WRR endeavours created employment and income generation opportunities	- POSH is not considered at all - Some staff involved in enforcement of SWM laws and regulations are not competent enough - Real SWM and WRR experts are not properly used while people who do not have formal expertise and experience in SWM and WRR are not used - Hazardous fractions of solid waste are not segregated for appropriate treatment and disposal - SWM service provision is generally underfunded while WRR is not funded at all - Cost-recovery basis is poor, not based on analysis – fees not based on cost recovery per se - Illegal service providers work alongside and compete with the legal ones	- There is a huge pool of capacity with respect to training, research and practice pertinent to general SWM and WRR - The government is committed to cleaner and greener environment - Formalisation and retro-planning of informal settlements is underway - A large pool of unemployed youths - Industrialisation drive is full of opportunities for SWM improvement - Training of environmental experts is increasing - Communication media are active in popularising WRR efforts and potential - Compliance with laws and regulations is improving across the board	Sporadic SWM efforts are not effective and are not sustainable - Potential policy changes could be disruptive - Well-intentioned but disruptive political actions - Dominance of unplanned settlements presents a challenge for SWM - Many SWM improvement efforts are donor funded which is not good for sustainability - In many instances SWM is handled in a campaign manner as if it is a passing need - The likes of monthly one day cleanliness day are disruptive of other services and hence may not receive sufficient support; they also overload some resources

SN	SWOT analysis aspect	Strengths	Weaknesses	Opportunities	Threats
			- Illegal waste collectors contribute to illegal waste discharge areas - High income areas are favoured by service providers because of ease of accessibility, easy of fee collection, and cooperation - Litter management is very poor - Thin film plastic used to make shopping bags is still in use and thus still in the waste stream - Weak SWM governance at lower levels of local government - Unpaved feeder roads increase street sweeping burden especially during the wet season - Most SWM workers are old and frail and thus not as productive and efficient as they ought to be		
	-				

Some of the SWOT analysis issues and aspects pointed out in Table 8.1 are covered in greater detail in discussions which are presented in later sections. Invariably, some of the issues have already been dealt with at least implicitly in earlier discussions.

9.0 ANALYSIS OF APPLICABLE IMPROVEMENT OPTIONS

9.1 Essence and Utility of Improvement Options Analysis

Potential improvement options for the identified improvement needs must be identified, but since there are likely to be more than one option for each per improvement need identified options must be evaluated. On the other hand, because some improvement options may be capable of addressing more than one improvement need, the identified options must be evaluated, optimised and prioritised. The foregoing are the essence and utility of the improvement options analysis.

9.2 Improvement Options Analysis

The SWOT analysis has done a considerable implicit analysis of the improvement options because many of the applicable improvement options are directly discernible from the improvement needs they are specifically supposed to address. Nonetheless, a further analysis serves as the basis for evaluation, optimisation, and prioritisation of the eventual improvement measures.

To make good use of the SWOT analysis results, a course of action that is cognisant of the aspects discussed next need to guide the selection, optimisation, prioritisation, and implementation of the improvement measures derived from the SWOT analysis.

Strengths: All the features and characterised that have been identified as strengths need to be maintained. They are not supposed to change unless the changes are for the better or reinforcing the strengths. Also something needs to be put in place to ensure that each of the strengths is sustainable in the long term as well as robust in the short term.

Weaknesses: Weaknesses are prime targets for improvement measures and they need to be rectified. All the elements, features and characteristics identified as weaknesses need to have their effects weakened and eventually eliminated through corrective actions.

Opportunities: The elements, features, and characteristics identified as opportunities are opportunities for gaining strengths. They are latent strengths, potential strengths and as such the goal is to make use or take advantage of the opportunities in order to gain strengths or sustain existing strengths.

Threats: The elements, features, and characteristics identified as threats have the potential to disrupt and weaken existing strengths, creating conditions conducive for disruptions, and reinforce existing weaknesses. They can also cancel or weaken existing opportunities. In addition, they can themselves become weaknesses. Therefore, threats must be addressed alongside other improvement needs in order to prevent their negative implications as pointed out in the foregoing discussion.

As a general rule, in terms of prioritisation, weaknesses have priority over all other improvement needs. Moreover, weaknesses which are recurrent across the analysis spectrum have the highest priority. It follows therefore that the improvement options that address weaknesses have priority over all options that address other improvement needs. Moreover, improvement options that address weaknesses that are recurrent across the analysis spectrum have the highest priority.

Disregarding recurrence frequency, the priority order for improvement options is: those for weaknesses, the ones for opportunities, those for threats, and the ones for strengths. The priority order applies considering that implementation of the improvement options has a cost element and as such require and compete for resources.

10.0 GUIDANCE ON SPECIFIC IMPROVEMENT PROPOSALS

10.1 Introductory Remarks

The discussion in this section takes up where the discussion in the previous section left off. It presents guidance on specific improvement proposals for the eventual alleviation of the problem of open burning of solid waste in the pilot project areas. The specific proposals are based on the options identified, evaluated, optimised and prioritised. The proposals presented here are the ones that will guide all the improvements that will lead to the alleviation of open burning of solid waste. The alleviation of open burning of solid waste is the ultimate goal of all improvement efforts.

An important thing to note here is that most measures address SWM and WRR directly while addressing the need for alleviation of open burning of solid waste indirectly. In any case, the measures addressing the problem of open burning of solid waste indirectly are more comprehensive and more effective in the long term as well as in the short term. They are also more sustainable individually as well as collectively.

10.2 Guidance on Specific Improvement Proposals

The evaluation and optimisation performed on the improvement options applicable to the identified improvement needs led to the conclusion that the optimal way to implement them is in the context of SWM and WRR. WRR is key because it addresses SWM needs in general and the problem of open burning of solid waste directly. Improvements in SWM and WRR will address most of the identified improvement needs. Improvements in SWM and WRR will have the greatest impact. Invariably, this leads to integrated waste management and resource recovery (IWM&RR).

Open burning of solid waste takes place at or near sources, at illegal solid waste discharge and at final disposal sites. Therefore, the relevant improvement options pertain to all the functional elements of SWM with a focus on primary storage and primary collection and proper disposal with emphasis on WRR.

More specifically with respect to this project, WRR is recommended to be the focus of immediate and medium term interventions with respect to prevention and control of open burning of solid waste with the ultimate goal of preventing and controlling UPOPs release from waste open

burning. Preferably, the focus of WRR should be at the pre-storage stage before the waste can reach potential opening burning premises far afield downstream.

