A green city is our home!
Jiji safi la kijani ni makao yetu!

Strategy on Organic Waste Management in Dar es Salaam, Tanzania

for 2017 - 2020

April 2017
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LIST OF ACRONYMS

AD	Anaerobic digestion
BMZ	German Federal Ministry for Economic Cooperation and Development
BORDA	Bremen Overseas Research and Development Institute
CBO	Community Based Organisation
CCAC	Climate and Clean Air Coalition
CDM	Clean Development Mechanism
DCC	Dar es Salaam City Council
DLAs	Dar Local Authorities (used interchangeably with LGAs)
EMA	Environmental Management Act
ISWA	International Solid Waste Association
LGAs	Local Government Authorities
MBT	Mechanical-Biological Treatment
MSWI	Municipal Solid Waste Initiative
NGO	Non-governmental organization
PET	Polyethylene terephthalate
PPP	Public Private Partnership
SLCP	Short-lived climate pollutant
RCC	Refuse Collection Charge
RDF	Refuse Derived Fuel

Acknowledgements

The International Solid Waste Association (ISWA) is a key partner in the Municipal Solid Waste Initiative of the Climate and Clean Air Coalition (CCAC) and has been involved in improving the solid waste management system in Dar es Salaam, Tanzania. One of the main actions focussed on organic waste management and short-lived climate pollutant (SLCP) mitigation through the diversion of organic waste from the landfill. In this framework, ISWA contracted WASTE to propose a strategy on organic waste management in Dar es Salaam.

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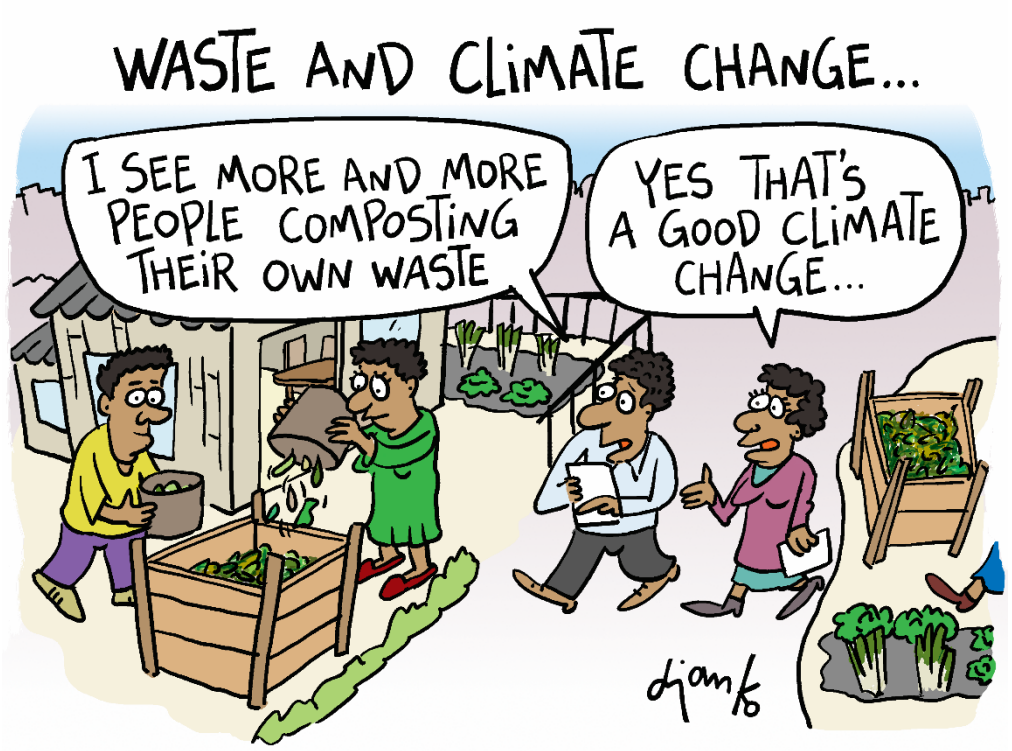

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Summary

The total amount of waste generated in Dar es Salaam is increasing at an alarming rate and only a small fraction is being collected and transported to Pugu, the only waste dump of the city, located at a distance of 30 km from Dar es Salaam. Harmful waste practices such as open burning and illegal dumping pose a threat to human health and pollute the environment. Furthermore, improper solid waste management causes unnecessary emissions of greenhouse gases. A recent analysis of the composition of household waste in Dar es Salaam shows that more than 50% of the waste is organic. In addition, the six large fruit and vegetable markets in de city generate a considerable amount of organic waste.

This document presents different types of technologies to treat organic waste and shows experiences from Bangladesh and Mali. Under the current circumstances, composting is seen as the best option for Dar es Salaam to treat the organic waste -anaerobic digestion will not be a viable option in the near future. The Strategy also includes the results of a baseline study and lessons learnt from a pilot awareness-raising project, which aimed to improve collection service and assess households' willingness for source separation of waste.

Development of a strategy on organic waste
In December 2016 a strategy was developed for the organic waste management of Dar es Salaam and a workshop was conducted so as to complete the strategy draft, based the input of key stakeholders, the results of the City Assessment (compiled by ISWA), and the baseline survey (completed by BORDA, the Bremen Overseas Research and Development Institute).

The main goal of this strategy is (timeframe 2017 - 2020)[1]:

Composting 50% of the organic waste from fruit and vegetable markets and composting 5% of the organic waste in households with gardens.

These goals fit into the overall vision for the City:

1. Promote business possibilities and reduce health risks by composting 50% of market organic waste and improve sustainable agriculture through educating farmers, market vendors and the general public.
2. Promote household composting (by source separation) and vegetable growing using compost instead of artificial fertilisers.

The strategy distinguishes composting at two levels: the first one is at a **centralized level** producing high quality compost for application in agriculture on large scale and on the second level is at the **household level** producing compost for their own use in vegetable or flower gardens.

Centralized level

[1] The Strategy does not intend to be an alone standing document and is supposed to be integrated into a city level solid waste management of Dar es Salaam. Moreover, the viability of the organic waste management strategy largely depends on the successful construction and operation of the Hamburg composting plant. Therefore, a rather short (4 years) timeframe was defined for the current document.

A centralized composting facility will be constructed with support from the city of Hamburg, which has been in partnership with Dar es Salaam for several years, and the German Federal Ministry for Economic Cooperation and Development (BMZ). Construction will start by May 2017 and it will be operational by the end of the year. It will compost organic waste from two fruit and vegetable markets initially, but in the future, the plant will also be able to accept segregated organic waste from households. If successful, this composting facility can be replicated in other districts. In addition, there is potential for agricultural markets to be developed with the cooperation of the company Guavay, who is currently operating a small-scale composting site at the Gongo la Mboto.

Household level

To promote household composting a master composter program is proposed which is a train-the-trainer approach to be executed in the parts of Dar es Salaam where households own a garden. This approach can be combined with training on cultivation of vegetables and flowers. The master composting training can reach a relatively large group of people, and be sustainable, since the expertise is locally available, and the people who would practice household composting have complete control and ownership of the process.

1. Introduction

Low-income countries are known to have the highest proportion of organic waste, which can range from 40-65% of the total waste stream. Composting can play an important role in the waste management system as an effective treatment of organic waste. Furthermore, organic waste that is composted well does not end up on the landfill, thus preventing rapid filling up of costly space and considerably reducing the amount of methane, produced by the degradation of organic matter. Next to addressing climate mitigation, compost is a useful product as it can improve the condition of the soil and as such support local agri- and horticulture.

However, in low- and middle-income countries where capital markets and markets for compost, best practices and supportive policy models are still being developed, it proves to be difficult to sustain and scale up composting activities.

Organic Waste and Climate Change
It is important to note the climate change aspect of municipal solid waste management. Waste management, specifically the treatment and disposal of organic waste, can produce various greenhouse gases (GHGs), of which the most important are CO_2 (carbon dioxide), CH_4 (methane) and N_2O (nitrous oxide). Methane originates form the decay of organic matter and has a 25 times higher global warming potential than carbon dioxide. Landfills are the third largest methane source and thus significantly contribute to climate change due to the organic waste fraction disposed to them[2].

Methane is a substance also categorized as a so-called short-lived climate pollutant (SLCP). Together with other SLCPs (black carbon, hydrofluorocarbons (HFCs), and tropospheric ozone) these pollutants have a relatively shorter atmospheric lifetime (for methane it is 12.4 years, which compared to N_2O, with a lifetime of 121 years, is short). The climate warming impact of SLCPs is significant, hence the high level of global efforts reducing them is expected to result in a rapid and positive effect on climate change.

If organic waste is composted or appropriately treated otherwise, its climate change impact becomes rather negligible.

The International Solid Waste Association (ISWA) is a key partner in the Municipal Solid Waste Initiative of the Climate and Clean Air Coalition (CCAC) and as such, it has been working closely with the Initiative on the leadership level and in project activities on the ground. In Dar es Salaam, Tanzania, ISWA is an implementer of the City Work of the Waste Initiative since February 2014. The City Work is staged in phases.

After the so-called *Phase I- City Work activities*, which included a scoping mission, the city assessment and the action plan completion, ISWA drafted and proposed a work plan, which outlined *Phase II- City Work activities*. The Work Plan was endorsed by the Waste Initiative and was started by ISWA as this second phase in September 2015 in cooperation with the City of Dar es Salaam.

[2] *Waste and Climate, Global Waste Management Outlook, UNEP and ISWA, 2015*

In the framework of this CCAC/ISWA project, WASTE was contracted to propose a strategy on organic waste management in Dar es Salaam based on the assessment by ISWA, the baseline survey executed by BORDA and the strategy workshop performed on the ground in December 2016.

Assessment
The preliminary assessment about organic waste management in Dar es Salaam was performed by ISWA with a twofold approach. Firstly, analysing a quite extensive literature, where the main data was included in a city assessment delivered to CCAC. The city assessment included experiences on composting not only in Dar es Salaam but also in other low-income countries. Secondly, during three on-field missions, meetings with main stakeholders were organized in order to discuss about the feasibility of the separate collection of organic waste and its proper treatment such as composting. Visits to two existing micro-scale composting facilities in Dar es Salaam (Kisiwani Buguruni, Gongo La Mboto) also took place.

Baseline study on solid waste management by BORDA, January 2016
A baseline survey was conducted by BORDA in Mabibo and Makuburi wards of Dar es Salaam in the Kinondoni Municipality covering 1000 families (500 in each ward). This baseline survey together with previous studies lays the foundation for the design of a sustainable, tailor-made, waste management strategy for Dar es Salaam, which is expected to be prepared in the future. The data collected was segregated by ward, type of waste and degradable vs. non-degradable waste. The results of the survey suggest synergies with the Hamburg composting plant future operations, business planning, and behaviour change campaign strategies. It will also provide a basis for carbon emission reduction calculations. The results are integrated in Chapter 1.

This report is primarily addressed to local decision makers in Dar es Salaam at different levels but it may be useful for private entrepreneurs, community groups, NGOs and knowledge institutions, in Tanzania but also in other countries.

This report is structured as follows:
Chapter 2 presents background information on solid waste management in Dar es Salaam and the performed baseline study, concluding with the key issues and challenges identified.

Chapter 3 provides an overview of options available for the treatment of organic waste adapted to the local context of low and middle-income countries including lessons learned from Mali, Bangladesh and further experiences.

Chapter 4 presents the strategy on organic waste management in Dar es Salaam on different scales of participation with a focus on the centralized and the household level.

2. Starting points – setting the baseline

2.1 Present situation - ISWM analysis

Figure 1 below presents the Integrated Sustainable Waste Management (ISWM) Framework. This framework is a tool for understanding waste systems and can be used in assessments, evaluations and planning to obtain improved, more sustainable solid waste management systems. This framework also allows for the analysis of the present situation of waste management in Dar es Salaam. It acknowledges the importance of three dimensions:

1. All **stakeholders or actors** involved or affected by the waste system, including local; regional and national governments; waste generators/service users (including industry, business, institutions and households); producers (those who put products on the market which become waste at the end of their life, including manufacturers, brand owners, importers and others in the supply chain); service providers (whether public or private sector, formal or informal, large or small); civil society and non-governmental organizations (NGOs) (which play a variety of roles, including facilitating the participation of other parties); international agencies; etc.

2. All **practical or technical elements** (infrastructure) of the system, from waste generation through storage, collection, transport, transfer, recycling, recovery, treatment and disposal.

3. All enabling or **governance** (strategic) aspects, including the political, health, institutional, social, economic, financial, environmental and technical facets.

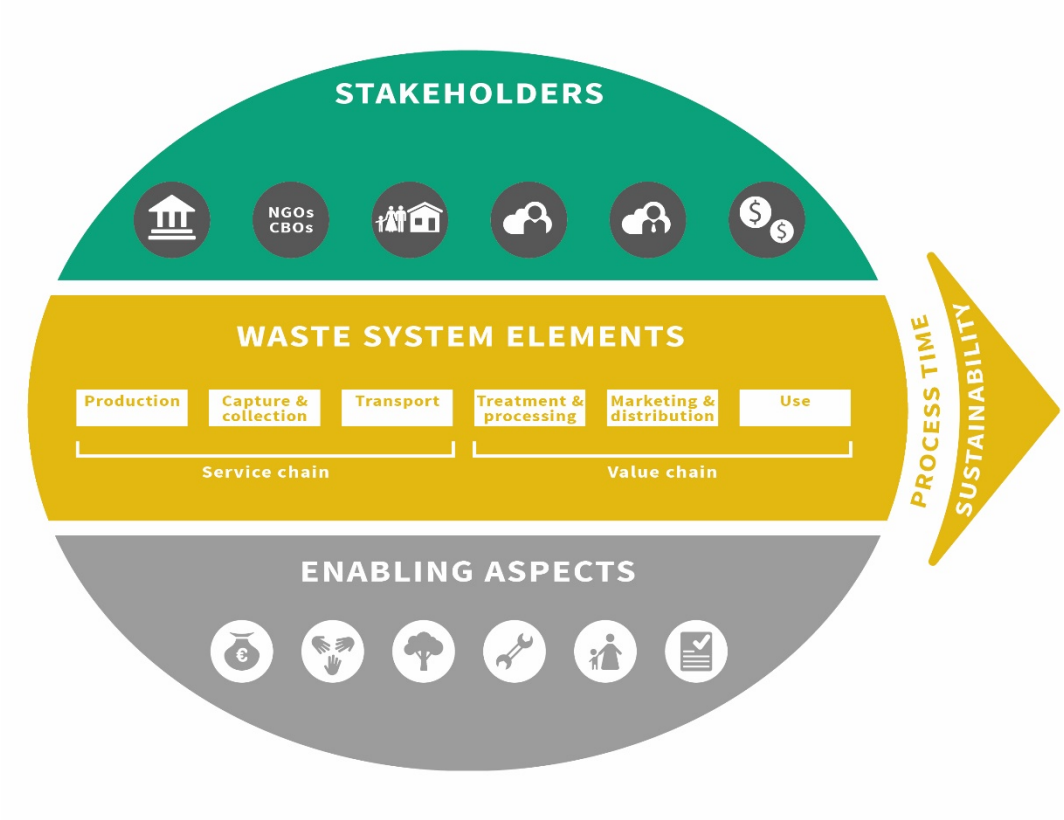

Figure 1. The Integrated Sustainable Waste Management (ISWM) framework

Baseline study on solid waste management by BORDA, January 2016
A baseline survey was conducted by BORDA in Mabibo and Makuburi wards of Dar es Salaam in the Kinondoni Municipality covering 1,000 families (500 households in each ward). Details of the baseline study are presented in Annex 1 and the results are integrated in this chapter.

