MODEL FRAMEWORK FOR SEGREGATION

Guidelines for managing municipal solid waste through segregation, reuse and recycling in Zanzibar

Centre for Science and Environment

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1. Need for segregation model in Zanzibar

Municipal solid waste (MSW) continues to be a severe problem in Zanzibar due to poor management. From collection of waste to its disposal, the semi-autonomous island in Tanzania, East Africa is struggling to implement an affordable and sustainable model of management. This is majorly because of the tourism sector. The island has limited resources and it has become a challenge to cope with a high influx (about 0.5 – 0.6 million every year) of tourists. Currently, there is in-sufficient data for the entire area of Zanzibar (Unguja and Pemba) to estimate the amount of waste generated, but the waste generation is increasing. The only available data for the solid waste management is for the Zanzibar Urban Municipal Council (ZUMC), which generates 260 tonnes of solid waste every day (2006 estimate).

As per ZUMC, eighty six percent of the waste is organic in nature, where as the balance 14 percent comprises of plastic, metals, textile, cardboard, glass, sanitary and inert waste. The municipal council takes care of solid waste management in four operational areas namely- stone town, west, north and south town. The informal groups majorly manage waste collection in Zanzibar, which comprises majorly of women.

It is well understood that segregation at source lies at the heart of good waste management. Segregation improves collection and processing efficiency. Better segregation mechanisms also ensure livelihood and skill upgradation for the communities engaged in waste handling and collection by building local entrepreneurs and ensuring women empowerment. Also, utilization of segregated streams for processing, cuts down on the numerous health risks that are otherwise caused due to handling, dumping or burning of garbage. But ensuring segregation at source requires better infrastructure and strict compliance systems. Municipalities will need to put in place processes ensuring segregated waste is transported and processed properly. They will also have to come out with bye-laws that support segregation.

Centre for Science and Environment (CSE) has been working in cities in India and Global South to document, promote and implement source-segregation model of waste management. We have understood that cities need to develop models which are primarily based on maximum waste recycling and reuse and are least dependent on landfills. Also, such models can be instrumental in livelihood and skill upgradation of the local people, especially women. Such model project aims to build capacity of women on waste collection, recycling and to enable them to generate revenues through economic initiatives. This *Model Framework for Segregation* has been developed based on our work and learnings in Zanzibar to implement a solid waste management model based on segregation at source, which has been instrumental in empowering women from the local community.

GENDER ISSUES IN SOLID WASTE MANAGEMENT IN ZANZIBAR

As per a 2012 report by United Nations Population Fund (UNFPA), 54 per cent of women employed as waste pickers, street vendors and home-based workers were the main breadwinners for their households in Africa. About 79.7 per cent of people are employed in the informal sector in Zanzibar, as per data furnished by the International Labour Organization (ILO), 2010 — 86.6 per cent are women and 73.3 per cent men work in informal sector. A large number of women in informal sector in Zanzibar are engaged in jobs directly or indirectly related to solid waste. These workers come from a low-income background and make a living by collecting mixed waste, sorting and selling recyclable waste to the dealer.

The gender analysis of solid waste management show that women in this sector face greater constraints than men. First, women might not be allowed access to recyclables with the highest values, therefore they usually earn less than men. Second, women are not encouraged to be the entrepreneur and run waste management business. Lastly, it is important to recognize that both women and men are exposed to several health risks while working with waste materials. The health of these workers is also highly compromised upon due to crude ways of dealing with mixed waste (generally with bare hands) that makes them expose to several vector borne diseases and other health and sanitation related risks.

The effectiveness of waste management model can only be improved through the incorporation of an understanding of gender differences and inequalities. What is needed is a good waste management model that recognizes and incorporates gender issues, empowers them and reduces the burden on health and diseases. The model project implemented by CSE-ZEMA-ZUMC in Zanzibar is gender sensitive and is addressing gender related issues.

The model framework highlights the importance of a three-way segregation system with cent per cent collection and transportation of segregated waste. The model encourages the adoption of decentralised waste management—composting of wet waste, recycling of dry waste, co-processing of non-recyclable waste with high calorific value and ensuring that only 5–10 per cent of the residual inert waste is sent to engineered landfills. What we wish to achieve through this model is to work towards making solid waste management financially self-sufficient and sustainable in Zanzibar.