Direct and indirect, as well as present and potential contribution of WRR to the reduction of open burning of solid waste have already been discussed at length. The combined contribution of the recycling industry, use of solid waste fractions in composting, use of solid waste in biogas production, and use of solid waste in fuel briquettes production is potentially very high. Most importantly, the potential for success of WRR is very high. This is the case considering that more than 70% of collected solid waste is organic in nature whose fractions are amenable to one or more of the identified WRR options. It is noteworthy that each of the identified WRR options is already practiced, with additional efforts mostly required with respect to enhancement for higher efficiency and more cost-effectiveness and promotion to achieve more widespread adoption in the project area. The widespread adoption of WRR is required to reach the critical mass required for WRR to really have an impact with respect to the project's goal.

The foregoing discussion has not considered the contribution of the recycling industry which encompasses removal of plastic waste fractions, scrap metal, and beverage metal cans from the solid waste stream. If a significant quantity of solid waste fractions that can be recycled, composted, anaerobically digested for biogas, and processed into fuel briquettes is removed from the solid waste stream, a significant quantity of solid waste will be reduced, facilitating indirect improvements in SWM, which will translate into reductions in open burning of solid waste. Furthermore, use of the solid waste fractions to produce biogas, compost, and fuel briquettes takes a considerable quantity of waste from the waste stream which translates into a reduction of the need for waste volume reduction. Notably, waste volume reduction is one of the main reasons for waste burning.

More directly, use of combustible fractions, which encourage open burning and are the main fuel and main fractions in waste open burning, reduces open burning of waste because then there is nothing or very little left to burn. If there is no fuel and nothing or little else to burn, open burning of waste will not be able to even take off; it will literally be extinguished.

Combustible fractions of solid waste include waste paper and significant quantities of biomass yard waste fractions. Biomass yard waste fractions are produced by vegetation that can be seen as the green cover that characterises a considerable part of the city. Most of the biomass yard waste

fractions are not collected from household or institutional sources and form a considerable portion of solid waste that is burnt even in areas that have access to solid waste collection service.

Ultimately, IWM&RR should be the goal of waste management improvements. The concept embodied in the multipurpose, multiuse, and multifunction systems and infrastructure owned and operated by ARU is the best ultimate solution to waste management challenges. The solution is ideal for not only the pilot project areas but also for other parts of Dar es Salaam city and in the rest of urban areas in Tanzania. The IWM&RR multipurpose, multiuse, and multifunction systems and infrastructure owned and operated by ARU provide actual IWM&RR service for communities and institutions, are used for hands-on training, and are used for IWM&RR technology demonstration. In addition, they accommodate research that require full-scale IWM&RR infrastructure and facilities.

Currently, awareness and knowledge on WM&RR is generally low. For the people who currently do not practice WRR to adopt it, awareness and education on WRR needs to be enhanced among the target population. Therefore, promotion of WRR must be accompanied awareness raising and education. Specific training programmes to cover all aspects of WRR one aspect at a time must be provided to the target population.

The target groups for awareness and training on SWM and WRR as well as full-fledged training on IWM&RR are mainly:

- Staff of commercial contractors currently involved in SWM;
- Staff of commercial contractors planning to be involved in SWM;
- Members of CBOs, women groups, and youth groups currently involved in SWM
- Members of CBOs, women groups, and youth groups planning to be involved in SWM
- Members of other eligible groups of people currently involved in SWM
- Members of other eligible groups of people planning to be involved in SWM
- Staff of companies involved in or planning to be involved in WRR
- Members of CBOs, women groups, and youth groups involved in or planning to be involved in WRR
- Members of other eligible groups of people currently involved in or planning to be involved WRR

The training contents will be customised accordingly and the training mode can be adjusted to fit the training target group's needs, proficiency, and background knowledge as well as prior

exposure. SWM contractors can be trained on the basics of SWM, hazardous waste management and WRR.

Potential compost production practitioners can be trained on the technology and practice of composting. Current compost production companies and groups need the training because many of them have superficial knowledge. ARU has organised such training in the past. It does have not only the training and capacity but also several tried and tested curricula. It developed the curricula and run the training programme several times.

The people targeted for biogas production training can be trained on biogas technology and biogas production practices. Just as for SWM and composting, ARU has undertaken in the past this kind of training. ARU developed the training programme and run the training several times. Therefore, ARU should easily repeat the training for the target groups. The foregoing also applies to training the target groups for recycling.

It can be argued that the anticipated awareness raising and training could be undertaken by any capable and experienced institutions or organisations, and could take place at any suitable premise or premises. Logically, training institutions are best suited for the task. In spite of this, the reality is that institutions with such capacity and experience plus the corresponding suitable training premises are hard to come by. Surveys and investigations carried out for this assignment lead to the conclusion that only Ardhi University fits the bill. ARU is best qualified and an ideal institution and campus to organise and run all the training pertinent to SWM and WRR because of its superiority with respect to all essential attributes.

- **Expertise:** ARU has a full spectrum of superior in-house expertise and corresponding experts for all aspects of SWM and WRR. No other entity (institution or otherwise) comes even close in this respect. This means the training content will be of high quality and original rather than second hand or recycled.
- **Ideal location:** ARU is an ideal location for training because it is secluded enough to provide the serenity and quietness suitable for training and yet it is close and well-connected to major roads to be easily accessible. That means the training will be convenient and hence more effective.
- **Practical and practice experience:** ARU has all round practical and practice experience in IWM&RR spanning many years. This means the training in IWM&RR will be informed by benefits of practice and practical experience and thus more down-to-earth and relevant.

- **Training proficiency and experience:** ARU has well established training proficiency and long experience IWM&RR training and similar training for various target groups from those who need basic training to the ones who need advanced training and those who need to be trained in order to be trainers.
- **Ideal IWM&RR infrastructure:** ARU has ideal systems and infrastructure suitable for all theoretical and hands-on training aspects of IWM&RR. Nothing like it exists anywhere else in the East African region. This implies that the eventual training stands a good chance of being the most effective practicable.
- **Large pool of trainers:** ARU has a remarkably large pool of potential trainers who have the requisite expertise and experience in IWM&RR. The resulting trainer flexibility translates into flexibility of both the planning and scheduling of the training. Flexibility in training planning and scheduling makes it possible to accommodate needs of different participants.
- **Organisational and operational experience:** ARU has organisational and operational experience with respect to IWM&RR training as a result of organising and running several similar training programmes in the past. The experience is necessary for cost-effective and successful execution of the training
- **Curriculum development capacity:** ARU has the capacity to develop user-defined, user-responsive, and user-customised curricula for IWM&RR and related fields. ARU has a stellar track record in this respect. This ability is necessary for customising the training to the people to be trained which is in turn necessary for effective training, this is different from forcing a curriculum on the people to be trained.
- **Linkage with industry:** ARU has established healthy linkages and access to networking within the recycling industry and among actual and potential stakeholders in WM&RR. All this translates into extension of ARU's effective reach and sphere of influence, all of which is good for the training itself and post-training follow-ups.
- **Institutional backing:** Any service provided by ARU has institutional backing and support. In the case of the IWM&RR training, this translates into assurance on training quality and consistency and guarantee on service delivery.