2.2 Stakeholders/actors involved

The main stakeholders of the Dar es Salaam waste management system as identified in the workshop conducted in December 2016 were:

Ministry of Health and Social Welfare (OSHA) – Responsible for the formulation of the environmental health control, hygiene and sanitation policy.

National Government: National Environment Management Council (NEMC) – Responsible for developing the overall framework and policy of the national solid waste management system.

Local Government: Dar es Salaam City Council (DCC) – DCC has a Solid Waste Management Department and is responsible for the overall framework and policy on solid waste management for Dar es Salaam.

Local Government Autorities (LGAs or DLAs) or districts: Municipalities of Dar es Salaam: Ilala, Kinondoni, Temeke, Ubungo and Kigamboni – LGAs are responsible to provide solid waste services and can collect the corresponding fees from households and businesses.

Private sector – LGAs can outsource solid waste services to private waste collection businesses (GreenWastePro, Tirima, Mor4Less and The Recycler) or Community Based Organisations (CBOs).

Informal sector (waste pickers/scavengers) – It is estimated that about 1200 waste pickers are actively involved in the solid waste management system of Dar es Salaam taking out valuable recyclables from the waste stream on streets, illegal dumpsites and Pugu dumpsite[3].

Local population – The local population of Dar es Salaam plays an important role in the solid waste management system by generating and handling waste in the households and in their willingness to pay for delivered services.

Knowledge Institutes: University of Dar es Salaam (UDSM), Dar Institute of Technology (DIT)

NGO's: BORDA and Nipe Fagio are very active in the field of awareness raising concerning waste management issues such as prevention of waste and separation of waste at household level. Furthermore they capacitate private collectors to improve their business performance.

Religious organisations: Have an important role in awareness creation.

Farmers: Provide the market for compost.

Donors/Financial Institutions: Can provide funding for waste management infrastructure.

In paragraph 2.4.1, a diagram of the involvement in waste management of the different public bodies is represented.

[3] A study about waste pickers in Dar es Salaam, Tanzania, May 2015, Palfreman, J

2.3 The physical elements/infrastructure

The physical elements (infrastructure) of the system, from waste generation, collection, transport, transfer, recycling, recovery, treatment and disposal. They are described for the solid waste management system of Dar es Salaam in the sections after the description of the demographics of Dar es Salaam.

Demographics

Dar es Salaam is the largest city of Tanzania and the largest city in eastern Africa by population, as well as a regionally important economic centre. It is Tanzania's most prominent city in arts, fashion, media, music, film and television. It is Tanzania's leading financial centre with the Dar es Salaam Stock Exchange (DSE) being the country's first and most important stock exchange market. Dar es Salaam is the largest and most populous Swahili speaking city in the world.

The Dar es Salaam municipal government is composed of the Dar es Salaam City Council (DCC) and three Municipal Councils: Kinondoni (KMC) to the north with 1.8 million inhabitants, Ilala (IMC) in the centre with 1.2 million inhabitants, and Temeke (TMC) to the south with 1.4 million inhabitants. In 2016, two additional municipalities were created: Ubungo and Kigamboni. The latter two districts are not taken into account in this report because the implementation of this change has not finalized yet during writing this publication.

Together, the three (or five) local governments are commonly referred to as the Dar es Salaam Local Authorities (DGAs or DLAs). At the time of the 2012 census Dar es Salaam had a total population of 4,364,541.

2.3.1 Waste generation and composition

A survey undertaken by the World Bank in 2012 indicated that households in Dar es Salaam produce an amount of approximately 4,200 tons waste per day. It is estimated that this amount will increase to 12,000 tons waste per day by 2025. Table 1 gives the amounts of waste generated for the three municipalities.

Table 1 Total amounts of waste generated in Dar es Salaam and average amount of waste collected

Municipality	Waste generated per day (tonnes)	Waste generated per year (tonnes)	Waste generated per capita (kg/day)	The average amount of waste collected per day
Ilala	1,088	397,120	0.89	600
Kinondoni	2,026	739,490	1.14	1,030
Temeke	1,138	415,370	0.83	398
Total:	**4,252**	**1,551,980**	**0.98**	**2,176**

Recent measurements by BORDA[4] of the amount of waste generated by households in two wards of Kinondoni resulted in 0.644 kg per capita per day (average) waste generation. This data seems to be more in line with statistics of other African cities, than the amount of 0.98 kg/capita per day measured previously.

Waste composition

Multiple waste composition analyses have been carried out in the past. The most interesting results are those referred to the low-income wards, where most of the population lives. As shown in Table 2 below, the major fraction is organic waste.

Table 2. Waste composition for different wards in Kinondoni

Waste component	Kinondoni[4] (Midizini + Mkunguni) Weight %	Kinondoni[5] Makuburi Weight % Baseline BORDA 2106	Kinondoni[3] Mabibo Weight % Baseline BORDA 2016
Organic materials	74.1	59.3	51.2
Sand mixed with waste		13.9	23.5
Paper (and cardboard)	8.3	3.2	4.0
Plastics (bottles and bags)	9.0	9.6	6.4
Glass	0.8	1.3	0.4
Metal	0.6	0.3	0.3
Residuals	7.2	8.1	14

In the recent baseline survey of BORDA a lower percentage of organic waste was observed in the waste stream (see annex 1). This might be because of animal feeding practices in these wards. It is always difficult to compare waste composition studies, due to the different definitions and methodologies used. Comparison of the results of the BORDA baseline study (2016) with the results of the characterization study from 2013 (see Paragraph 2.3.2) shows a decrease in the organic waste fraction from 74% to 55%. However, it should be considered, that sand might be included into the organic waste in the 2013 results and in the BORDA baseline study the low percentage of organic waste might be due to organic waste being fed to animals. Since 11% of the interviewed inhabitants used organic waste as animal feed.

2.3.2 Waste collection, transfer and transport

Reports state that waste collection coverage has increased from 16% of year 2000 to 51% currently, however this figure might be lower[6]. The steady pace of population increase especially in unplanned areas affects the collection rate negatively; illegal dumping and open burning are still prevalent in most parts of the city, as a direct consequence of the inefficient collection scheme in place. Table 3 gives the official collection coverage percentages for 2014 for the three municipalities of Dar es Salaam as reported by the Dar City Council.

Table 3. Collection coverage (%) for Dar es Salaam

Municipality	Collection coverage[7] (%)
Ilala	55
Kinondoni	51
Temeke	48

[4] Aisa Oberlin, Characterization of Household Waste in Kinondoni Municipality, Dar es Salaam. Academic Journal of Interdisciplinary Studies, Dec 2013

[5] Findings from baseline on solid waste management in Mabibo and Makuburi wards, Borda, January 2016

[6] According to the expert mission on Integrated Solid Waste Management to Dar es Salaam of September 2016, collection rates are much lower based on the amount of waste that the Pugu dumpsite is receiving.

[7] CCAC Solid Waste Managment City Profile, February 2015 (note: only three municipalities existed)

Total	**51**

In low-income areas, municipalities contract collection activities to CBOs (Community Based Organizations) who perform the primary, door-to-door collection by means of simple pushcarts and deliver waste to official collection points. In this case, the municipalities perform the secondary collection (transportation to Pugu dumpsite). In middle-income areas, the contractors collect waste with their own trucks and deliver it directly to the dumpsite.

The other half of the generated waste does not get formally collected -according to previous literature, confirmed by BORDA's survey - and it is mainly burned and buried close to the households, or dumped into rivers and illegal dumpsites, as shown in the following table.

Table 4. Household Solid Waste Management in two wards in Kinondoni

Waste management practice at household level in Mabibo and Makuburi Wards Baseline BORDA 2016	**Percentage (%)[8]**
Dumped in streets, river, garden and ponds	8
Buried	18
Open Burning	22
Disposed at municipal containers	1
Disposed at collection points	0.3
Collected by registered service providers[9]	43
Collected by informal service providers	38

2.3.3 Waste recovery and recycling

Waste collection is officially implemented with a scheme that includes the few municipal vehicles, waste collection enterprises and CBOs, which are both contracted by the Local Authorities. While the collection enterprises have their own vehicles, the CBOs operate a door-to-door collection with pushcarts, delivering waste to neighbourhood collection sites (transfer points) where private trucks, or vehicles provided by DLAs, clean up the area from time to time and deliver the waste to the Pugu dumpsite. As is the case in many African cities, Dar es Salaam also has informal waste picking done by waste pickers who go to the transfer points or to house-to-house to collect specific materials.

However, it is important to highlight that as DLAs estimated, overall less than 30-50% of the total waste generated in the city is collected and disposed of in the Pugu dumpsite or otherwise recovered by the informal sector. The remaining waste is either burnt and buried or dumped on the road side or into drainage canals contributing to health, annual flooding and uncontrolled methane generation.

"Transfer points" range from skips to large open areas and are often also problematic as waste dumped in such space spreads freely, blown by the wind, gets openly burned and carries the potential for disease vectors. Many of these sites are semi-formal while others are turning into illegal dumpsites. Informal waste recovery operations take place by CBOs and informal enterprises, who recover materials for recycling - with the biggest market for hard plastics and PET. Besides

[8] Total is not 100% as more than one answer was possible

[9] The difference between registered and informal service providers was not clear according to the baseline study of BORDA

plastic bottles, metals, cans and cardboard is recovered. Additionally, a limited amount of jute bags is recycled.

Existing experience with composting in Dar es Salaam

Very limited experiences on composting practices exist in the city. One experiment has been done currently by BORDA who implemented two small-scale composting facilities in Dar es Salaam (Kisiwani Buguruni and Gongo la Mboto). These two facilities were visited by ISWA in 2015. Both trials resulted in showing poor results, not in terms of compost quality but rather regarding the economic viability for such small scale facilities – due to the amount of investment cost and human labour required, compared with the low income from selling compost, the end product of the process. The facilities are designed to treat less than 1 ton of organic waste per day, but are actually operated on lower capacity and with basic manual equipment for turning and screening. A small CBO in Kisiwani Buguruni is still active and is trying to set up a business with composting and is looking for markets for their end product[10].

BORDAs composting pilots

BORDA implemented composting according to the DESWAM (Decentralized Solid Waste Management) approach in the Gongo la Mboto sub ward of the Gongo la Mboto ward in Dar es Salaam. This included the organising of service providers to collect waste from households to be transported to a transfer point. At this transfer point the waste was separated, recyclables were sold and the organics were meant to be composted. The remaining residuals were to be taken to the final dumpsite by trucks from the municipality. The whole project was not effective due to factors such as the low efficiency of the plant, or the piling up of the residual waste, which was not shipped to Pugu dumpsite and left at the site. After a year of unsuccessfully trying to influence the service provider, BORDA withdrew from the project and handed it over to the responsible municipality. Waste is still being collected from the community but the transfer point is nowadays not used for separation anymore. By now, another small organization uses the place for composting of organic waste from hotels and markets.

There is a number of lessons learned from such a pilot cases. A main one is the importance of awareness creation in the community and thus the sensitisation of individuals for the importance of compost, source separation of waste, or the environmental/health benefits of poor waste management. BORDA has been actively working in this field and carried out the "Cleanest Mtaa" awareness raising programme with great success, commissioned by the CCAC/ISWA. Another lesson is the importance of good selection criteria for a service provider, such as political neutrality, having enough start-up capital and the interest in providing the service. With respect to the economic and technical side of composting, the learned lessons are:

- Marketing for the compost product was not done before the start of the project and consequently the service provider did not see the benefits immediately.
- Transport chain: since the remaining waste was brought to the final dumpsite by municipal trucks, there was no interest to reduce the amount of it (which should be a main incentive for separation and composting).

[10] *Information from BORDA, June 2016*

- The main income for the service providers were waste collection fees from the community and sales profit from any recyclables. This was not economically feasible, mainly due to the low amount of service collection fees in unplanned settlements.
- The composting component was rather a top down approach and not demand-driven. Consequently, the interest in making it a viable business was not very high; especially since the market was not clearly defined (i.e. there was not enough attention for market development).

The following successes were identified in the composting project:

- Testing of the compost produced which in the beginning showed that the quality of the product was good.
- It was also noted for future projects that the better the separation from the other residuals, the better the quality of the compost.
- The main objective of the project was reached, to transport the waste out of the community.

Hamburg composting facility

A large scale composting facility in Kinondoni will be constructed, supported by the city of Hamburg and the German Federal Ministry for Economic Cooperation and Development (BMZ). This facility will be implemented within the framework of a carbon emission offset agreement between Hamburg and Kinondoni Municipal Council, and will be one of the very few case studies in the world of a large scale composting facility with emission offsetting financial mechanisms. Construction will start in May 2017 and the plant will be operational by the end of 2017[11]. Organic waste will be collected from two of the larger fruit and vegetable markets (Tandale, Tegeta) and will be located in the North of Dar es Salaam (Mabwepande). In the future, the facility would like to accept segregated organic waste from households.

2.3.4 Final disposal

Waste collected through the formal scheme is delivered to a large centralized dumpsite (Pugu Kinyamwezi) which is located outside of the city (30 km with difficult access roads), has no liner, no soil cover and no leachate treatment. Although it was initially designed to operate as a sanitary landfill, due to lack of funding and thus insufficient construction it now operates as a dumpsite.

2.4 Enabling or governance (strategic) aspects

In the following sections, the main governance aspects will be discussed: the policy framework including the institutional framework and the financial aspects.

2.4.1 Policy framework

At a national level, the **Central Government** through the Prime Minister's Office Regional Administration and Local Government Authorities is responsible for instituting a system of solid waste management, which can be used by the LGAs to deal with the generated solid waste in their respected areas.