The segregation model

The model is based on the following principles:

1. 100 per cent segregation of waste at household level into dry, wet and domestic hazardous waste.
2. 100 per cent segregation of waste by commercial entities.
3. One-time distribution of a pair of bags and bin to households to incentivize segregation.
4. Redesigning of waste collection vehicles to collect and transport segregated waste.
5. Provision of litter bins and containers at commercial and other public places.
6. Daily collection of segregated dry, wet and sanitary waste such as diapers and sanitary napkins by waste collectors. Weekly collection of domestic hazardous waste from households such as discarded paint drums, pesticide cans, CFL

bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles and syringes and contaminated gauge.

7. Disposal of bio-medical and hazardous waste through authorized entities.
8. Decentralized processing of wet and dry waste.
9. Channelization of dry waste, after sorting, to waste dealer or authorized recycler.
10. Ownership of dry waste to be vested in waste collectors. Money earned from selling dry waste to be distributed to waste collectors.
11. Composting of wet waste. Money earned from compost to be used by municipal council or informal co-operative members.
12. User fees for collection, transportation and processing of waste. Penalty for littering and non-segregation of waste at source.
13. Implementation of Plastic Waste Management under section 118 (m) of the Environmental Management for Sustainable Development Act No. 2 of 1996, the Plastic Bags Banning Regulations of 2011. Under the regulation, a person shall not manufacture, import, store, sell, transport, supply, possess or use any plastic bags in Zanzibar and if found to commit any of such offence shall be liable to give fine of two hundred Tanzanian Shilling (Tsh) upto seven million Tsh or imprisonment of up to two years. No person can use any plastic bags and if found of offence shall be liable to give fine of thirty thousand Tsh to upto 100,000 Tsh or imprisonment of up to six months. Any manufacturing plant that is seized under this rule can be confiscated and destroyed.
14. A three-year propagation cycle to institutionalize segregation at source and implement the model.
15. Revision and enactment of municipal bye-laws which focus on segregation, recycle and reuse to implement the above model.

The major advantages of this model are:

1. Reduced dependence on land for disposal of waste. The space required for the landfills is reduced by 90 per cent.
2. Reduced cost of collection and transportation. Up to 40–50 per cent of municipal funds allocated for solid waste management are spent on salary of staff and contractual workers, 20–40 per cent on collection and transportation, and only 5 per cent on disposal. By adopting this model, the cost of collection and transportation will be reduced by at least 50 per cent, as waste will be treated much closer to the source.
3. Additional resources will be generated from composting and recycling, as more than 90 per cent of waste can be recycled and reused. This means an additional income for a large set of people (such as waste collectors and recyclers) in the chain.
4. The environmental costs incurred due to pollution of land, water and air from unsanitary landfills will also be reduced drastically.
5. The model focuses on livelihood and skill upgradation, also, promotes women empowerment.

The above model is highly cost-effective and environmentally sustainable. It creates a large number of well-paying jobs. Informal waste collectors are brought into the net and provided with decent earnings and dignity. The operation and maintenance cost of the system is more or less paid for by user charges and sale of gas and compost. This is a unique model of solid waste management—frugal and generating wealth from waste.

2. Implementing Segregation

In order to develop decentralized waste management systems for Zanzibar, a systematic approach is necessary. Figure 1 summarises the step-by-step approach for making a decentralised waste management plan, which is broadly divided into three phases— pre-implementation phase, implementation phase and monitoring and evaluation phase. Each phase consists of the following steps:

2.1 Baseline Study

A baseline study involves inventorization and gathering relevant background data. This information shall help in preparation of an effective solid waste management plan.