The attributes and accolades outlined above in favour of Ardhi University are indisputably unmatched by any other institution or organisation in the whole East African region, let alone in Tanzania. This says a lot about the potential of success of the measures to be undertaken under the auspices of the project. It also says something about the role ARU can play in ensuring the success of the measures implemented with respect to IWM&RR for the project.

PART F: CONCLUDING REMARKS AND RECOMMENDATIONS

11.0 CONCLUSION AND RECOMMENDATIONS

11.1 Concluding Remarks

This report has been prepared to document the output of the assignment in respect of the project on: ”PROMOTION OF BAT AND BET TO REDUCE UPOPS RELEASES FROM WASTE OPEN BURNING IN THE PARTICIPATING AFRICAN COUNTRIES OF SADC SUB-REGION” with a focus on the Tanzania component. The report presents baseline data and information on solid waste management and resource recovery as well as practices pertinent to open burning of solid waste in Dar es Salaam city with a focus on pilot project areas of Kigamboni and Ubungo municipalities. It has also covered the waste resource recovery industry in its entirety in so far as it applies to the pilot project areas. Furthermore, it has covered integrated waste management and resource recovery capacity that can support the overall goal of the project.

The most important conclusion of the assignment in the context of the project for which it was carried out are embodied in the concluding remarks presented here:

- Solid waste management in the pilot project areas as well as in the rest of Dar es Salaam city is poor both in terms of service provision and in terms of effectiveness. It is also poor in terms of disposal of the waste, and this influences its role in respect of open burning of solid waste.
- It is unequivocal that open burning of solid waste is rampant in the project area. Both accidental and deliberate cases of open burning of solid waste have been observed in both Kigamboni and Ubungo municipalities. However, deliberate burning cases far outnumber accidental cases. Notably, the burning of solid waste does not discriminate the waste in any way. Both potentially toxic and non-toxic fractions of solid waste are burnt especially where large piles of solid waste are burnt to reduce their volume as well as to try to get rid of them. Therefore, the problem addressed by the project is very real and serious, which implies that the project is timely and potentially useful.
- Poor solid waste management including poor service provision and inept final disposal contributes to open burning of solid waste in the pilot project areas. This is in part because, it also gives rise to illegal disposal which turn into solid waste open burning premises.
- Inept enforcement of environmental sanitation laws and regulations is an important factor with respect to open burning of solid waste.
- Open burning of solid waste has many implications that are observable and recognised in the pilot project areas. The ones clearly and widely recognised in the pilot project areas include fire risks to humans, animals and properties; nuisance from smoke and fly ash, aesthetic degradation due to smoke and ash; and health risks from inhaled smoke and fly ash.

- Waste resource recovery has the potential to contribute to the reduction in open burning of solid waste. It can take out of the waste stream the materials that can be burned; it can also remove from the waste stream potentially toxic waste components.
- The waste resource industry is thriving in the pilot project areas, but to contribute significantly to a reduction in open burning of solid waste, improvements are needed with respect to the upstream end of the chain where a great number of low cadre people are involved.
- Biomass from utility and ornamental vegetation is a major component of yard waste which itself contributes greatly to open burning of solid waste. However, the solid waste fraction is amenable to resource recovery by way of composting, production of fuel briquettes, and even biogas production. Therefore, resource recovery based on yard waste biomass has the potential to make a significant contribution to the project.
- Although, solid waste resource recovery takes place in the pilot project areas and contribute to the reduction of open burning of solid waste, public and occupational health and safety (POSH) is poor in the current practice. POSH management is poor in even the current solid waste management practices.
- There is a wealth of knowledge, data and information on integrated waste management and resource recovery (IWM&RR) whose existence might not be expected or known by many and as such, the wealth is not put to good use. This wealth stands a good chance of contributing to the project.
- There is a considerable IWM&RR capacity within reach of the project in terms of technical expertise, practical experience, availability of research and development infrastructure and facilities, availability of training facilities and experience in such training, and IWM&RR technology demonstration capacity. These are great potential resource for the project.
- The lower value end of the resource recovery chain is dominated by local people while the higher value end is dominated by foreigners. For long term sustainability, the local people also need to move up the ladder.

11.2 Noteworthy Lessons

The most important noteworthy lesson from this assignment is one that is not central to the assignment, but it is important with respect to the launching of the next phases of the project at hand. Even though it was reasonable to expect the execution of this assignment to take place without considerable field work (using mainly secondary sources of data) a shortage of data and poor quality of available data necessitated comprehensive primary data acquisition. To this end, extensive and comprehensive field work incorporating field surveys and investigations had to be carried out to make up for the shortfall in the required quality data and information. This increased the cost of the assignment and caused delays in execution and completion of the assignment.

The situation in the other countries included in the project may be different from the one observed in Dar es Salaam city. However, disregarding Tanzania, experience from my work in other similar African countries (Burundi, Kenya, and Rwanda) suggests that the data and information poverty challenge observed in Dar es Salaam is likely to prevail in the other project countries as well.

Existing secondary source data should be used with considerable caution. Where practicable efforts should be expended in obtaining more reliable and more up-to-date data and information specifically for this project. This obviously applies to later stages of the project. The lesson can also be taken on board wherever and whenever an opportunity to replicate the project comes up.

11.3 Recommendations

This report has revealed that a wealth of solid waste management and solid waste resource recovery data and information as well as expertise and facilities available at ARU are underutilised. This is despite the fact that the waste resource recovery industry is experiencing a remarkable growth and an accompanying need for such resources. This project presents an opportunity for change in this respect.

The report has indicated the need for more professionalism in solid waste management and resource recovery practice an improved professionalism in enforcement of laws and regulations pertinent to solid waste management. Ineptness and laxity on the part of professionals in respect of the foregoing have been shown to be a contributing factor with respect to open burning of solid waste.