[11] *Information provided at the workshop in December 2016*

At a national level, the legislation governing all environmental issues is the Environmental Management Act (EMA) of 2004[12], which is actually the umbrella law on environmental management in Tanzania. Sections 114 to 119 of the Act stipulate the duty of local government authorities in managing and minimizing solid waste and they include basic but important principles such as the need for source separation at source and the management via transfer stations.

Besides that, the Solid Waste Management Regulations, and Hazardous Waste Control Regulations, of 2009, specifically apply to all matters pertaining to solid waste management. It includes some good principles, some of them listed below, which unfortunately have been usually neglected.

- *Any person who litters... including in storm-water drains, or fails to collect litter from outside his premises commits an offence*
- *Any person who does not ensure that reusable receptacles are kept clean, maintained and in good repair and ensure that each waste receptacle is used in a way which protects the contents from spillage, rain, storm water, birds, flies or other pests and vermin commits an offence.*
- *Local government authorities must designate waste transfer stations to adequately and appropriately prevent the release of waste to the environment until appropriate recovery, recycling, treatment and disposal options are available.*
- *Government authorities shall... develop respective waste disposal plans to prevent occurrence of environmental and health hazards'*[11]

Based on the Local Government (Urban Authorities) Act No. 8 of 1982, all the urban authorities in Tanzania are given the mandate to make their own by-laws in order to execute their responsibility of waste management in their respective areas of administration. Thus, **Local Government Authorities** (LGAs, or DLAs in the case of Dar es Salaam) are required to conduct solid waste management services in their districts and are allowed to charge solid waste fees. Therefore, the LGAs of Dar es Salaam are responsible for both collection of solid waste and collection of solid waste fees. However, they can also outsource these services if they prefer this option.

In the case of Dar es Salaam, **Dar City Council** is managing overarching issues, such as the management of the dumpsite of Pugu Kinyamwezi.

The overall policy framework has been assessed as being weak by many audits and reports, such as the official national audit of 2009[13] that found that, for instance, by-laws and general policies are not enforced: all municipal councils audited were conducting sporadic inspections, but none of them had inspection plans, set priorities, or clear objectives. Moreover, the audit highlighted the fact that the central government is not adequately engaged in monitoring and evaluation of solid waste activities in the country.

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[12] 'Tanzania - Environmental Management Act, 2004', 3/3 Law, Environment and Development Journal (2007), p. 290, available at http://www.lead-journal.org/content/07290.pdf

[13] The United Republic of Tanzania, National Audit Office, A Performance Audit on the Management of Solid Waste in Big Cities and Region(S) In Tanzania, 2009. http://afrosai-e.org.za/sites/afrosai-e.org.za/files/reports/SWM_MAIN__REPORT.pdf

Figure 2 below displays the solid waste management system in Tanzania, accounting for the national and local legislation procedures and the roles of governments and the private sector.

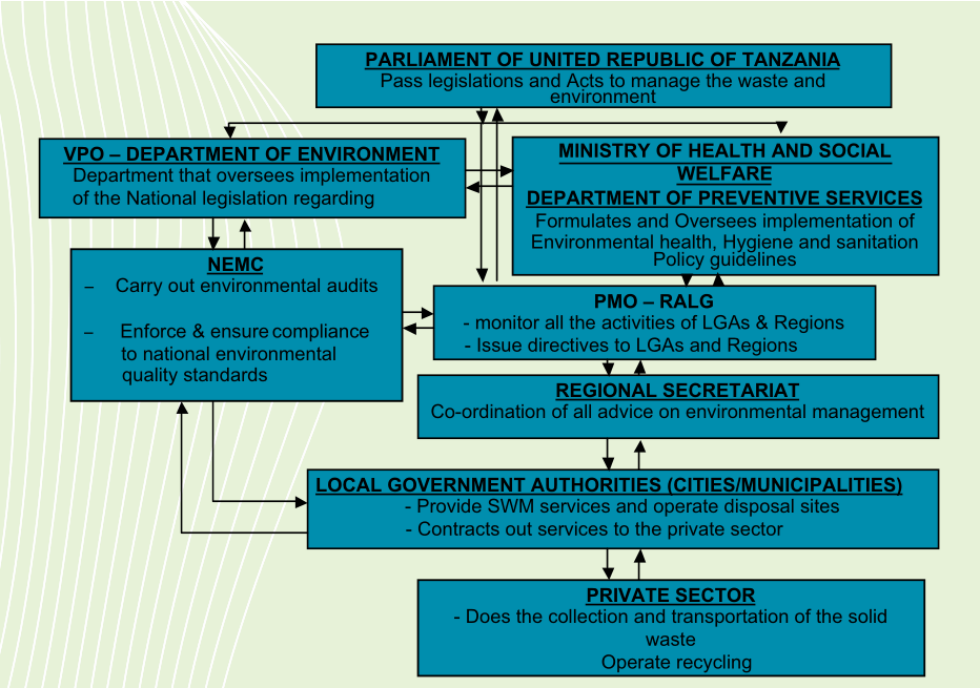

Figure 2: System graph – Solid Waste Management in Tanzania (source: The United Republic of Tanzania, National Audit Office)

2.4.2 Financial aspects

Waste services are financed through Refuse Collection Charges (RCC), which were introduced in 1993 with the privatization of waste management (DCC bylaws), and subsequently in 2000-2001 by the three municipalities. The fees are paid by the citizens on a monthly basis; minimum and maximum ranges defined according to the average income of the areas, typically around USD 0.51 per month. This amount is considered too low to be sustainable by the private contractors. Additionally, especially in low-income areas, only 30-50% of citizens pay their monthly due. For businesses, the fee is higher and negotiable according to their size and location. The municipalities also use a part of their general budget to do the secondary collection, i.e. the transportation to Pugu from the collection points in unplanned areas where CBOs operate in a very limited way.

The fact that the solid waste management system basically relies on waste collection fees paid monthly on the spot from citizens to CBOs and collection companies, and that households do not pay because of bad services in many areas of the city, negatively supports the viability of any improvement in new equipment, collection frequencies, etc. This results in citizens using illegal and environmentally harmful means of waste disposal such as open burning or dumping into streets and rivers. In addition, informal sector waste collectors pose a competition to the official service providers as they go door to door and collect the waste for even a smaller fee than others. More importantly, informal waste collectors are also a threat to human health and the environment, since they typically burn the collected residues, or dump them into the rivers.

The current gate fee at the Pugu dumpsite is only 1,700 TZS (USD 0.79) per ton. An updated by-law has been submitted to the National Government (Ministry) for final approval in 2015, which would

increase the gate fee to 30,000 TZS/ton (USD 13.94). However, approval for the regulation is pending.

2.5 Key issues and challenges

Based on the described analysis and the BORDA baseline study, the following key issues and challenges were identified, with focus on organic waste management:

Waste generation/ separation at source

The amount of waste generated in two wards of Kinondoni is 0.644 kg per day per person, of which more than half consists of organic material. Hardly no separation at source takes place, although more than half of the population states in the baseline study that they would be interested to separate mainly for environmental reasons.

Collection rate

Collection coverage is low. According to official figures, only 30-50% of the generated waste in Dar es Salaam is collected, especially in low-income areas, where households are not provided with regular and proper collection services. Furthermore, the BORDA baseline study shows that in some places, although collection services exist, the quality of the service is poor. There is no separate collection of organic waste and formal source separation options are not present.

Management of organic waste

Especially in areas where there is no collection service, the waste is burned, buried or dumped at illegal dumpsites without any treatment at all. Previous experiences with neighbourhood composting were not very successful, although a compost market analysis research from 2012[14] successfully identified potential markets for compost and claimed a high demand for the product from sport clubs, landscapers and pineapple farmers.

The decentralised composting pilots of BORDA (described in earlier chapters) cannot be deemed successful, as economies of scale could not be reached with the rather low capacity of the plants.

Disposal

The disposal situation of solid waste is unfavourable in Dar es Salaam; only one dumpsite exists with difficult access during the rainy seasons and without protective measures to prevent pollution of the environment (e.g. leachate management). Several illegal dumpsites are present in the city. Waste pickers take out valuable recyclables and sell them for further recycling.

Institutions

LGAs are responsible for both solid waste collection and fee collection but the function of waste collection from those of fee collection should be separated. There is no control of the delivered service.

[14] *Compost Market analysis Research Report – Strategies and current market for food waste based compost, BORDA and Sustainable cities, December 2012*

The National Environmental Act and local by-laws have been recently approved by DCC and by the DLAs. The by-laws include the waste collection fees to be paid by citizens; however, there is no law enforcement in place.

Financing of waste management

Insufficient municipal budgets are present to deal with increasing waste volumes and more complex waste streams. Furthermore, service fees often times do not channel through to the municipalities, as there is no proper control over their collection. Although the baseline study of BORDA shows a high willingness of households to pay for a reliable waste collection service, waste collection fees often do not channel through to the municipalities – due to the lack of proper controlling or enforcement measures. The non-transparent handling of money might well affect most levels of the waste management system. The city claims that it does not have the power to invest into new waste management infrastructure and thus largely depends on international development grant funding.

Awareness about environmental/health threats and human behaviour

One of the most important thread on human health and the environment originating from bad waste management practices is the black carbon emissions from open burning. This harmful practice is prevalent throughout every region of the city and although the law prohibits it, there is no enforcement to the regulation.

Waste is often dumped nearby and into rivers, contaminating not only the water, but the surrounding flora and fauna. Uncollected waste can accumulate in canals and block drains, causing floods during the rainy seasons, which help the spreading of virus vectors and increase the risk of outbreaks.

There is a low awareness level of waste management at source: the majority of inhabitants does not separate their solid waste at source but more than half would be willing to separate for environmental reasons. LGAs are typically not aware of such willingness. In addition, the awareness about other key issues in waste management is equally low, for example about health hazards, the payment of waste collection fees and environmental impact.

3. Options in the selection of organic waste treatment technologies

3.1 Basics of the composting process[15]

What is composting?

Composting is "the decomposition of materials from living organisms under controlled conditions and in the presence of oxygen". Composting is an aerobic process, which means that without air, the process does not happen. The final product, compost, is biologically stable and can serve as an excellent soil conditioner. Composting occurs through the activities of soil organisms. Organisms do not have to be added to a pile of organic materials, as long as there is contact with the soil, the organisms come by themselves. Under the right conditions, the composting process takes place by itself.

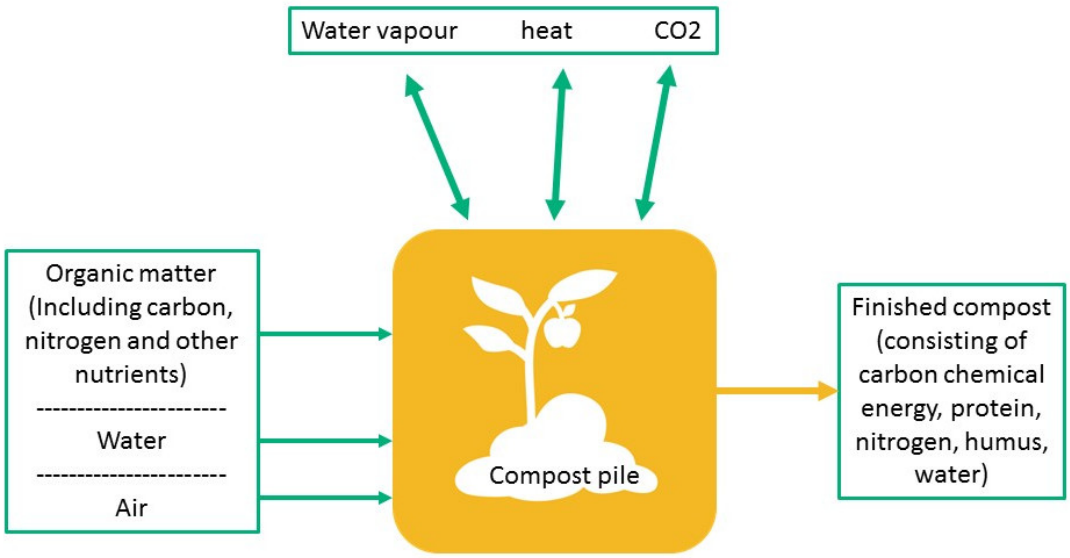

Figure 3. Schematic overview of a compost pile

So what are the right conditions? Compost bacteria, the main decomposers of organic matter, need air, water, carbohydrates and protein. In the world of composting these four substances and sufficient mass to retain heat are essential:

- **Air.** Air can be added to a compost pile when the pile of organic materials is turned or moved. The pile needs to be aerated to keep the aerobic organisms happy, otherwise they suffocate. For very fine-grained materials, it is good to add wood chips or shells or other rigid materials in small fragments, as "bulking agents" to preserve air spaces. Air is also the reason that clumps of soft porridge or rice have to be broken up to compost well. This is due to the compost bacteria being surface dwellers. Bacteria do not burrow into things they just attach to surfaces. Thus, a big clump of rice would compost on the outside and decompose anaerobically – turning reddish and with a bad odour – on the inside.

[15] *The Botswana Recycling Guidelines – Advice on Valorisation for Middle-Income Countries, WASTE, 2012*

- **Water.** Most failed compost piles prove to be too dry. Organic materials have to contain 40% water by weight to keep the bacteria happy. A compost pile needs as much or even more water than a vegetable garden. An effective way to add air and water at the same time is to turn the compost during rainstorms. Furthermore, compost does not need clean water. Grey water from showers or washing (as long as it is not bleached) is perfectly good for compost. Using black water (water carrying human faeces) is also possible, but requires special techniques to avoid the spread of disease[16].
- **Brown materials.** Carbohydrates, or starches in our diet come mainly from potatoes or rice. In the world of composting carbohydrates are called "brown materials" and consist of dry leaves, straw, ground branches or wood chips, rice hulls, peels, skins and shells of fruits, vegetables, and nuts.
- **Green materials.** Proteins. In composting, proteins are called "green materials." Vegetative materials have a lot of protein when they are fresh, so sources of protein are fresh grass clippings, vegetable and fruit wastes, pressates from juice production, animal manures, slaughterhouse wastes or other sources, and dairy products. Compost, like people, only needs a small amount of protein to be happy and healthy.
- **Sufficient mass to retain heat.** A pile of less than one cubic metre will compost in the summer, but in the winter (in temperate climates) it will become inactive because of the insufficient mass to insulate and maintain thermophilic temperatures. Thermophilic temperatures are created by the action of the bacteria. A hot compost pile is 55 to 60 ^{o}C and steams when is opened. The hot temperature ensures that both weed seeds and bacteria are eliminated and die off or become inactive. In tropical areas, having enough mass helps to act as a "buffer" limiting the effects of too much drying or too much rain penetrating in the heap during the rainy season.