The following information is required:

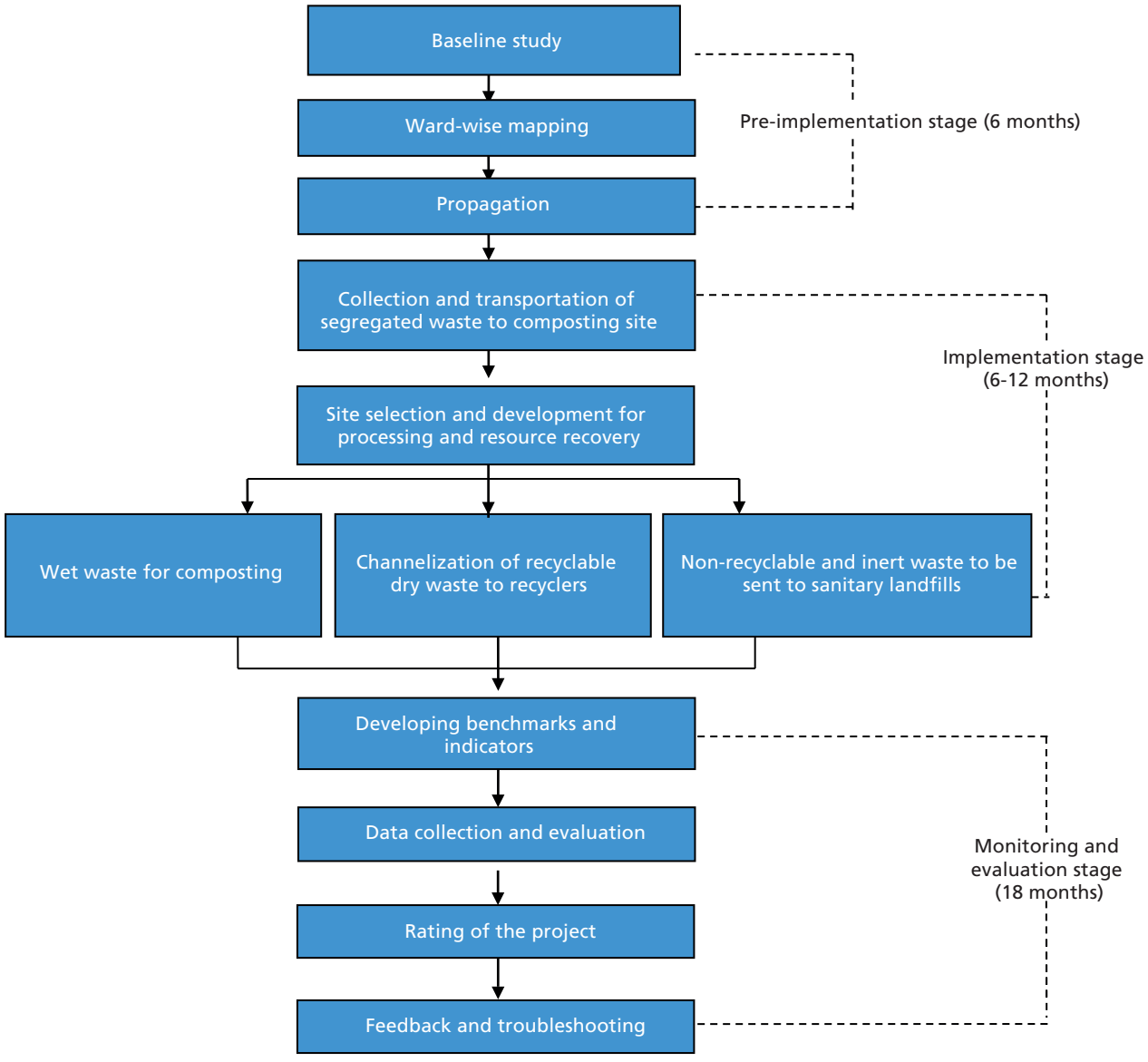
a) What is the population of each municipal council?
b) How is it planned – households (HHs), shehia or ward wise or zone wise?
c) How many households (HHs), commercial establishments, schools, institutions (government and private), industrial areas etc. are there in each municipal council?
d) How much municipal solid waste (MSW) does the municipal council generates—overall and per capita?
e) What is the composition of the generated MSW? How much percentage is wet, recyclable, domestic hazardous waste and inert wastes?
f) What are the existing processing and disposal mechanisms for MSW? If any.
g) Does each municipal council have byelaws on solid waste management? If yes, what is the implementation status of the byelaws?
h) What is the existing municipal capacity for solid waste management?
   - Manpower
   - Infrastructure
   - Availability of funds
i) Is there scope of any partnerships that can be worked out with corporates, donors, NGOs for resource provision and handholding?