11.4 The Way Forward

This assignment has been very interesting as well as revealing partly because many information and data leads pursued led to even more leads some of which lead outside the implied as well as the stated ToR of the assignment. Disregarding their being outside the scope of the assignment, those which were found to be too relevant to the project to ignore were taken on board, while the rest were put aside, at least for a while.

Another remarkable thing that deserves to be stated is that useful and more up to date information and data on the waste resource recovery industry (WRRI) have kept trickling in even as the time for winding up the assignment has come and gone.

The RRI can play a decisive role in the reduction of UPOPS release from open burning of solid waste along improvements in solid waste management in general. The RRI can effect this in the following distinct ways:

- Directly, by removing from the waste stream waste fractions that directly give rise to the release of UPOPS from open burning of waste.
- Yet more directly, owing to the fact that the WRRI actually provides a form of solid waste management service in all the areas it acquires waste resources
- Indirectly, by removing from the waste stream the waste fractions that contribute to or encourage open burning of waste.
- Yet even more indirectly, by reducing the overall volume of waste that needs to be managed from storage, through collection and transportation, to treatment and final disposal, and thereby relieving the burden of solid waste management service provision and cost making it easier and cheaper to provide the solid waste management service. Consequently, this can reduce illegal discharge of solid waste thereby reducing the number of illegal solid waste discharge premises which are often scenes of open burning of waste. Moreover, it can contribute to improvements in disposal the same consequential outcome as pointed out above.

The foregoing discussion serves to show just how important and potentially critical the role of the WRRI is to the project. Therefore, the information and data pertinent to the WRRI that have already been acquired and used and that which are still being acquired are critical to charting the way forward for the project.

It is neither reasonable nor practicable to keep this assignment open anymore just so as to accommodate the foregoing WRRI related needs. Nonetheless, it is possible for us to keep on acquiring the relevant data and information and keep on analysing and compiling them as they come. Again, that is part of the essence of the Way Forward that was effective even before the submission of the assignment report.

PART G: REFERENCES AND SUPPLEMENTARY MATERIALS

LIST OF REFERENCES

Chaggu, E. J., Kaseva, M. E., Kassenga, G. R. (1998). Report on pilot project on organic solid waste composting, report submitted to National Environment Management Council.

Chaggu, E. J., Kaseva, M. E., Kassenga, G. R. (1998). Report on pilot project on solid waste recycling, report submitted to National Environment Management Council.

Diaz, L. F., Savage, G., Eggerth, L., & Golueke, C. (1996). Solid Waste Management for economically developing countries. Copenhagen: Internation Solid Waste Association.

Grasso, D., Kahn, D., Kaseva, M. E. and Mbuligwe, S. E. (2002). Hazardous Waste. In: Knowledge for Sustainable Development: An Insight into the Encyclopaedia of Life Support Systems, Volume 3, pp 897 - 926, Eolss Publishers Co. Ltd, Oxford, UK.

Kahn, D., Kaseva, M. E. and Mbuligwe, S. E. (2002). Hazardous Waste Issues in Developing Countries. In: Knowledge for Sustainable Development: An Insight into the Encyclopaedia of Life Support Systems, Eolss Publishers Co. Ltd, Oxford, UK.

Kaseva, M. E and Mbuligwe, S. E. (2002). Hazardous Waste Management in Tanzania: Retrospection and Future Outlook. In: Knowledge for Sustainable Development: An Insight into the Encyclopaedia of Life Support Systems Eolss Publishers Co. Ltd, Oxford, UK.

Kaseva, M. E., Mbuligwe, S. E. and Kassenga, G. R. (2002). Recycling Inorganic Domestic Solid Waste: Results from a Pilot Study in Dar es Salaam City, Tanzania. Resources, Conservation and Recycling 35(4); 243 - 257.

Kaseva, M.E and Mbuligwe, S.E. (1999). Ramifications of Solid Waste Disposal Site Relocation in Urban Areas of Developing Countries - A Case Study in Tanzania. Resources, Conservation and Recycling 28(2000); 147 – 161.

Mbuligwe, S. E. (1997). Design of ARU solid waste recycling and composting unit, ARU.

Mbuligwe, S. E**.** (2000). Report on Special Training for Solid Waste Management Contractors, DCC staff and NGOs Representatives: Solid Waste Management Course Material. UCLAS, Dar es Salaam, Tanzania.

Mbuligwe, S. E. (2002). Feasibility and constraints of composting community organic solid waste, resources conservation and recycling.

Mbuligwe, S. E. (2002). Institutional Solid Waste Management Practices in Developing Countries: A Case Study of Three Academic Institutions in Tanzania. Resources, Conservation and Recycling 35(3); 131 – 146.

Mbuligwe, S. E. (2004). Assessment of Performance of Solid Waste Management Contractors: A Techno – Social Model and its Application. Waste Management 24(7); 739-749.

Mbuligwe, S. E. (2011). Small Scale Industries and Informal Sector Activity Premises: Environmental and Occupational Health Issues. Encyclopedia of Environmental Health (Elsevier Science), pp 95 -105.

Mbuligwe, S. E. (2012). Solid Waste Management Strategies and Practices that Work: A Developing Country Perspective. International Journal of Environment and Waste Management.

Mbuligwe, S. E. and Kaseva, M. E. (2006). Assessment of Industrial Solid Waste Management and Resource Recovery Practices in Tanzania. Resources, Conservation and Recycling 47(006); 260-276.

Mbuligwe, S. E. and Kassenga, G. R. (2004). Feasibility and Strategies for Anaerobic Digestion of Solid Waste for Energy Production in Dar es Salaam City, Tanzania. Resources, Conservation and Recycling 42(2); 183-203.

Mbuligwe, S. E. and Mgana, S. M. (2000). Training in Solid Waste Management for Solid Waste Management Contractors. UCLAS, Dar es Salaam, Tanzania.

Mbuligwe, S. E. and Mgana, S. M. (2001). Training in Occupational Health and Safety for Solid Waste Contractors. UCLAS, Dar es Salaam, Tanzania.

Mbuligwe, S. E. and Mgana, S. M. (2010). Design of ARU integrated waste management and resource recovery infrastructure and facilities– ARU, ARU.

Mbuligwe, S. E. and Mgana, S. M. (2010). Design of integrated waste management and resource recovery infrastructure and facilities – Segerea, ARU.