Table 5. Sources of Carbon (C) and Nitrogen (N).

Carbon (BROWN) = 40x	Nitrogen (GREEN) = 1 x
Wood, sawdust, wood chips, ground brush	Grass clippings
Bagasse, cashew shells	Dairy and meat wastes
Straw, hay, dry leaves	Sauces, cooked vegetables, rice, etc.
Branches	Urine
Rice hulls	Animal manures
Paper, shredded cardboard	Fish wastes, shells, bones

When is the compost finished?

Finished compost is dark in colour and has an earthy smell (i.e. like the smell of soil). Usually, it is difficult to recognize any of the original ingredients, although bits of hard-to-decompose materials (such as straw) can be seen sometimes. There is no single point at which compost is finished - is the process is rather subjective. For many outdoor garden applications, for instance, it can be fine to use compost that still has a few recognizable bits of leaves or straw.

16 *https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/EWM/Project_reports/CCP_SW_FS_guidelines.pdf*

Compost impurities can be separated depending on their final use (e.g. parts of plastics, glass, metals or oversized not fully composed organic material, etc.). For this purpose, a manual sieve can be used (Figure 4) or for larger volumes a mechanized rotating sieve (Figure 4) is usually applied. Next to this purpose of sieving, the devices are also used to produce a various range of products suitable for end uses such as soil conditioning, mulching and others.

Figure 4. Sieve used at waste dump in Mali to produce compost and mechanized rotating sieve (source: WASTE and EAWAG)

Benefits of composting

The use of compost as a soil conditioner in agriculture, horticulture, and open space management has the following significant benefits:

- It is **a source of valuable mineral and organic materials**, including slow-release nitrogen, although it is not a fertilizer,
- It contributes to water retention,
- It promotes soil structure by increasing the stability of the soil.

3.2 Composting technologies[17]

This paragraph presents the most basic options and parameters to support the selection of composting technologies, especially in low-income countries. There are two fundamental types of composting techniques: open or windrow composting, which are done outdoors with simple equipment, and enclosed system composting, where the composting is performed in a building, a tank, a bin, a container or a vessel. In-vessel systems are oriented towards less operators, avoiding direct contact with the composting mixture and limit the emission of odours. They are able to deliver finished compost in a shorter period of time. Open systems are simpler, less expensive, use less energy but require more space and time in order to produce finished compost. They also require greater oversight management to avoid potential health, environmental or nuisance problems.

3.2.1 Windrow composting

Open composting processes are simpler, require less capital, and use less energy. They generally rely more on land and labour and less on machinery. They require significant land surface and produce compost in a longer period of time than enclosed systems. In labour-rich and capital poor countries, such systems are usually more reliable and adaptable to local needs and the capabilities of local authorities to sustain operations over a longer period of time. The exception is when there is a

[17] *Based on "The Organic Waste Flow in Integrated Sustainable Waste Management", WASTE, 2001 and EAWAG*

shortage of land. Operating costs range from USD 5 to USD 20 per ton, depending primarily on the accessibility of the site and the frequency of turning.

Figure 5. Basic windrow composting

Passively Aerated Static Windrow Composting

This technology relies on the fact that inside the piles there is a passive natural convective flow of air due to the higher temperature inside the pile, and its triangular section ("chimney effect"). Thus, there is no forced aeration but rather, especially in micro-scale plants, there may be perforated pipes placed into the piles, which promote convective airflow through the organic material. The pipes can be located at different positions in the windrow. The air gets into the pile and brings the required oxygen for the microorganisms. These windrows are normally not turned during the process; therefore, it is important to mix the feedstock very well before placing it on the site. It is advisable to insulate the windrows with finished compost to ensure the high temperature, which occurs in the inner layer.

Figure 6. left: The Chinese model for small scale passively aerated composting (source: UMP - The World Bank) right: Micro-scale plant passively aerated pile with triangular wood frame inside *(source: ISWA, Dar es Salaam Kisiwani Buguruni)*

Forced Aerated Windrow Composting

In this technology, appropriate for medium scale plants (5,000 – 50,000 tons/year), air blowers are installed to aerate the windrows mechanically. Airflows can be adjusted. These windrows do not need to be turned and the insulation of the finished compost is advisable to control any odours.

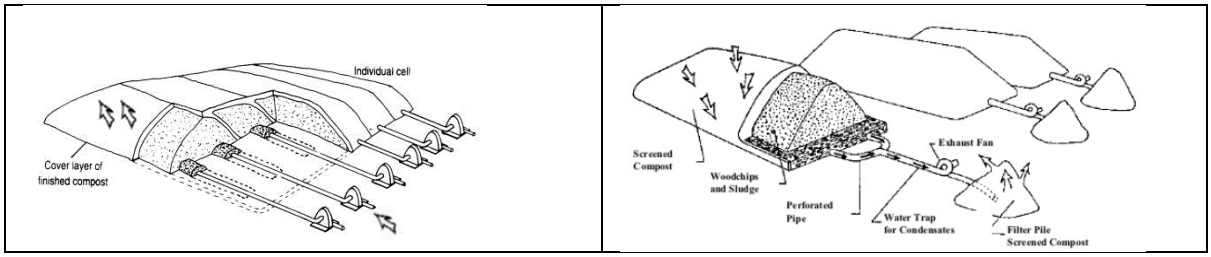

Figure 7. Forced aeration in actively aerated composting, blowing (left) and sucking air (right) ***(source: CVC)***

3.2.2 In-vessel or enclosed composting

In-vessel systems, such as drum or agitated bed technologies, require equipment that is more complex and are usually used for medium-large scale plants. These systems are highly engineered, capital intensive and have automated control systems. They also use substantial amounts of energy. Ongoing operation and maintenance is critical. If the system is imported, spare parts might be a problem. The equipment might be designed for specific climate conditions and may not be universally applicable. They allow for the use of less land and they produce compost in a shorter time. However, automated in-vessel systems cannot respond always to the realities of the socio-economic situation of different locations in the developing world (e.g. limits of education, limits to existing institutional infrastructure support, labour rich poor economies). Their operating costs usually start at USD 40 per ton, for the least expensive variant; systems that are more expensive can cost up to USD 100 per ton.

Bin Composting

This technology is mainly practised at household level and will process little amounts of organic waste for own use in gardens. Organic waste is mostly inserted from above and finished compost is removed from the bottom. Air holes need to provide the oxygen for the composting process.

	Investment	Maintenance	Space	Time	Labor
Windrow Composting	•	•	•••••	•••	•••••
Passively Aerated W.	••	••	•••••	•••	••
Forced Aerated W.	••••	••••	••••	•	••
In-Vessel	•••••	•••••	•••	•	••
Bin Composting	•••	••	•••	•••••	••

Figure 7: Comparison of composting technologies[18]

Figure 7 shows a comparative impression of the different technologies assuming they are all treating the same amounts of waste. The table allows a quick assessment of the technology, which could suit the best to the needs of Dar es Salaam.

[18] *MOOC Municipal Solid Waste Management in Developing Countries, EAWAG and EPFL, Switzerland*

However, some key boundary factors have to be considered prior to a viability assessment of a composting technology in low-income countries, as summarized below in Figure 8.

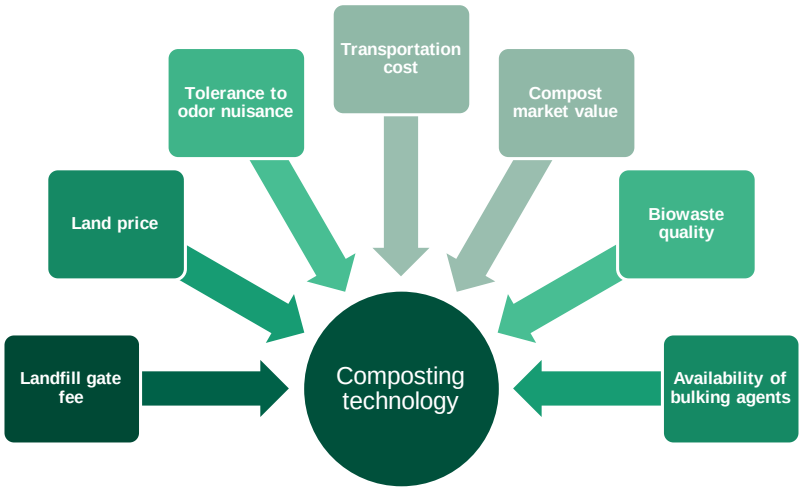

Figure 8. Boundary factors affecting the choice of a composting technology (Source: M. Giavini for ISWA, CCAC webinars)

3.3 Composting on different scales: households, city/cities

3.3.1 Household composting[19]

Small-scale composting systems adapted for households (household composting) include heaps in and above the ground, pits, boxes, bins, garbage cans, drums and barrels. Each method has its advantages, but when choosing the composting method, factors such as availability of space, types of material and available construction facilities have to be taken into account.

Figure 9. Compost bin made out of old boards and chain-link fencing, the front opens for easy access.

The simplest way to compost material is to build a heap. A small compost heap can be either in a stack above the ground or in a pit dug into the ground. A heap can be of any size but a manageable heap is 1 to 2 m wide and 1 to 1.5 m high, although considerable heat losses occur with smaller

[19] *Options appraisal for Bo City Council by Derek Greedy & Glenn Fleet*

heaps. This method is appropriate for gardeners or on farms that have plenty of space, ample materials, sufficient time and no nearby residents. The composting time is quite long and may be up to one year. Composters made out of wire are the most common compost structure. Bins made out of concrete, brick, wood or masonry are also used. Composters made out of wire have the advantage of allowing air circulation; however, flies and rodents also have free access to the compost. It is quite difficult to trap heat in a compost pen and therefore high temperature composting may not develop.

Figure 10. The big bin design can be made of cinder blocks, bales of hay, wooden pallets, landscape timbers or basic lumber. Generally anything that will hold a pile of yard and kitchen waste will work.

Household composting prevents garden and vegetable waste from entering the waste stream, and, as such, is an important contributor to the diversion of biodegradable waste from landfill.

Household Composting Benefits and Risks

The following benefits and risks can be identified when exploring the opportunity of household composting:

Benefits:

- Reduced costs for collection and disposal
- Reducing resource/energy use
- Reduced volumes of waste to be sent to landfill therefore reduced landfill costs
- Reducing weight of residual waste
- Reduced emissions due to less skip vehicles on the roads
- Social inclusion through community composting projects
- Convenience

Risks:

- Quantities of waste diverted may not reach expected levels due to low demand /participation rate remains low because of lack of knowledge
- Composting is considered by some to be smelly and unpleasant

- Potential for pests

In order for household composting schemes to be successful, the individual citizen needs to play an important role in the uptake of the scheme. The Dar City Council and DLAs should be responsible for awareness raising, making the scheme more accessible and assisting residents where necessary. Nevertheless, a significant change in behaviour from residents is necessary to achieve increased participation.

Authorities will need to adopt the promotion of household composting initiatives as a means of reducing the amount of household waste collected and disposed. Comprehensive education campaigns will be needed to create awareness among the population for household composting.

It is important that decision makers and households understand that every ton of organic waste processed at household level according to an estimation provided by DCC will save approximately USD 20 of solid waste management costs (collection, transportation, dumping fee, etc.).

3.3.2 Scaling up to decentralized composting

Tackling organic waste management through composting in megacities in low-income countries is a real challenge. In some cases, including Dar es Salaam, the approach of decentralized composting has been tested in the past. Decentralized composting usually refers to all kind of micro-scale solutions that can be performed in small areas, a little bit larger than household composting but still not considered as industrial composting plant. The typical size of a decentralized composting plant is about 0.5 -3 tonnes per day. Some investigations have been performed to find out how the key factors are affecting the overall viability of decentralized composting inside large urban areas. One result was that land price and compost sale price are the most relevant influences. Furthermore, in urban areas, typically the price of land is very high compared to people's income, so a "low revenue enterprise " such as a decentralized composting facility, even if it is useful for environmental reasons and needed for the city, will most probably turn out to be a failure.

The figure below refers to the case study of Dhaka in which both - a decentralized and a centralized approach - were tested. The chart highlights the fact that if land price is high, the compost produced in the decentralized micro-scale option should be sold at a much higher price than the one produced in a large scale facility to maintain the economic viability. On the contrary, if land price is low, the compost produced in micro-scale plants could be even delivered for free and the net management cost compared to the large scale facility would be lower in any case.

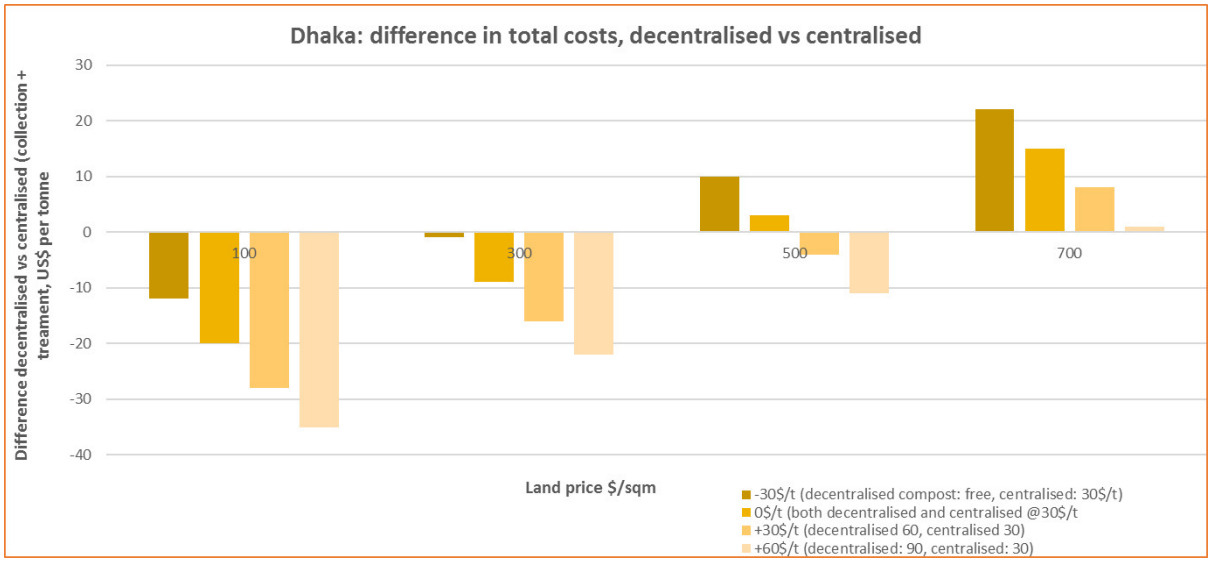

Figure 11. How land price and compost sale price affects the net operational cost of the decentralized micro scale composting solution vs. large-scale one. (Source: M. Giavini, ORBIT 2014)

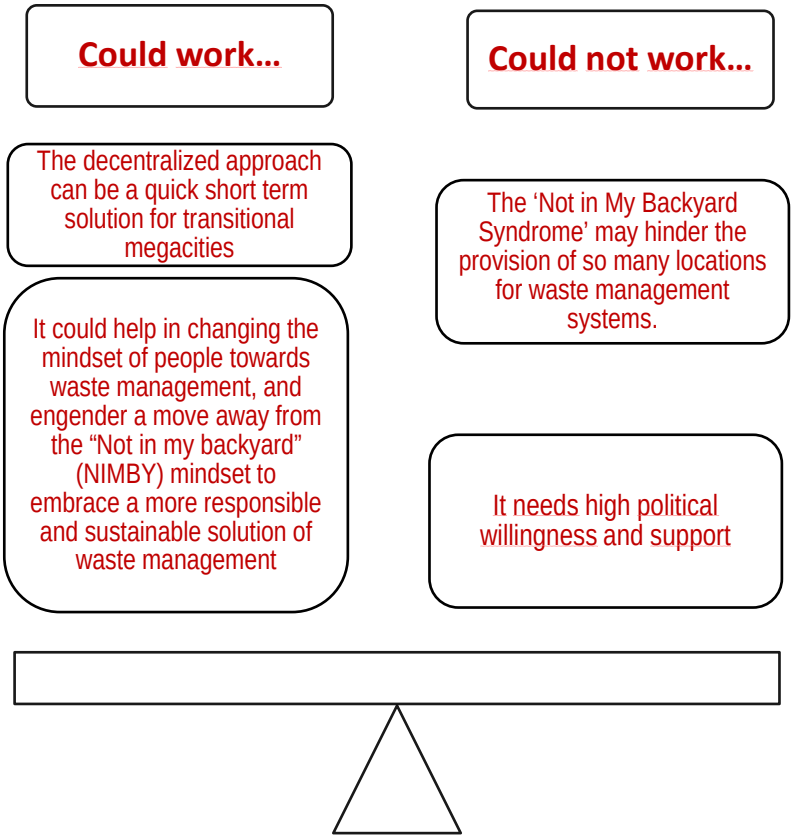

Figure 12. Pros and cons of the decentralized small scale composting approach in low-income urban areas (Source: M. Giavini, ORBIT 2014)

3.4 Marketing of compost and market development

A good marketing strategy for the sales of compost should be established in advance, where the needs of the users can influence the type and quality of the finished product. The market strategy has two important objectives:

1. To find a destination for the compost, so that nothing that is produced needs to be disposed of as waste.
2. To identify and receive commitments from a range of potential customers willing to purchase compost in the future and able to pay for compost.

Some markets require fine, high-quality compost, delivered in small quantities, and will pay well for a good quality product (e.g. bags of 5 kg compost that have a market selling to nurseries/urban horticulture). Other markets will always accept compost no matter what quality and quantity (e.g. compost utilization for erosion control). Both options have to be explored so that the manager of the composting facility never needs to dispose of any produced compost as waste.

Market development

Compost can be difficult to market, since in many places, it is not a recognised product (i.e. people are not familiar with its use) and has no established market value. As a result, part of the process of starting the production of compost is the development of its market. Market development includes several types of activities:

- Giving away compost -free of charge- to high-profile users or well-respected farmers and gardeners, whose experiences people will trust and whose opinion will have influence on their peers.
- Promoting or advertising the use of compost through environmental or recycling education campaigns.
- Using compost in municipal parks, to landscape national monuments or cemeteries and to green roads and public spaces, with clear indications to identify that a composting product is being applied in the specific case, instead of chemical fertilizer. Additionally, the origin of the compost can be indicated.
- Convincing high-prestige businesses, such as hotels and resorts, to use compost on lawns and gardens.
- If available, collaborating with an agricultural education institution to test the compost on specific end-users and then make this information available for similar end-users in the market.

Technical backup to market development will be a series of formally monitored compost yield trials. Positive results of these trials can help to convince the local agricultural sector, since they are the main clients for the final product (compost).

3.5 Case studies of composting

Two case studies are presented in this chapter: the successful case of composting in Dhaka, Bangladesh, and the example of producing terreau, an intermediate stage compost for the agricultural sector, in droughts struck Sikasso, Mali.

3.5.1 Case study: Composting organic waste of Dhaka

In Dhaka, Bangladesh, an integrated approach on composting has been implemented in 2002, led by the environmentally focused organization Waste Concern.

The first pilot project of Waste Concern involved four waste collection companies to collect organic waste from about 800 households, who were requested to separate organics from dry recyclables and residual waste. Waste Concern recruited their workers from the interested poor from the neighbourhoods of the plant. Employees received a minimum wage allocated by the government. A

small-scale composting plant with a capacity of three tons of solid waste per day was set up, with simple but effective technology (box composting, see Figure 13.).

It is important to highlight, however, that for this pilot project the land was provided for free by the municipality.

Figure 13. The box composting decentralized composting solution implemented in Dhaka (Source: Waste Concern)

In 2006, to scale up its model, Waste Concern, a Social Business Enterprise, partnered with the private Dutch company WWR to implement an ambitious initiative in Dhaka to build large-scale profit oriented composting plants. WWR Bio Fertilizer Ltd. Bangladesh, a joint venture of Waste Concern and WWR, developed the world's first carbon trading-based and large-scale composting project in Bangladesh, a low-income country. The project run under the Clean Development Mechanism (CDM) of the Kyoto Protocol and had a total cost of approximately 13 million USD. The project aimed to construct plants with a total capacity of 700 tons of organic waste per day and had other aims as well, such as the development of a landfill gas extraction and utilization of the extracted gas through three planned recycling plants. The first plant was located in Bulta, Roopganj, Narayanganj District of Dhaka, with compost recycling capacity of 130 tons per day (40,000 t/y). 32-39 tons of high quality compost was bagged and sold to farmers. Operations of this first facility saved ca. 15,600 metric tons CO2-equivalent in emissions in the 2008-2012 period and provided about 90 direct jobs.

Figure 14. The centralized composting solution implemented in Dhaka (Source: Waste Concern)

About 70% of the revenue of the compost recycling plant originates from the compost sold on the market, while the remaining 30% is provided by carbon trading.

Overall, the project was expected to result in about 1 million tons of GHG emission reduction over eight years, the production of 50,000 tons of good quality compost annually and the creation of 1,000 new jobs for the Bangladeshi poor. The project has other added benefits, such as formalising parts of the informal sector, creating provisions for women's employment, setting up child day care centres, providing workers' insurance and free meals, or a minimum wage received from the government. At the moment, the facility is running at 60% of its capacity, income from carbon credits has stopped and the only revenues come from the sales of compost. These circumstances make it difficult to sustain operations.

3.5.2 Case study: Producing "terreau" in Sikasso, Mali, from household and market waste

In Sikasso, a secondary town in Mali, **terreau**, a soil conditioner, is produced from organic waste collected from households and markets since 2014. Terreau is compost in an intermediate stage, without controlled maturation and elevation of the temperature. It is made of thoroughly sorted organic waste mixed with sand and paper. The organic waste fractions are carefully sorted not to contain potential sources of heavy metals, such as batteries, and other contaminations (i.e. plastics, metals)

The association in charge of this activity is called KENE FORCE and consists of 15 producers. There is at least one terreau producer per neighbourhood, especially active in the peri-urban areas. The associates work on available pieces of land or on illegal dumpsites, sorting and cleaning the waste before it is transported to the final landfill and using the organics to make terreau. With the placement of community containers in the city, production of terreau has moved to vicinity of the communities and takes place all year long except during the rainy season.

Terreau is used mainly on cereal crops (i.e. millet, sorghum, maize) and staple crops; as these crops are not consumed raw, the risk of contamination with pathogens is limited. There are more than 70 individual/company users, which adds up to about 350 m^3 of terreau per month. Users rely on this cheap source of organic material that enhances water retention of the soil.

Figure 15. The sieving of the terreau before sale

The terreau producers sell one m^3 at about 2,200 FCFA (3.66 USD) and that is why it is affordable in comparison to compost that is sold at 2,500 FCFA (4.16 USD) in a bag of 50 kg (approximately 130 litres). The farmers pick up the terreau with their own tractors or trailers at their expense. They are willing to travel 10 to 20 km to the production site.

Producing terreau is an ancient practice in Mali

This practice of producing terreau has always been in Mali (ancestral practice) and did not generate any negative impact until the composition of household waste changed, with the predominance of plastics and batteries.

In 2001-2004, a project team of a multidisciplinary project involving local researchers and NGOs, supported by the EU sampled and analyzed the sorted soil conditioners. The chemical and microbiological analysis carried out showed that most of the samples fell into the wide range of norms available (World Bank, EU). There was no indication that this practice of peri-urban farmers applying sorted urban solid waste to their fields was leading to the accumulation of dangerous levels of toxic heavy metals. Yet, the study highlighted that this issue deserved attention and could be addressed relatively easily, through proper sorting. With respect to pathogens, results indicated the relative lack of risk of microbial contamination (E. coli and salmonella in particular) for un-composted waste applied on agricultural field, given the extended period this material spends under the sun towards the end of the dry season and during the run-up to the rainy season. The study also indicated that, with respect to the desirability of recycling of urban organic waste in urban agriculture, the most significant risks appeared to come from water quality issues and not from the use of urban solid waste.

Use of terreau

Using fresh compost (terreau) is attractive because the nitrogen loss during stabilization period when producing compost is avoided. However, fresh compost may support regrowth of pathogenic bacteria, but since terreau is used for staple crops, which are not consumed raw, the risk is limited. Terreau must be mixed with top soil immediately after application to minimize vector attraction.

3.5.3 Lessons learned from composting case studies

Several lessons can be learned from the case studies from Bangladesh and Mali, the past BORDA projects, and from own research conducted by WASTE[20]:

Marketing

Selling compost is a challenge and many projects have failed due to the lack of a marketing opportunity for compost. BORDA's past composting projects also experienced difficulties in selling their compost. Waste Concern is able to sell its compost to the agriculture sector around Dhaka by using a private company specialized in marketing to the agro business. In Mali, the project detected that there is a market for cheap terreau, while fully matured compost has proved to be too expensive. The above observations show that the marketing component of future composting projects in Dar es Salaam needs to be taken very seriously and it is advised to develop a marketing plan in partnership with the agricultural sector.

Quality of compost and source separation

Depending on the target market, it is important to determine the quality of compost that will be produced. Input materials determine compost quality. In the case of Mali, a lower quality input material can be used to produce terreau, which is an intermediate quality product. However, Waste Concern has a demand for high quality compost, which requires higher quality input material – thus organic waste is expected to be separated at source as much as possible.

Economic feasibility

When the composting activity is outsourced to a private company, BORDA's projects show that the income from household waste collection and the sales from compost and recyclables is not enough to sustain the current business model of composting as an economic activity. More attention should be given to implementing composting as a viable business activity from the start, such as deciding the scale of the activity, ensure market for the product and tailor technology needs to other criteria of the composting activity.

Difficult to compete with chemical fertilizer

Compost has to compete with chemical fertilizers, which are subsidized in Tanzania. To make composting projects viable, incentives are needed in the form of free use of land, subsidies or lower taxes.

Clear guidance on PPP (Public Private Partnership) with roles and responsibilities

When involving the private sector in treating the municipal organic waste, it is of vital importance to define clearly their roles and responsibilities of the stakeholders. Businesses have a very different way of working than municipalities, are more result-oriented, think commercially, and act less bureaucratic. To avoid problems, a contract explaining activities, indicators and responsibilities is crucial.

[20] *Sustainable valorisation of organic urban wastes – Insights from African case studies, WASTE and WUR, March 2011*

3.6 Anaerobic digestion

Anaerobic digestion (AD) is a microbiological process whereby organic matter is decomposed in the absence of oxygen. From that process the generated products include biogas, which is rich in methane (about 60%), and digestate, a semi-solid fraction that can be used as a fertilizer or be further composted.

While large-scale anaerobic digestion (i.e. plants with an operational capacity of more than 50 tonnes per day) is a widespread technology in high-income countries and treats a wide range of organic materials, it is an investment intensive technology and its economic viability is in most cases related to the presence of national subsidies on renewable energy. Typical operational costs per tonne are in the range of 50-100 USD/ton.

In low-income countries, a different approach has been extensively used, which is small-scale anaerobic digestion aimed at generating gas for cooking.

Different biogas support programmes focus on rural families with a few cattle, where animal manure and human faeces can be used as feedstock, with the addition of small amounts of kitchen waste. The development drivers for introducing such systems, to provide people with biogas, is to reduce consumption of firewood and the respective deforestation, decrease indoor air pollution and improve soil fertility[21].

The three main types of digesters that have been implemented in developing countries are:

- the fixed-dome digester,
- the floating-drum digester, and
- the tubular digester.

All of them are wet digestion systems operated in continuous mode under mesophilic conditions (30-40°C). The basic features of this solution include the fact of being inexpensive, mostly built with locally available material, easy to handle, do not have many moving parts, hence they are less prone to failure.

Table 6, Figure 16, Figure 17, and Figure 18 show the three main types of AD technologies implemented in low and middle-income countries around the world. The table also summarizes specific advantages and disadvantages of the technologies.