Mbuligwe, S. E., Kassenga, G. R., Kaseva, M. E. and Chaggu, E. J. (2002). Potential and Constraints of Composting Domestic Solid Waste in Developing Countries: Findings from a Pilot Study in Dar es Salaam City, Tanzania. Resources, Conservation and Recycling 36(1); 45 - 59.

Mbulligwe, S. E. (2014). Exploring a framework integrated waste management and resource recovery (IWM&RR), consultancy report submission and presentation at a workshop in Naivasha, Kenya.

NIRAS (2012). Country Environmental and Social Assessment (CESA) (for obsolete pesticide treatment and clean-up of contaminated sites), report submitted to NEMC (Tanzania).

Tayrol, N. (1999). Information system on plastic consumption and waste management in Europe. Association of Plastic Manufacturers in Europe.

Tchobanogous, G., Theisen, H., & Vigil, S. (1993). Integrated Solid Waste Management. New York: The McGraw Hill Companies.

Tongleta, M., Phillips, S., & Batesb, M. (2004). Determining the drivers for householder pro-environmental behaviour: waste minimization compared to recycling. Resource Conservation and Recycling, 1(42), 27-48.

UNEP. (2009). Developing Integrated Solid Waste Management Plan Training Manual. Osaka, Japan: United Nations Environmental Programme.

UN-HABITAT. (2010). Solid Waste Management in the World´s Cities: Water and Sanitation in the world Cities. London & Washington DC: Earthscan.

SUPPLEMENTARY MATERIALS

APPENDIX 1: SW GENERATION IN KIGAMBONI MUNICIPALITY										
CLUSTER 1										
Point	**Description**	**Ward**	**No. people**	**WEIGHT(Kg)**				**Total(Kg)**	**Average/day**	**Kg/c/day**
				Day 1	Day 2	Day 3	Day 4			
1	Residential	Mji Mwema	9	6.2	5.6	3.2	5.0	20.0	5.0	0.56
2	Residential	Mji Mwema	4	3.5	2.1	1.2	2.4	9.2	2.3	0.58
3	Residential	Mji Mwema	2	0.7	3.0	2.1	2.0	7.8	2.0	0.98
4	Residential	Mji Mwema	8	3.6	5.0	1.5	7.5	17.6	4.4	0.55
5	Residential	Mji Mwema	6	7.0	4.5	2.6	4.0	18.1	4.5	0.75
6	Residential	Mji Mwema	6	3.8	1.0	0.0	4.7	9.5	2.4	0.40
7	Residential	Mji Mwema	5	1.8	4.0	2.5	4.0	12.3	3.1	0.62
8	Residential	Mji Mwema	2	1.7	0.0	0.0	3.5	5.2	1.3	0.65
9	Residential	Mji Mwema	7	5.5	4.2	6.5	7.4	23.6	5.9	0.84
10	Residential	Mji Mwema	4	3.0	2.2	3.0	3.2	11.4	2.9	0.71
11	Residential	Mji Mwema	10	7.0	6.0	8.0	3.5	24.5	6.1	0.61
12	Residential	Mji Mwema	2	2.4	1.5	6.0	4.0	5.3	1.3	0.66
13	Residential	Mji Mwema	6	3.3	4.5	6.7	9.5	24.0	6.0	1.00
14	Residential	Mji Mwema	10	6.0	16.0	5.8	11.3	39.1	9.8	0.98
15	Shop	Mji Mwema	3	1.5	1.8	2.0	1.6	6.9	1.7	0.58
16	Residential	Mji Mwema	3	3.5	5.5	4.0	2.0	15.0	3.8	1.25
17	Residential	Mji Mwema	4	1.5	4.2	1.9	3.0	10.6	2.7	0.66
18	Guest house	Mji Mwema	12	8.9	4.6	12.3	7.4	33.2	8.3	0.69
19	Residential	Mji Mwema	7	5.6	8.7	12.0	4.4	30.7	7.7	1.10
20	Residential	Mji Mwema	5	4.4	7.2	2.7	10.5	24.8	6.2	1.24
21	Residential	Mji Mwema	7	7.8	18.0	4.8	4.0	34.6	8.7	1.24
22	Residential	Mji Mwema	5	5.7	3.5	3.0	2.5	14.7	3.7	0.74
23	Residential	Mji Mwema	3	4.3	2.0	6.5	2.8	15.6	3.9	1.30
24	Residential	Mji Mwema	4	6.3	5.7	1.5	2.1	15.6	3.9	0.98

25	Residential	Mji Mwema	5	7.4	4.3	6.9	6.5	25.1	6.3	1.26
26	Residential	Mji Mwema	4	3.4	0.5	2.5	5.3	11.7	2.9	0.73
27	Residential	Mji Mwema	6	4.2	4.6	0.0	17.0	25.8	6.5	1.08
28	Residential	Mji Mwema	9	5.6	7.5	4.8	6.3	24.2	6.1	0.67
29	Residential	Mji Mwema	7	4.6	9.5	7.0	4.5	25.6	6.4	0.91
30	Residential	Mji Mwema	4	2.5	1.5	3.9	3.6	11.5	2.9	0.72
									Average generation per capital per day	0.83

CLUSTER 2

Point	Description	Ward	No. people	WEIGHT(Kg)				Total(Kg)	Average/day	Kg/c/day
				Day 1	Day 2	Day 3	Day 4			
1	Residential	Kibada	5	5.5	2.0	3.6	4.0	15.1	3.8	0.76
2	Residential	Kibada	6	2.5	11.2	5.5	5.0	24.2	6.1	1.01
3	Residential	Kibada	2	1.0	2.5	1.5	4.0	9.0	2.3	1.13
4	Residential	Kibada	3	4.0	0.0	0.0	6.0	10.0	2.5	0.83
5	Residential	Kibada	5	3.5	11.2	0.0	7.0	21.7	5.4	1.09
6	Residential	Kibada	6	3.8	1.5	4.0	5.0	14.3	3.6	0.60
7	Residential	Kibada	3	6.0	3.5	2.5	4.0	16.0	4.0	1.33
8	Residential	Kibada	4	8.0	3.5	2.0	6.5	20.0	5.0	1.25
9	Residential	Kibada	4	3.0	1.5	1.0	0.0	5.5	1.4	0.34
10	Residential	Kibada	6	5.0	3.5	2.0	5.5	16.0	4.0	0.67
11	Residential	Kibada	5	6.0	4.0	3.0	2.4	15.4	3.9	0.77
12	Residential	Kibada	3	0.0	0.5	0.0	1.2	1.7	0.4	0.14
13	Residential	Kibada	10	6.0	4.5	3.6	8.7	22.8	5.7	0.57
14	Residential	Kibada	15	1.5	3.2	2.5	3.0	10.2	2.6	0.17
15	Shop	Kibada	11	4.3	2.4	7.2	5.5	19.4	4.9	0.44
16	Residential	Kibada	9	6.9	7.5	6.5	2.6	23.5	5.9	0.65
17	Residential	Kibada	8	7.4	7.5	5.5	5.3	6.4	1.6	0.20

18	Residential	Kibada	6	6.5	7.2	3.0	4.2	20.9	5.2	0.87
19	Residential	Kibada	4	1.5	3.0	4.2	2.1	10.8	2.7	0.68
20	Residential	Kibada	6	4.0	3.4	2.5	1.7	11.6	2.9	0.48
21	Residential	Kibada	8	9.0	4.6	5.0	2.5	21.1	5.3	0.66
22	Guest house	Kibada	11	3.4	6.0	6.5	5.7	21.6	5.4	0.49
23	Residential	Kibada	4	3.2	2.5	1.6	4.3	11.6	2.9	0.73
24	Residential	Kibada	6	2.5	4.9	8.0	3.7	19.1	4.8	0.80
25	Residential	Kibada	7	3.4	4.5	3.9	2.9	14.7	3.7	0.53
26	Residential	Kibada	7	4.6	8.0	6.0	4.5	23.1	5.8	0.83
27	Guest house	Kibada	10	4.0	2.5	3.5	2.0	12.0	3.0	0.30
28	Residential	Kibada	8	3.4	4.3	4.0	6.3	18.0	4.5	0.56
29	Residential	Kibada	15	6.0	7.5	8.5	10.0	32.0	8.0	0.53
30	Residential	Kibada	8	5.0	4.5	6.4	3.6	19.5	4.9	0.61
									Average generation per capital per day	0.67
									Ave rage SW generation rate in Kigamboni Municipality(Kg/c/day)	**0.75**

SW GENERATION IN UBUNGO MUNICIPALITY

CLUSTER 1

Point	**Description**	**Ward**	**No. people**	**WEIGHT(Kg)**				**Total(Kg)**	**Average/day**	**Kg/c/day**
				Day 1	Day 2	Day 3	Day 4			
1	Residential	Kibamba	5	3.2	4.6	0.0	8.5	16.3	4.1	0.82
2	Residential	Kibamba	6	4.0	16.0	5.2	0.0	25.2	6.3	1.05
3	Residential	Kibamba	10	6.8	11.2	5.3	13.5	36.8	9.2	0.92
4	Residential	Kibamba	4	4.3	5.5	2.5	3.0	15.3	3.8	0.96
5	Residential	Kibamba	5	2.8	9.0	0.0	4.0	15.8	4.0	0.79
6	Residential	Kibamba	3	1.9	5.0	6.5	2.0	15.4	3.9	1.28
7	Residential	Kibamba	6	3.0	12.5	0.0	4.9	20.4	5.1	0.85

8	Residential	Kibamba	3	1.4	2.8	3.0	1.5	8.7	2.2	0.73
9	Residential	Kibamba	5	4.2	2.3	6.0	0.8	13.3	3.3	0.67
10	Residential	Kibamba	6	7.0	0.0	4.6	19.0	30.6	7.7	1.28
11	Residential	Kibamba	8	7.8	11.5	3.5	7.3	30.1	7.5	0.94
12	Residential	Kibamba	4	1.5	6.0	3.7	0.0	11.2	2.8	0.70
13	Residential	Kibamba	6	3.1	7.2	2.0	4.5	16.8	4.2	0.70
14	Shop	Kibamba	2	1.7	1.3	0.5	1.0	4.5	1.1	0.56
15	Residential	Kibamba	6	3.5	4.0	2.0	8.3	17.8	4.5	0.74
16	Residential	Kibamba	2	5.0	2.4	1.3	0.0	8.7	2.2	1.09
17	Residential	Kibamba	4	6.5	0.0	0.0	3.0	9.5	2.4	0.59
18	Residential	Kibamba	3	2.3	3.2	3.0	0.0	8.5	2.1	0.71
19	Residential	Kibamba	4	3.5	2.5	2.5	5.7	14.2	3.6	0.89
20	Residential	Kibamba	4	6.0	1.2	0.0	6.5	13.7	3.4	0.86
21	Residential	Kibamba	9	5.0	7.8	4.0	9.2	26.0	6.5	0.72
22	Residential	Kibamba	3	4.4	2.5	1.5	3.2	11.6	2.9	0.97
23	Residential	Kibamba	3	2.0	1.7	4.1	0.5	8.3	2.1	0.69
24	Residential	Kibamba	7	13.0	0.0	4.9	9.5	27.4	6.9	0.98
25	Guest house	Kibamba	12	9.5	12.0	5.0	8.5	35.0	8.8	0.73
26	Residential	Kibamba	6	4.0	6.5	3.7	6.7	20.9	5.2	0.87
27	Residential	Kibamba	3	0.0	0.0	6.0	3.1	9.1	2.3	0.76
28	Residential	Kibamba	6	3.7	4.0	2.0	2.0	11.7	2.9	0.49
29	Residential	Kibamba	3	2.7	0.0	4.0	1.2	7.9	2.0	0.66
30	Residential	Kibamba	3	1.7	0.0	2.4	0.8	4.9	1.2	0.41
Average generation per capital per day										0.81