[21] *EAWAG, Anerobic Digestion of Biowaste in Developing Countries*

Table 6. Advantages/disadvantages of anaerobic digestion systems for low-income countries (Source: Kossmann et al)

	Advantages	Disadvantages
Fixed dome	- Relative low construction costs - Long life span if well-constructed - Absence of moving parts or corroding metal parts - Underground construction saves space and protects the digester from temperature fluctuations - Local construction provides opportunities for skilled local employment	- Certain specific technical skills are required to ensure a gas-tight construction - Fluctuating gas pressure depending on volume of stored gas - Special sealant is required for the inside plastering of the gasholder - Gas leaks may occur when not constructed by experienced masons - Difficult to construct in bedrock - Difficult to repair once constructed as the - reactor is located under soil
Floating drum	- Simple and easy operation - The volume of stored gas is directly visible - Constant gas pressure - Relatively easy construction - Construction errors do not lead to major problems in operation and gas yield	- High material costs for steel drum - Susceptibility of steel parts to corrosion (because of this, floating-drum plants have a shorter life span than fixed-dome plants) - Regular maintenance costs for the painting of the drum (if made of steel) - If fibrous substrates are used, the gasholder shows a tendency to get “stuck” in the scum layer (if gasholder floats on slurry)
Tubular	- Low construction cost - Ease of transportation - Easy to construct - High digester temperatures in warm climates - Uncomplicated emptying and maintenance - Shallow installation depth suitable for use in areas with a high groundwater table or hard bedrock	- Relative short lifespan - Susceptibility to mechanical damage - Material usually not available locally - Low gas pressure requires extra weights - Scum cannot be removed from digester - Local craftsmen are rarely in a position to repair a damaged balloon

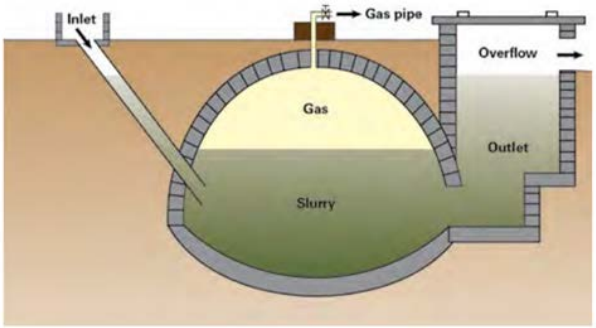

Figure 16. Fixed dome anaerobic digestion (Source: EAWAG)

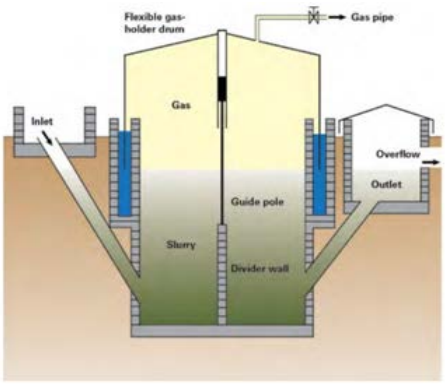

Figure 17. Floating drum anaerobic digestion (Source: EAWAG)

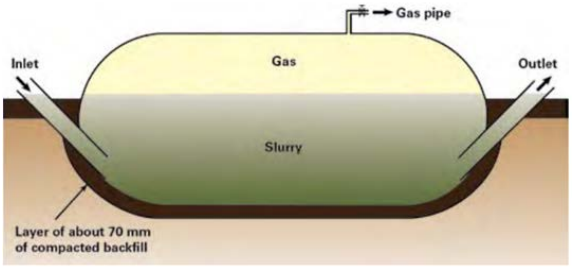

Figure 18. Tubular anaerobic digestion (Source: EAWAG)

These technologies have been widely implemented mostly in rural areas, while there were a few successful large-scale implementations in densely populated areas or in megacities. ISWA visited two resellers of floating drum AD technology in Dar es Salaam, SimGas (Figure 19. picture on the left) and ARTI Tanzania (Figure 19. picture on the right). By interviewing those resellers, it turned out that the viability of the implementation of this technology has been low also because of low willingness of people to perform a proper maintenance and operation of the equipment. Some trials have been performed also at ARDHI University of Dar es Salaam.

Figure 19. Two types of anaerobic digesters (Source: ISWA)

4. Strategy and Work Plan on organic waste collection and management in Dar es Salaam

4.1 Introduction

Based on the inputs from the analysis of the solid waste management system of Dar es Salaam, the baseline survey of BORDA and the lessons learned from other composting projects, the strategy on organic waste management has two pillars:

1. **Composting is a way of reducing the costs of the solid waste management system,** by reducing the amount of organic waste that has to be transported to the dumpsite and be disposed of. Additional reason can be to reduce the emissions of greenhouse gases and short-lived climate pollutants generated through open dumping and burning of waste.
2. **Composting is a way of producing a valuable product** that can be sold and set up as a feasible business with marketing being one of the main activities.

In Dar es Salaam, several pilots and projects have been undertaken in organic waste management but all without an integrated approach. Much of the information on the results were not publicly shared, thus projects were either not replicated or failed without learning from mistakes made. Lessons from future projects should be shared between DGAs, the private sector and other stakeholders to be able to learn from successes and mistakes.

The organic waste strategy should be integrated in a broader solid waste management strategy. Annex 2 shows the framework of the organic waste management embedded in an overall solid waste management strategy of Dar es Salaam. The issues related to organic waste are highlighted in green.

Considering cultural, socio-economic and technical factors given in Dar es Salaam, it was concluded that the following technologies are currently not suitable for large scale implementation:

Small scale anaerobic digestion did not prove to be a very viable option in Dar es Salaam, as the advantage of having one-two hours of "free" biogas for cooking is not deemed important or beneficial by the urban households. It is interesting in more rural areas of Tanzania, where the technology is spreading. Large-scale anaerobic digestion is economically not viable, since the operational cost without national subsidies on the biogas generated adds up to around 65-110 USD/ton, a cost much higher than any standard landfill gate fee in Africa.

Other bio-stabilisation technologies, such as Mechanical-Biological Treatment (MBT) are often used as a “transitional” solution with the main purpose of reducing the environmental impact of organic waste landfilled. Unfortunately, even the simplest technologies operate at a cost of around 30-50 USD/ton, significantly higher than the current dumping fee. Therefore, these installations need political support (e.g. banning landfilling of not stabilized organic waste fractions) in order to make them economically viable. The most advanced facilities, with even higher operational costs, can produce RDF (Refuse Derived Fuel), but the viability of this solution is highly dependent on the quality of the RDF produced and its economic value is uncertain, especially in Tanzania. Besides technologies for organic waste, **waste to energy** is not a viable solution for Dar es Salaam; where more than 50% of generated waste is of organic nature. The low calorific value of waste and the extremely high investment need do not make this solution attractive or feasible.

The guiding principle of this strategy is to address:

- The existing situation and lessons learned from previous projects (Where are we now? What is the status of composting in the city currently?)
- The preferred state (Vision: where do we want to go? How and where should composting evolve/extend in the future?)
- The strategy (How do we get there? What actions are needed to reach these goals?)

Table 7 describes the three target actions for organic waste management strategy as discussed in the strategy workshop in December 2016. It has a focus on household composting, community composting and centralized composting at a large scale.

Table 7. The organic waste management strategy focuses on three levels: households, school communities and centralized

Level	Purpose	End-user	Characteristics of compost
Household	Gardening (vegetables and flowers), environmental education	Households	Varying quality and quantity
Community (school/business)	Application of compost in erosion prone area, parks and other public areas, minimization of waste going to dumpsite, agriculture, cost reduction	Municipalities and specific crops in agriculture (in case of producing terreau/mulch: staple food that is not consumed raw)	Varying quality and quantity
Centralized large scale	Application of (enriched) compost in agriculture, cost reduction	Agricultural users of compost	High quality, stable supply

Discussions during the strategy workshop in December 2016 and lessons learned from BORDA's pilots with community composting in Dar es Salaam showed that it is very difficult to set up community composting in a financially sustainable way. Instead of having a focus on community composting, it is advised to support the centralized composting facility constructed in Kinondoni district by the City of Hamburg and additionally set up pilots to promote household composting.

Potential users of and markets for compost

A compost market analysis research from 2012[22] successfully identified a market for compost and showed that there is a high demand for compost from sport clubs, landscapers and pineapple farmers. There is a good potential for selling the compost, provided a good marketing strategy[23] can be developed and implemented. Key issues in this marketing strategy are a stable and reliable supply of certified compost to the end users. Competing products for compost include chicken droppings, cow dung and chemical fertilisers need to be considered.

[22] *Compost Market analysis Research Report – Strategies and current market for food waste based compost, BORDA and Sustainable cities, December 2012*

[23] *Marketing Compost - A Guide for Compost Producers in Low and Middle-Income Countries, EAWAG, 2008 https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/SWM/Market_Demand/marketing_compost_low.pdf*

4.2 Goal and vision

Based on inputs from the workshop executed in December 2016 (see workshop report in Annex 3), the main goal of the strategy on organic waste management is to

Compost 50% of the organic waste from fruit and vegetable markets and to compost 5% of organic waste in households with a garden. Additionally, use basic composting technology for the remaining market waste and use it as cover material for the Pugu dumpsite.

This fits into the overall vision as developed at the strategy workshop in December 2016:

1. **Promote business possibilities and reduce health risks by composting 50% of market organic waste to promote sustainable agriculture through educating market vendors and general public by 2020.**
2. **Promote household composting and vegetable growing by using compost.**
3. **Mitigate the CO_2 and methane emissions from the Pugu dumpsite, by using a basic composting technology (e.g. windrow composting) for organic waste coming from markets, and using the end-product as a daily or weekly cover material for the dumpsite operation.**

4.3 Strategy on organic waste management

The workshop executed in December 2016 (see Annex 3) directed the strategy to two levels: activities should firstly focus on **centralized composting of organic waste from fruit and vegetable markets** and secondly promote **household composting** in regions where households own a garden and (could) grow vegetables.

4.3.1 Centralized composting of the organic waste from fruit and vegetable markets.

Centralized composting can range from 10 tonnes per day to more than 500 tonnes per day. Since centralized composting is on a significantly larger scale, environmental, social and technical considerations should be approached in a more formal manner and address the following requirements[24]:

- Technical assessment of the area, soil, and geographic characteristics of potential sites
- Inclusion of engineering and design professionals in site selection and facility design
- Environmental assessment of the site (Environment and Social Impact Assessment)
- Formal evaluation and site selection processes that involve all relevant stakeholders
- Program to minimize and/or compensate for nuisance effects of traffic, odour, leachate, and noise produced by the composting operations
- Separate collection and/or pre-processing system to ensure that unwanted materials do not enter the composting system; special attention paid to the informal sector in pre-processing the waste and recovery of non-compostable materials
- Establishing of a marketing strategy for the compost
- Enforceable standards for the quality and composition of the compostable materials delivered to the facility
- Formal agreements made between all municipalities within the jurisdiction for siting, design, financing, operations, maintenance, environmental compliance, and billing for services and waste delivery
- Designated routes for the delivery of organic materials to the facility

[24] *Hoornweg, D., Composting and Its Applicability in Developing Countries, World Bank, 1999*

Hamburg composting site

A centralized composting facility will be established in the north of Dar es Salaam, supported by the City of Hamburg and the German Federal Ministry for Economic Cooperation and Development (BMZ). Organic waste from two of the larger vegetable and fruit markets (Tandale and Tegeta) situated in Kinondoni Municipality will be transported to the composting site.

The foreseen large-scale facility is currently designed to treat 50 tonnes of food waste from markets per day. The technology is based on aerated windrows and frequent turning. After a maturation period, the final product can be sieved and sold as compost.

The advantage of having a large quantity input material allows for a more homogeneous quality of the final compost; however, the plant operators will need to have some specific skills in order to avoid typical problems of aerated static piles, such as compaction, poor oxygen supply inside the heap, or stratification.

When the composting plant shows operational and financial sustainability, it can be replicated in other areas of Dar es Salaam. Agricultural markets can be developed by cooperation with the existing composting activities of the Guavay Company.

Pilot source separation providing organic waste to Hamburg composting site

The Hamburg composting plant will start composting the organic waste from vegetable and fruit markets, but in the future, it is planned that the facility would be able to accept segregated organic waste from households as well. When the plant is in full operation, a pilot could be started in one of the neighbourhoods to implement a source separation program.

In this case, in a selected area of Dar es Salaam, a pilot project for a separate household waste collection system will be designed and implemented, with the involvement of the informal recycling sector and the waste picker community. The objectives of such a system would be on the one hand to obtain higher quality organic input material for the Hamburg composting facility and on the other hand to improve the working conditions of the waste pickers by organizing them during such source separation programme. Separation must always be integrated in the existing municipal waste management system. Source separation has the following advantages:

- The amount of waste that needs to be disposed of at the landfill site is reduced considerably.
- Source separation supports clean, marketable recyclables and compostable organics by limiting the levels of contamination.
- Source separation encourages individual responsibility for the environment and taking ownership for everyone's own waste.
- Source separation improves the working conditions of waste workers because the materials they are working with are less contaminated.

The following guidelines can be followed when designing a pilot on source separation[25]:

Communication

- It is essential that people are aware of and understand the reasons behind separation at source and that they receive sufficient information about how to take action.

[25] *Sustainable source separation of domestic waste materials in Santa Cruz, Bolivia, Sophie van den Berg, 2005*

- Information about the logistics and quality requirements of the materials must be clear and simple.
- Background information must be given on the incentive during the pilot period (awareness raising).
- The activities need to focus on children through environmental education as they are the future adults and besides it is possible to reach out to the parents through them.
- Positive feedback about results achieved in the project can encourage more people to participate in the source separation project.
- The message needs to be repeated, preferably in various ways, to reach different audiences.

Incentives

- Incentives can be used to motivate people to participate in a source separation pilot programme, but it must be kept in mind that participation will go down when the incentive is removed. In order to use incentives effectively one has to know the motives of people participating in the programme. For example, in a pilot project in Bolivia, all participants handing over recyclable materials obtained a ticket for a lottery. With this ticket, they could win a price. This incentive was only used in the beginning of the project and participation went down after the start-up phase, when there was no lottery anymore.

Convenience of service

- The collection service must be very reliable.
- The degree of separation must be low (choose between 2-bag or 3-bag system).
- Collection systems are more convenient and generate better recyclables than drop off systems (people bring the recyclables to a container placed on strategic places in the city) but they are also are more expensive for the service provider.

Demographic and situational factors

- High-income neighbourhoods are more suitable to start a source separation project than low- and middle-income neighbourhoods, since their willingness to participate is higher and they can generate more valuable recyclables.

Figure 20: Example of source separation at household level

Example from Knysna Municipality, South Africa

Knysna Municipality uses a 3-bag system. One to collect general waste (maximum of one black bag per week), the second for recyclables (no limit for clear bags per week), and the third (blue) for garden waste. Waste is collected with a cage truck with trailer. All waste is collected from residential areas in one trip only.

Vision:
Knysna, where people and nature prosper.

Mission:
To provide affordable quality services, alleviate poverty, and facilitate social and economic development in the Greater Knysna municipal area through integrated development planning, skills development and the sustainable use of resources.

4.3.2 Master household composting – a train-the-trainer approach

The first proposed strategy to reduce the amount of organic waste in Dar es Salaam is the promotion of household composting through so-called master composting programmes. Household composting is a way to stimulate environmental education on household and community level and also supports the waste management system as the waste collector has more capacity to collect more waste from other households. Households that have gardens may be interested in composting their organic waste for their gardens.