CLUSTER 2										
Point	**Description**	**Ward**	**No. people**	**WEIGHT(Kg)**				**Total(Kg)**	**Average/day**	**Kg/c/day**
				Day 1	Day 2	Day 3	Day 4			
1	Residential	Manzese	6	1.5	4.0	3.3	4.0	12.8	3.2	0.53
2	Guest house	Manzese	12	3.0	9.0	6.0	15.0	33.0	8.3	0.69
3	Residential	Manzese	6	1.0	4.2	2.5	7.3	15.0	3.8	0.63
4	Residential	Manzese	5	1.5	2.7	3.0	4.4	11.6	2.9	0.58
5	Residential	Manzese	6	2.0	3.0	4.3	6.0	15.3	3.8	0.64
6	Residential	Manzese	3	2.0	0.5	3.0	5.0	10.5	2.6	0.88
7	Residential	Manzese	8	5.0	6.0	11.5	2.5	25.0	6.3	0.78
8	Residential	Manzese	5	2.0	4.0	8.0	5.3	19.3	4.8	0.97
9	Residential	Manzese	4	3.3	5.0	0.0	8.7	17.0	4.3	1.06
10	Residential	Manzese	3	3.2	4.6	4.7	0.6	13.1	3.3	1.09
11	Guest house	Manzese	10	5.2	1.7	2.9	4.4	14.2	3.6	0.36
12	Guest house	Manzese	6	2.5	2.5	3.0	3.5	11.5	2.9	0.48
13	Residential	Manzese	6	4.5	4.0	5.0	5.5	19.0	4.8	0.79
14	Shop	Manzese	4	1.5	2.0	1.0	1.5	6.0	1.5	0.38
15	Residential	Manzese	12	17.0	5.5	6.0	5.0	33.5	8.4	0.70
16	Residential	Manzese	6	3.0	2.7	2.3	3.4	11.4	2.9	0.48
17	Residential	Manzese	7	5.0	3.5	5.5	9.0	23.0	5.8	0.82
18	Residential	Manzese	8	3.5	9.3	3.1	6.5	22.4	5.6	0.70
19	Residential	Manzese	11	4.0	3.5	6.5	5.5	19.5	4.9	0.44
20	Residential	Manzese	6	5.5	5.0	4.5	4.0	19.0	4.8	0.79
21	Residential	Manzese	10	2.0	3.5	7.0	2.5	15.0	3.8	0.38
22	Residential	Manzese	6	8.0	2.0	6.8	3.2	20.0	5.0	0.83
23	Residential	Manzese	6	2.4	2.5	3.6	5.2	13.7	3.4	0.57
24	Shop	Manzese	5	3.4	1.7	5.0	6.3	16.4	4.1	0.82

25	Shop	Manzese	2	1.5	6.0	0.0	0.0	7.5	1.9	0.94
26	Residential	Manzese	6	6.0	2.3	4.7	6.5	19.5	4.9	0.81
27	Residential	Manzese	6	0.0	7.6	1.8	5.3	14.7	3.7	0.61
28	Residential	Manzese	8	21.0	3.4	4.6	1.3	30.3	7.6	0.95
29	Residential	Manzese	7	5.5	6.0	8.0	5.0	24.5	6.1	0.88
30	Residential	Manzese	6	6.4	2.0	6.0	3.0	17.4	4.4	0.73
									Average generation per capital per day	0.71
									Average SW generation rate in Ubungo Municipality(Kg/c/day)	**0.76**

APPENDIX 2: SW CHARACTERIZATION IN KIGAMBONI MUNICIPAL DUMP SITES																
TIPER DUMP SITE																
	Plastics	Textiles	Glass	Kitchen	Wood	Grass	Other organics	Nylon (hard)	Nylon (soft)	Coconut shells	Papers	Poly sacks	Al & Metals	Soil	Rubber	TOTAL(Kg)
Sample 1(Kg)	8.5	4.6	10.0	84.0	0.0	12.5	94.0	3.4	4.2	6.6	4.0	8.2	2.0	30.4	3.2	275.6
Sample 2(Kg)	14.0	9.0	13.0	67.0	6.7	9.0	103.2	9.7	5.6	4.6	6.0	5.4	0.0	40.3	2.6	296.1
Average(Kg)	11.3	6.8	11.5	75.5	3.4	10.8	98.6	6.6	4.9	5.6	5.0	6.8	1.0	35.4	2.9	285.9
MJI MWEMA DU MP SITE																
Sample I(Kg)	6.5	4.6	8.3	46.0	4.2	3.1	67.2	2.3	3.5	2.5	3.5	5.3	0.0	13.7	0.0	170.7
Sample 2(Kg)	2.1	3.2	5.7	25.6	0.0	4.7	46.3	3.0	2.6	0.8	2.8	4.4	1.6	5.9	0.5	109.2
Average (Kg)	4.3	3.9	7.0	35.8	2.1	3.9	56.8	2.7	3.1	1.7	3.2	4.9	0.8	9.8	0.3	140.0
SW CHARACTERIZATION AT PUGU-KINYAMWEZI DUMP SITE																
Sample 1(Kg)	25.5	15.0	86.0	244.0	12.0	23.5	341.2	24.0	12.0	6.7	35.7	19.8	15.5	17.7	8.0	886.6
Sample 2(Kg)	17.0	5.9	23.0	156.0	3.4	12.0	278.5	12.2	7.8	2.5	14.2	8.6	3.2	22.4	4.3	571.0
Average	21.3	10.5	54.5	200.0	7.7	17.8	309.9	18.1	9.9	4.6	25.0	14.2	9.4	20.1	6.2	728.8

APPENDIX 3: SW CHARACTERIZATION AT GENERATION POINTS															
KIGAMBONI MUNICIPALITY															
	Plastics	Textiles	Glass	Kitchen	Wood	Grass	Other organics	Nylon (hard)	Nylon (soft)	Coconut shells	Papers	Poly sacks	Al & Metals	Soil	TOTAL(Kg)
Sample 1	0.5	2.3	0.0	5.8	0.0	3.2	7.9	0.0	0.3	0.3	0.0	0.0	0.0	0.9	21.2
Sample 2	0.2	0.4	0.0	5.2	0.5	4.6	8.4	0.0	0.5	0.0	2.6	0.8	0.0	1.7	24.9
Sample 3	0.0	0.0	0.3	5.3	0.0	2.1	7.1	0.0	0.2	0.0	0.0	0.1	0.0	2.6	17.7
Sample 4	0.5	0.0	4.2	7.8	0.0	4.7	12.3	0.1	0.8	0.3	1.4	0.0	0.0	0.6	32.7
Sample 5	0.2	3.2	2.1	6.8	0.0	2.3	9.6	0.0	0.5	0.0	1.2	0.4	0.0	1.5	27.8
Average (Kg)	0.28	1.18	1.32	6.18	0.1	3.38	9.06	0.02	0.46	0.12	1.04	0.26	0	1.46	24.86
Percentage (%)	1.13%	4.75%	5.31%	24.86%	0.40%	13.60%	36.44%	0.08%	1.85%	0.48%	4.18%	1.05%	0.00%	5.87%	100.00 %
UBUNGO MUNICIPALITY															
Sample 1	0.3	1.8	2.3	8.5	1.5	2.7	11.7	0.0	0.5	0.0	0.0	0.0	0.5	2.3	32.1
Sample 2	0.1	0.5	0.3	7.2	0.0	2.3	5.6	0.0	0.0	0.3	0.2	0.1	0.3	0.0	16.9
Sample 3	0.0	0.0	0.0	12.0	0.0	1.2	9.5	0.0	0.1	0.0	0.2	0.0	0.0	2.5	25.5
Sample 4	0.0	0.0	0.0	18.0	0.0	4.2	14.3	0.0	0.0	0.0	0.0	0.3	0.0	2.1	38.9
Sample 5	0.3	0.0	2.5	17.6	0.0	0.0	19.2	0.0	0.2	0.0	0.5	0.0	0.0	1.1	41.4
Average (Kg)	0.14	0.46	1.02	12.66	0.3	2.08	12.06	0	0.16	0.06	0.18	0.08	0.16	1.6	30.96
Percentage (%)	0.45%	1.49%	3.29%	40.89%	0.97%	6.72%	38.95%	0.00%	0.52%	0.19%	0.58%	0.26%	0.52%	5.17%	100.00 %