The approach of a **master composter programme**[26] is to train selected motivated people in composting, who can in turn teach households in their neighbourhoods to practice household composting. This process is also referred to as 'training of trainers'. After successfully finalizing the master composting training, the trainee becomes a master composter. Those who receive the 'title' of master composter keep each other informed and updated on worst and best practices in the (household) composting process.

The objectives of a master household composting programme are:

- support families to begin with household composting
- help households who are already composting to improve the quality of their compost

[26] *No Place Like Home: Capacity development in master composting programmes, WASTE, 2010 http://www.ruaf.org/sites/default/files/UAM23%20pag35-38.pdf*

- raise awareness amongst the wider public on the benefits of composting and compost use
- encourage the creation of a community-wide composting strategy

Master household composting is an instrument to exchange knowledge and skills between experts in composting and the trainees, who will become experts in teaching the composting process after they are educated. This way, the master composting training reaches a relatively large group of people, while at the same time also building on sustainability – the knowledge is locally available, and the people who are practicing household composting have complete control and ownership of the process.

A master composting programme usually follows a process with this structure:

- "Trainees" are trained as master composters. The master composters are not required to pay for their training and will obtain a certain status in their neighbourhood as master composter, which motivates them to join the programme.
- The master composter promotes composting in the neighbourhood by telling others about the programme, especially potential households, the press and media, school and religious groups and government officials
- Households request composting assistance
- Each master composter has a relationship with 5-25 households
- The initial orientation for each household is about two hours
- The master composer visits the household periodically to check on the composting process
- The family can call the master composter whenever they feel that they need help
- In every district a demonstration and training facility is established

Households can use the compost in their own gardens to grow flowers or vegetables by adding it to the soil and spreading it around plants. A contest with a price for the most beautiful garden can motivate more people to start composting.

4.4 Stakeholders and division of roles

National government

The role of the national government is to develop national policies and guidelines, which can be implemented on municipal level. An important regulation is the increase of the gate fee for disposal of waste at the landfill site to cover the full costs of waste collection and transfer, and create incentives for recycling and composting. An updated by-law has been submitted to the National Government (Ministry) for final approval one year ago which would increase the gate fee of USD 0.79 per ton to USD 13.94 per ton. At the moment of writing this document it is still a proposal, the approval is pending[27].

Dar es Salaam City Council and DGAs/DLAs

The role of the Dar es Salaam City Council and the DLAs should be focused on **creating an enabling environment,** set city targets for composting, facilitate encouraging conditions for the private sector, and monitor and evaluate the activities and results related to collection and composting. Examples are that DLAs can provide a market for lower quality compost produced at schools for

[27] *Source: Personal communication with Alexander Fecher, CIM / Dar Es Salaam City Council*

landscaping and for usage in public parks. Moreover, they can support the Hamburg composting facility by providing land for the construction of the site, the necessary licences and facilitate a source separation project with households at a later stage. Furthermore, **Dar City Council** is managing overarching issues, i.e. the management of the dumpsite of Pugu Kinyamwezi.

As different levels are involved in the solid waste management system of Dar es Salaam, it is advised that a Metropolitan Waste Authority is established and be tasked with coordination, planning and overseeing implementation of solid waste management.

Private sector and CBOs

The private sector and the waste collecting service providers are responsible for providing a reliable collection of solid waste for the households. Tasks, responsibilities and the necessary indicators to monitor their activities are described in a contract between the DGA and the company/CBO.

The Informal private sector

Informal activities, in contrast with the formal sector in waste collecting and recycling, are often driven by poverty, and are initiated individually and spontaneously in the struggle for survival (although some enterprises, especially the ones engaged in recycling activities, manage to make considerable profits). Consequently, the choice of materials to collect is in the first place determined by the value of the waste materials, and in the second place, by their ease of extraction, handling, and transport. Paper, metals and plastics, usually collected from more wealthy residential or industrial areas, tend to attract more attention than organic or biodegradable materials, even though these materials are present in much smaller percentages than organic waste or manures.

Waste pickers can be seen as economic and highly skilled actors of the solid waste recycling system. Nevertheless, they usually struggle with social prejudice or political problems and therefore have a rather low social status in their communities. These, together with low self-image and experience of harassment, make integration a complex process. A guideline, published by Women in Informal Employment: Globalizing and Organizing (WIEGO) provides advice on how to facilitate sustainable involvement of this sector in formal, modernised waste management[28].

In Dar es Salaam, it is estimated that a total of 1,237 waste pickers are operational at both the fifteen identified informal collection points and the one city dumpsite at Pugu Kinyamwezi[29].

Knowledge institutions

Additionally, academic institutions, such as universities and research centers, should be involved in the realisation of the waste management baseline in Dar es Salaam and any market research to support the solid waste management framework. Agricultural institutions can start demonstration plots using compost and provide assistance with the certification of compost.

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[28] Informal Sector Integration and High Performance Recycling: Evidence from 20 Cities. Anne Sheinberg. Women in Informal Employment: Globalizing and Organizing (WIEGO). March 2012. Available: http://wiego.org/sites/wiego.org/files/publications/files/Scheinberg_WIEGO_WP23.pdf

[29] http://globalrec.org/2015/05/13/a-study-about-waste-pickers-in-dar-es-salaam-tanzania/


CREATING VALUE FROM WASTE...
Garbage
Chemical Fertiliser
djamb
THROWING AWAY YOUR WASTE...
...IS A WASTE OF YOUR MONEY...

Annex 1: Solid waste composition (baseline study BORDA) of Makuburi and Mabibo Wards of Dar es Salaam City

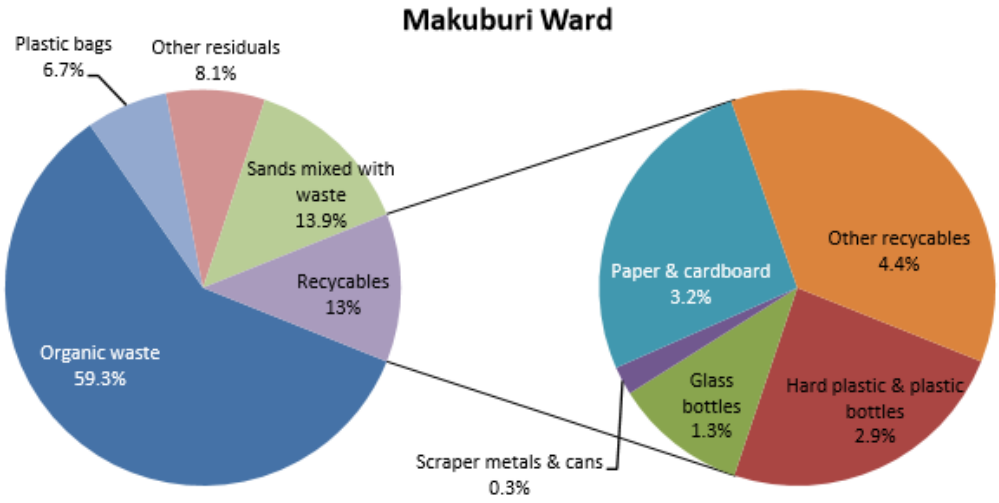
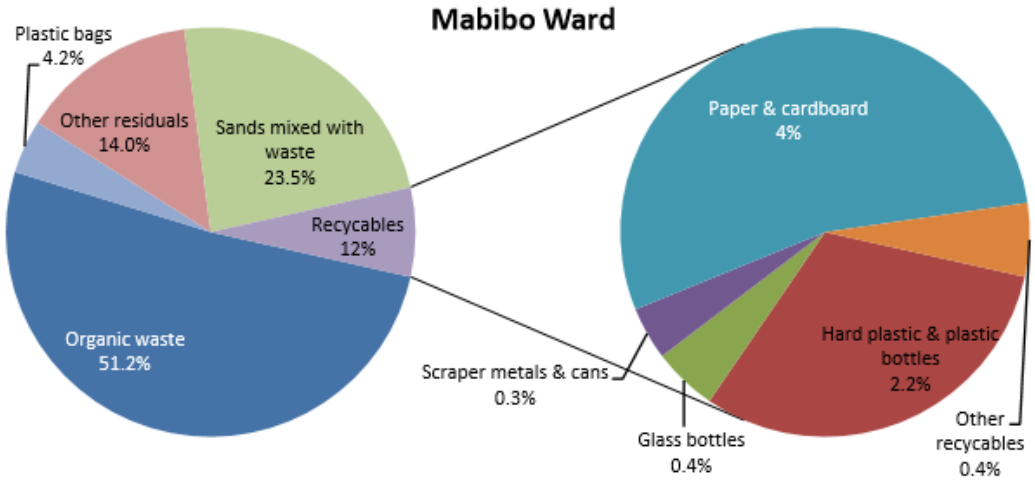


Figure 17: Average solid waste composition in Makuburi households



Annex 2: Summarized description of the present (organic) solid waste management situation in Dar es Salaam and recommendations for improvement

	ASPECTS[30]	DETAILS	RECOMMENDATIONS[31]
Generation/separation	Figures about waste generation and composition are determined by ISWA/BORDA	Organic waste accounts for more than half of the generated household waste.	Increase knowledge about waste generation and composition by regularly measure/sample waste composition data in different income areas of the city
	Lack of knowledge on waste issues and waste separation	Awareness is low	Develop Communication Strategy
	Waste separation at household level is generally not done	Willingness to separate their household waste is found at more than half of the households for environmental reasons (BORDA)	Develop pilot on household source separation to supply the Hamburg composting facility with high quality organic waste
Collection/Transport	Only 30-50% of generated waste is collected and especially in low-income areas with difficult access no service exists.	In wards with difficult access people burn, bury or illegally dump waste	Increase efficiency by improving door to door collection of service providers and improve secondary collection to landfill Support (household) composting and recycling
	Service of CBOs is not reliable	Households' confidence in collection system is low	Set up capacity development strategy for CBOs to improve business skills and increase professionalism Develop Communication Strategy
	Monitoring		Set clearly stated performance requirements and targets for SW collection

[30] *Based on city assessment and BORDAs baseline*

[31] *A.o. based on General report on the performance and specialized audits for the period ending 31st March 2015, Report of the controller and auditor general of Tanzania, March 2015*

	ASPECTS[30]	DETAILS	RECOMMENDATIONS[31]
			Improve the System for Monitoring Performance
Treatment of (organic) waste	Burning of waste	Common practice in the city	Improve door to door collection of waste Increase awareness about health hazards, such as black carbon
	Feeding of animals	Quite some people have animals and feed them with food leftovers and other organic waste. In Makuburi ward this accounts for about 15% of the population.	Support these practices
	Composting is not widely practiced, only some experiences exist	Composting will reduce costs of transportation and disposal of waste There is a high demand for compost from agriculture, landscapers and pineapple farmers[32] Compost competes with cow dung, chicken droppings and expensive fertilizer	Implement composting strategy including a vision on organic solid waste management: - Promote household composting in semi urban areas - Support school composting - Construction of Hamburg composting facility (high quality compost for agricultural use) sourcing organic waste from fruit and vegetable markets - Support Hamburg composting facility with a source separation pilot to collect high quality organic waste from households. Organic waste management strategy must be part of an overall solid waste management policy
	Monitoring and evaluation		Improve the System for Monitoring Performance
Disposal	Illegal disposal sites	There are several illegal disposal sites in the city	Improve waste collection system and increase the awareness of the population combined with enforcement Register, close, plan for and clean up the sites

[32] Compost Market Analysis Research Report, strategies and current market for food waste based compost, BORDA and Sustainable Cities, December 2012

	ASPECTS[30]	**DETAILS**	**RECOMMENDATIONS**[31]
	Pugu dumpsite	No environmental measures Waste pickers collect recyclables	Increase gate fee in order to cover full costs and create incentives for waste diversion. Enforce payment Upgrade dumpsite to a controlled dump, if possible compact waste and install liner. Apply measures for basic leachate management. Install sorting place for waste pickers at the dumpsite taking into account safety and health hazard measures, integrate waste pickers in the formal solid waste management system
Institutional	No division between service provision and monitoring		Separate the roles of service provision and monitoring, improve reporting and implement benchmarking Set clearly stated performance requirements and targets for SW collection, composting and recycling which can be monitored
	No division between fee collection and providing of service		The function of waste collection from those collecting the fee should be separated combining it with utility fees (inclusion of waste management fee into the water or electricity bill)
	National Environmental Act and local by-laws recently approved by DCC and by the 3 DLAs	The by-laws include the waste collection fees to be paid by citizens	Improve law enforcement
	Chemical fertilizers are subsidized	Farmers can buy cheap fertilizers. It is difficult for compost to compete with these cheap fertilizers	Composting businesses can receive incentives (free land, lower taxes, etc.) to be able to sustain themselves in the starting period
Financing	Willingness to pay a collection fee for a reliable waste collection service is high (source: BORDA)	The majority in Mabibo and Makuburi wards pay their collection fees to either formal or informal service providers (source: BORDA baseline survey)	Improvement of fee payment based on income of households accompanied by an awareness campaign and improvement of collection service The budget for a proper waste management is too low or is often offset to other municipal budget. Make sure that a specific budget line is allocated to waste management and that municipalities pay the adequate landfill gate fee in order to manage solid waste management system properly.

	ASPECTS[30]	**DETAILS**	**RECOMMENDATIONS**[31]
	Insufficient funds for waste collection		Increase amount of households paying their collection fees Improve efficiency of collection
Awareness	Awareness about waste issues, importance of paying for waste collection and waste separation is low	No separation at source takes place	Increase awareness by implementing a communication strategy including an awareness raising campaign, set up a complaint management system

Green colour indicates that these issues are of special importance in the organic waste management strategy

Annex III.

CCAC WORK PLAN FOR DAR ES SALAAM

Workshop on Organic Waste Management, 4-9 December 2016

ISWA's 3rd Activity under the CCAC MSWI City Projects framework for Dar es Salaam to organise a capacity building and interactive event for strategy preparation on organic waste management in Dar es Salaam.

April 2017

Workshop on Organic Waste Management – CCAC Work Plan for Dar es Salaam

Workshop on Organic Waste Management, 4-9 December 2016

Introduction and summary

The International Solid Waste Association (ISWA) is working with the city of Dar es Salaam, Tanzania under the city funding programme of the Climate and Clean Air Coalition (CCAC) Municipal Solid Waste Initiative (MSWI). The Phase 1 scoping missions started in December 2014 and was concluded with an Action Plan in April 2015, focusing on improving the status of solid waste management in the city of Dar es Salaam.
Following this period, ISWA received Phase 2 funding to assist the city to conduct Work Plans for various areas in solid waste management, based on the city's priorities previously outlined in the Action Plan. The Phase 2 period started in September 2015 with a kick-off meeting gathering the most relevant local stakeholders on the ground in order to allow for a better planning for the projects to be completed. Additionally, ISWA invited representatives of the National Environment Management Council (NEMC), to ensure support on the country level, and visited the local UNEP office to learn and discuss about opportunities to align the Work Plan activities with other on-going and potentially relevant projects in Dar. The Work Plan was prepared with the input of the Dar local authorities (the Dar City Council (DCC) and the Local Government Authorities (LGAs) of three Municipalities, Ilala, Kinondoni and Temeke), ISWA experts and other important stakeholders (such as BORDA, the Bremen Overseas Research and Development Association and Nipe Fagio, a local NGO).

After the kick-off meeting in September 2015 the continuation of the implementation period was deferred, due to local elections and changes on the national and city level. By the time ISWA's work could be resumed in August 2016, substantial changes have been made in the city's administrative divisions; two additional municipalities (Ubungo and Kigamboni) were in the process of being established in addition to the existing three (Kinondoni, Ilala and Temeke).

In August 2016, ISWA has conducted a 2.5-day capacity building event which focused on the Pugu Kinyamwezi dumpsite and potential actions to be done for its upgrade. Additionally, participants could learn about basic principles for the construction of sanitary landfills, many of which could be applied to Pugu during improvements. The workshop was attended by 19 stakeholders from all sectors, including the local authorities, academia, NGOs and private companies.

Another element of the Work Plan activities was to develop and discuss a potential strategy for organic waste management in Dar es Salaam. A strategy draft was developed and presented during a 1.5-day event on 7-8 December 2016. The workshop combined capacity building and active teamwork, trying to account for the inputs and comments of all stakeholders. This document describes the trip

conducted to Dar es Salaam including strategic meetings made during the visiting period. WASTE, a Dutch NGO who is also a member of ISWA, was commissioned to be the main author of the organic waste management strategy and the facilitator of the capacity building event.

MEETINGS & VISITS WITH LOCAL STAKEHOLDERS

December 5 - Monday

***10 am -1 pm* administrative arrangements**

Discussion of capacity event details and arrangements with hotel for flip chart and taxi.

***2 pm* meeting with BORDA**

Participants:

- Jutta Camargo, Regional Director, BORDA
- Joyce Zablon, Project Coordinator, BORDA
- Sophie van den Berg, Consultant, WASTE
- Kata Tisza, Technical Manager, ISWA

BORDA gave an account on the awareness raising campaign which was a part of the CCAC Work Plan project for Dar es Salaam (Activity 4.2.). There were many lessons learnt from the awareness raising, but the generic outcome was very positive, clearly indicating that households would be willing and financially capable to participate in the waste management system if they see improvements (such as a regular and reliable waste collection service. Please refer for details to the Awareness Raising Campaign project report, which is a deliverable of the CCAC Work Plan project for Dar es Salaam. BORDA is in discussion with the Embassy of the United States who would be likely willing to finance similar pilot projects in other sub-wards as well.

BORDA was requested to present the results of the baseline study and the awareness raising campaign during the workshop on the 7th December. Details of this presentation were touched upon during the discussion.

5 pm: Meeting with CEFA

Location: CEFA Office and Hostel, Old Bagamoyo Road

Participants:

- Dario De Nicola, CEFA Community Director
- Sophie van den Berg, WASTE
- Kata Tisza, ISWA

CEFA (http://www.cefaonlus.it/uk/who-are-we/who-we-are.asp) is an Italian NGO which has been operating in Tanzania for the past 40 years working on fighting hunger and poverty. CEFA and its cooperation partners run a high quality dairy business (AfricaMilkProject) and are also active in the African agriculture, intending to improve the life of the poorest rural populations. In Dar es Salaam one of CEFA's main focus is child sponsorships and improving street children's lives through involving them into arts and music. The group accepts various invitations and can develop a 'Forum Theatre' for practically any topic. The forum theatre is a very dynamic and powerful tool which originates from the theatre of the oppressed born in Brazil in the 70's. Such an event is focusing to

communicate one or multiple key messages during a play and allows the audience to intervene into the play highlighting community issues. The methodology allows the audience to work on solutions for a problem in a low-risk framework, which can be a protected environment to discuss sensitive issues (e.g. politics, or waste management).
After ISWA's first unofficial visit with CEFA in January 2015, ISWA recommended the organisation to other local stakeholders and the CEFA Forum Theatre group was requested to develop a play on solid waste management problems for a UN-Habitat sanitation project. This play was also showed to the ISWA delegation on Thursday, 8th December, in the expectation of having a series of plays before the final CCAC/ISWA Work Plan project conference.

December 6 - Tuesday

12 pm meeting with representatives of the Dar City Council
Participants:

- Ms Enezael Ayo, Dar City Council (DCC)
- Alexander Fecher, DCC
- Sophie van den Berg, WASTE
- Kata Tisza, ISWA

Ms Ayo welcomed the ISWA delegation and ensured DCC's support for the upcoming workshop. Kata Tisza provided information on the upcoming activity and on the CCAC Work Plan project in general. Details for Mr Fecher's presentation during the workshop and the opening keynote speech were discussed.

3 pm meeting with City Director
ISWA's first official in person meeting with the City Director after an unformal meeting at the WasteCon in Johannesburg on 17-21 September, where the City Director of Dar es Salaam was invited by a delegation of the Dutch Environmental Ministry.
Since the City Director has been appointed in late August, ISWA explained the CCAC City Work in Dar es Salaam since 2014.

CAPACITY BUILDING EVENT DETAILS

7 December – Wednesday

1st day of workshop on Organic Waste Management Strategy

Participants:

- Ms Aisa Oberlin, Dar es Salaam Institute of Technology
- Mr Alexander Fecher, Dar es Salaam City Council (CIM integrated expert)
- Mr Carlos Mdemu, Nipe Fagio
- Mr Christoph Scholz, Moshi Municipality (CIM integrated expert)
- Mr Danford Kamenya, Moshi Municipality
- Mr Deogratius Bernado, BORDA
- Ms Eliwaza Kitundu, BORDA
- Ms Kassim Salha Dr., Dar Institute of Technology
- Ms Kata Tisza, ISWA
- Ms Lena Drabig, Nipe Fagio
- Mr MKW A Hanje, Ilala Municipality
- Ms Flower Manase, Dar es Salaam University
- Ms Selestina Lwanga, Dar es Salaam University
- Ms Neema Majija, Ilala Municipality
- Mr Noah Bendera, Guavay Company Limited
- Mr Peter Abilu, Kinondoni Municipality
- Mr Richard Kishere, Dar es Salaam City Council
- Mr Said Marco, Guavay Company Limited
- Ms Sophie van den Berg, WASTE
- Mr Ulrich Juhudi, Embassy of the Kingdom of the Netherlands

The first day of the workshop was opened by Mr Alexander Fecher, as the designated representative of the City of Dar es Salaam. He expressed the significance of the training event, due to the high organic waste content in the generated municipal solid waste. The organic waste should be diverted and managed properly to avoid organic fractions going to the dumpsite and also to mitigate climate change. There have been multiple organic waste management activities in the city over the past few years, most of them were setting up of decentralized and small scale composting solutions. Now the City of Hamburg is planning to construct a large-scale composting plant in Kinondoni Municipality. A proper waste

management is not only beneficial for human health and environment, it also indicates good governance of the respective city.

BORDA presented the components of their awareness raising programme which involved extensive work with a selected number of households in two sub-wards of Kinondoni Municipality. The baseline study assessing in total 11 sub-wards in Kinondoni found that several households (with a mixed income portfolio) do not separate waste, however there is a willingness to do it mainly driven by financial or environmental reasons. A high ratio of households were not aware of the affiliation of their service providers – many thought that the informal pickers were employees of their respective wards. Some of the areas have very bad level of public service provision (provided by the Municipalities) which can be as bad as waste collection once per month. Based on these results BORDA conducted a one year long awareness raising campaign in two selected sub-wards in Kinondoni, improving the waste collection services and focusing on teaching school kids and civil society on environmental and waste issues.

Recommendations were provided to LGAs on how to support SWM improvements, such as:

- Support service providers with contracts to officially employ them
- Awareness creation and sensitization of communities so that they would want to contribute more actively to waste management system
- LGAs need to reduce driving distance to Pugu, with setting up transfer stations, etc.

The details of BORDA's on-the-ground projects can be found in the workshop presentations attached to this report and are part of the deliverables for the CCAC Dar es Salaam Work Plan project.

Alexander Fecher reported on the status of the composting plant construction by the City of Hamburg. The partnership between Hamburg and Dar es Salaam was established in 2007 by signing a joint declaration and identifying 14 areas of cooperation for SWM management & Climate Change Mitigation and Adaptation. The composting plant project was identified in 2013 and in 2014 Hamburg applied for co-funding. The implementation started in April 2015, however due to contracting and permission issues both the land allocation and the construction were delayed. Due to the social and environmental impact assessment the project is still pending and Hamburg hopes to start the construction phase by May 2017. Market development for the compost is still needed and Hamburg will likely cooperate with BORDA to create market for its product. Moreover, Hamburg is trying to establish cooperation with the Tanzanian fertilizer company. If this project succeeds, Dar es Salaam will be the second city to have large scale composting plant in the developing world, next to Dhaka.

Representatives of the Guavay Company Limited composting enterprise showing their site at Gongo la Mboto

Sophie van den Berg presented about lessons learnt by cases in Dhaka and Mali. Details of this presentations can be found in the attached presentations and the Organic Waste Management Strategy which is a deliverable of the CCAC Work Plan project for Dar es Salaam.

In the afternoon the workshop attendees visited the Gongo la Mboto composting site, which was initially setup by BORDA and operated as a small scale composting site. The operations included the organising of service providers to collect waste from households, separate organics and recyclables at the Gongo la Mboto site and transfer the residuals to Pugu dumpsite. However, due to the low efficiency of the plant and the low level of cooperation by the municipality the leftover waste was left at the site and BORDA eventually handed the project back to the municipality. Currently, the site is operated by a small enterprise, Guavay Company Limited, which organization uses the place for composting of organic waste from hotels and markets. Waste is still being collected from the community but Gongo la Mboto is not used as a transfer point to separate recyclables anymore. Representatives of the Guavay Company Limited gave a presentation and also introduced the workshop team to their site.

Workshop participants at the Gongo la Mboto composting site

8 December – Thursday

2nd day of workshop on Organic Waste Management Strategy

On the second day of the workshop Sophie van den Berg introduced the concept of Integrated Sustainable Waste Management (ISWM) to the participants and presented the draft Organic Waste Management Strategy. During the vision and action plan development sessions participants formed breakout groups and provided valuable input to the strategy. The comments and suggestions of these breakout groups are incorporated into the Organic Waste Management Strategy document, which is a deliverable of the CCAC Work Plan project for Dar es Salaam.

CEFA Theatre Forum Team

5 pm presentation of the CEFA Theatre Forum on their SWM related street play.
An excerpt of this play in Swahili is available among the deliverables for the CCAC Work Plan project.

7 pm meeting with First Secretary Economic Policy of the Embassy of the Kingdom of the Netherlands

Sophie van den Berg and Kata Tisza were invited to a meeting with Mr Eugene Gies, the First Secretary Economic Policy of the Kingdom of the Netherlands. Discussions touched upon the CCAC Work Plan projects, ISWA's and WASTE's activities in Africa and specifically focused on the solid waste management related work in Dar es Salaam and the past and planned future efforts of the Dutch Delegation. Mr Gies is actively supporting the Dutch initiative which intends to work with all local authorities in Dar so as to set up a Metropolitan Waste Management Authority, invest grant funding in the current SWM system and eventually find and cooperate with larger donors to set up a full scale Integrated Sustainable Solid Waste Management system in the city. The 'Tanzania Report Expert Mission 251116', an assessment of SWM situation in Dar conducted by the Dutch Delegation (consisting of representatives of the Ministry of Environment of the Kingdom of the Netherlands) can be found in the ISWA Knowledge Base.

9 December - Friday

Public holiday in Tanzania. Departure of the ISWA experts from Dar es Salaam.

Agenda for the CCAC/ISWA Workshop on
Organic waste management in Dar es Salaam

Day 1 - 7th December 2016 – Introduction & Site visit		
Time	**Topic**	**Facilitator**
8:30 - 9:00	Registration	
9:00 - 9:20	Welcoming keynote	Sipora Jonathan Liana, City Directress Dar es Salaam
9:20 - 9:30	Welcoming notes - ISWA	Kata Tisza, ISWA
09:30 – 09:40	Introduction to CCAC – Climate & Clean Air Coalition	Kata Tisza, ISWA
09:40 - 10:00	Introduction WASTE Netherlands Introduction of the 2-day workshop program	Sophie van den Berg, WASTE
10:00 - 10:30	Personal Presentation of Participants, Objectives of the workshop, Expectations of Participants, Setting Ground Rules	Sophie van den Berg, WASTE
10:30 - 10:45	Coffee Break	
10:45 - 12:00	BORDA on baseline study and awareness raising	BORDA and Nipe Fagio
12:00 - 12:30	Hamburg Composting Facility in Dar - update and discussion	Alexander Fecher / Dr. Florian Koelsch
12:30 - 13:00	Lessons learnt from composting projects in other countries	Sophie van den Berg, WASTE
13:00 - 14:00	Lunch	
14:00 - 14:45	Presentation about small scale composting	Noah Bendera, Guavay Company Limited
14:45 - 17:00	Field visit to Gongolamboto Composting Start Up	
17:00	Day Closure	

Day 2 - 8th December 2016 – Towards an Organic Waste Management Strategy for Dar es Salaam		
Time	**Topic**	**Facilitator**
8:30-9:00	Registration	
9:00 – 9:30	Summary of Day 1 (including discussion of site visit) and Introduction of Day 2	Sophie van den Berg, WASTE
9:30-10:45	Introduction to Integrated Solid Waste Management and reflection on baseline (city profile)	Sophie van den Berg, WASTE
10:45 – 11:00	Break	
11:00 - 12:30	Vision and action plan development as part of the organic waste strategy (group work)	Sophie van den Berg, WASTE
12:30 -13:00	Summary of group discussions	Sophie van den Berg, WASTE
13:00 – 14:00	Lunch	
14:00 - 14:30	Evaluation of workshop with questionnaire, and handing over of certificates to participants	Sophie van den Berg, WASTE, Kata Tisza, ISWA
14:30	Closure of the day	