APPENDIX 4: TOTAL SOLID WASTE GENERATION			
KIGAMBONI MUNICIPALITY			
No.	Ward	Population	Total SW generation
1	Kigamboni	46137	34.60
2	Kibada	12988	9.74
3	Mjimwema	37701	28.28
4	Somagila	26161	19.62
5	Pembamnazi	13122	9.84
6	Kimbiji	8698	6.52
7	Vijibweni	39358	29.52
8	Tungi	31720	23.79
9	Kisarawe II	12566	9.42
		Total	171.34
UBUNGO MUNICIPALITY			
No.	Ward	Population	Total SW generation
1	Makurumla	87850	66.77
2	Mburahati	47318	35.96
3	Sinza	56225	42.73
4	Manzese	97772	74.31
5	Mabibo	118889	90.36
6	Makuburi	79608	60.50
7	Ubungo	77676	59.03
8	Kimara	106189	80.70
9	Mbezi	101803	77.37
10	Msigani	76422	58.08
11	Kwembe	78902	59.97
12	Kibamba	40055	30.44
13	Goba	59169	44.97
14	Saranga	144393	109.74
		Total	890.93

APPENDIX 5: LIST OF STAKEHOLDERS CONSULTED

LIST OF STAKEHOLDERS CONSULTED

DATE	NAME	INSTITUTION	POSITION	ADRESS/PHONE NUMBER	SIGNATURE
13/11/2018	SIXBERT KYARUSI	Manispal	Ag Mwenyekiti	0713943956	
13/11/2018	BERNADETHA MASOLA	WARD	KIGAMBONI	0713909752	
14/11/2018	ASHA M. ISSA	KIGAMBONI	MTENDAJI	0747462584	
14/11/2018	Juma X. Mtingamano	FERRY	MKUU SHIA	0713 454811	
15/11/2018	MARTHIN P. SHIKANDO	MJI MWEMA	MTENDAJI	0668918844	
15/11/2018	HAWA S. CHIHAMAO	SALANGA	MTUMBE	0653676575	
15/11/2018	SALOME P. MYONI	KIBADA-WARD	WEO	0658053105	
15/11/018	SAID PAZI	MYAKWALE	MKUU	0713 967 966	
15/11/018	JOYCE RENATUS	RECYCLABLE COLLECTOR KIBADA		0654 188 178	
16/11/2018	JULIANA LAIZER	VIJIBUENI	MTENDAJI	0713 099163	
16/11/2018	EDWARD PEMBE	VIJIBUENI	MEO	0713339427	
16/11/2018	VITUS DEZIDERI	TUNGI	Ag WEO	0762364825	
16/11/2018	BONIPHACE ABUNUASI	MWUNGANO	MWENYEKITI	0717414511	
19/11/2018	RICK P. PASCAL	WEO Kimbiji	WEO	0659606162	

LIST OF STAKEHOLDERS CONSULTED

DATE	NAME	INSTITUTION	POSITION	ADRESS/PHONE NUMBER	SIGNATURE
19/11/2018	KHADIL H. KANYANA	MEO-KIZITO	MEO	0654741234	

LIST OF STAKEHOLDERS CONSULTED

DATE	NAME	INSTITUTION	POSITION	ADRESS/PHONE NUMBER	SIGNATURE
09.11.2018	Ezra Guya	Ubungo Municipal Council	MEMO	0713499380	
12/11/2018	GEMA CHIFUNDA	KIBAMBA	AFISA AFIA	0715-045048	
12/11/2018	SOPHIA MBUGA	KWEMBE	AFISA AFYA	0766899230	
13/11/2018	WILLYJOHN MSANGI	UBUNGO WARD	WEO	0713455983	
13/11/2018	IKUPA DONALD	TASIPA LTD	HR	0764878750	
12/11/2018	[illegible]	SINZA	P/S	0654780581	
14/11/2018	SHILWA L. DICKSON	SINZA D	MEO	0714095838	
14/11/2018	ERICK TARIMO	UMC SINZA C	MEO	0719552265	
14/11/2018	SALEHE R LUCAS	KAWAWA	MKT-SM	0656-087230	
14/11/2018	ROZINA KIWARU	WEO MABIBO	WEO	0712678506	
14/11/2018	IDDI MKUMBE	MTAA JITEGEMEE MABIBO	M/S	0786-468828	
14/11/2018	[illegible]	MABIBO	MABIBO	0714821251	
15/11/18	N.O SWAI	WEO MANZESE	WEO	0771631214	
15/11/2018	B.A. MWAMENDE	MANZESE MUUNGANO	MEO	0673-990809	

LIST OF STAKEHOLDERS CONSULTED

DATE	NAME	INSTITUTION	POSITION	ADRESS/PHONE NUMBER	SIGNATURE
15/11/18	SAMWA SEMBA	MANZESE	EHO	0717793827	
15/11/2018	MAHMOUD JABALI	MANZESE	MEO	0769 329 073	
15/11/2018	MBUOTO Z.K.	MBEZI.	EHO	0758 737010	
15/11/2018	AGNES SENDA	MBEZI	MEO	0715772327	
16/11/2018	LUCY SUYA	GOBA	EHO	0713-147411	
16/11/2018	PETER KULA	GOBA	MKT	0754677021	
19/11/2018	DAMIAN KITO	KIMARA	MEO	0655207603	
19/11/2018	IQBAL A. JANJA	KIMARA	EHO	0712843056	
19/11/2018	GODWIN F. MANGOWI	BARUTI	MEO	0658283680	