2.2 House mapping

For the execution of a waste management plan, mapping of households or wards is imperative. Mapping is done based on the following parameters:

i) Number of households in the pilot area
ii) Number of waste collectors in the pilot area
iii) Number of collection vehicles (tipper, pushcart, tricycle) present in the pilot area
iv) Routes of each collection vehicle moving within the ward with details of number of households covered per tipper, pushcart/tricycle.

Figure 1: Steps for adoption of a decentralized waste management plan



Source: CSE, 2018

v) Number of scrap vendors present in the pilot area.
vi) Availability of space for treatment such as composting
vii) Number of litter spots in pilot area

2.3 Propagation

The following resources are required for effective propagation of waste management plan:

Table 1: Resource requirement for propagation

Resources required for propagation	Role and responsibility
Informal workers or Municipal waste collector or volunteers	• Hiring and training of waste collectors for sensitizing households • As a thumb rule, for 200 households, 8 volunteers or waste collectors are required during the implementation phase for a period of one year.
Stickers for marking households	• Households that have received the bin/bags and have committed for segregation need to be marked to keep a track on the percentage of segregation. Also, after a span of 3 months, to monitor for segregation in HHs, stickers with the following color coding to be put up: - Green: For HHs that have segregation levels 80 per cent and above - Yellow: For HHs that have segregation levels between 50-79 per cent and need further improvement - Red: For HHs that have segregation levels below 50 per cent and need assistance from local co-operatives/volunteers/municipal workers to improvise. Refer Annexure 1 for sample copy of sticker used for mapping of households in Shaurimoyo
IEC material	• Pamphlets can be utilized to create awareness on segregation of waste and its importance amongst citizens. See Annexure 2 for document on IEC material
Bins / Bags	• A standardised bin (10 litres capacity) and two bags to be given to households, to aid them in the process of segregation. • Households to compulsorily segregate waste into wet (biodegradable waste such as cooked food waste, fruit and vegetable peels) and dry (paper, plastic, metal, glass, etc.) and shall put the segregated waste into bin and blue bag respectively. • The domestic hazardous waste like discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles and syringes and contaminated gauge, etc., generated at the household levels shall be stored separately in red bag. Sanitary waste can be wrapped properly with paper and handed over to collector.
Record books	The record book shall have the following details: • Daily enter details of the quantity of segregated dry waste brought to the local scrap dealer by the waste collector on a daily basis • Amount of incentive obtained per collector • Amount of recyclable waste sent for recycling by the waste dealer on a weekly/monthly basis • Amount of non-recyclable waste stored on a monthly basis • Amount of wet waste transported to processing facility on a daily basis. • Amount of compost generated on a monthly basis.

Source: CSE, 2018

The steps involved in propagation are as follows:

2.3.1 Launch of door to door propagation in each ward

i) Municipal council to conduct inaugural programme to launch door-to-door propagation in each ward or shehia with participation of ward councilor.

ii) Municipal council in association with NGOs/informal groups/volunteers to conduct awareness programmes and motivation amongst residents to participate in making their ward clean.

iii) Use of local media (newspaper, local news channel, local cable) to spread further awareness about the programme.

2.3.2 Door to door propagation through municipal councils/ informal workers/volunteers

i) Municipal council along with informal workers/volunteers to distribute bin and bags to each household, along with a pamphlet explaining how to segregate at source.
ii) Municipal council along with informal workers/volunteers to fill up the household record keeping form for each household (*Refer Annexure 3*).
iii) A sticker to be put on the entrance of every house as a mark that the household has received bins and has committed to segregate.

2.3.3 Training of waste collectors for collection of segregated waste from households

i) Waste collectors to be trained by municipal council to collect and transport segregated waste in collection vehicles (push carts).
ii) Collectors to be given personal protective equipment (PPE) such as gloves, appropriate tools for ensuring their safety while handling municipal solid waste.
iii) Incentives given to collector for collection of segregated waste by allowing them additional income from selling the segregated dry waste to the nearest dealer.

2.3.4 Regular follow up

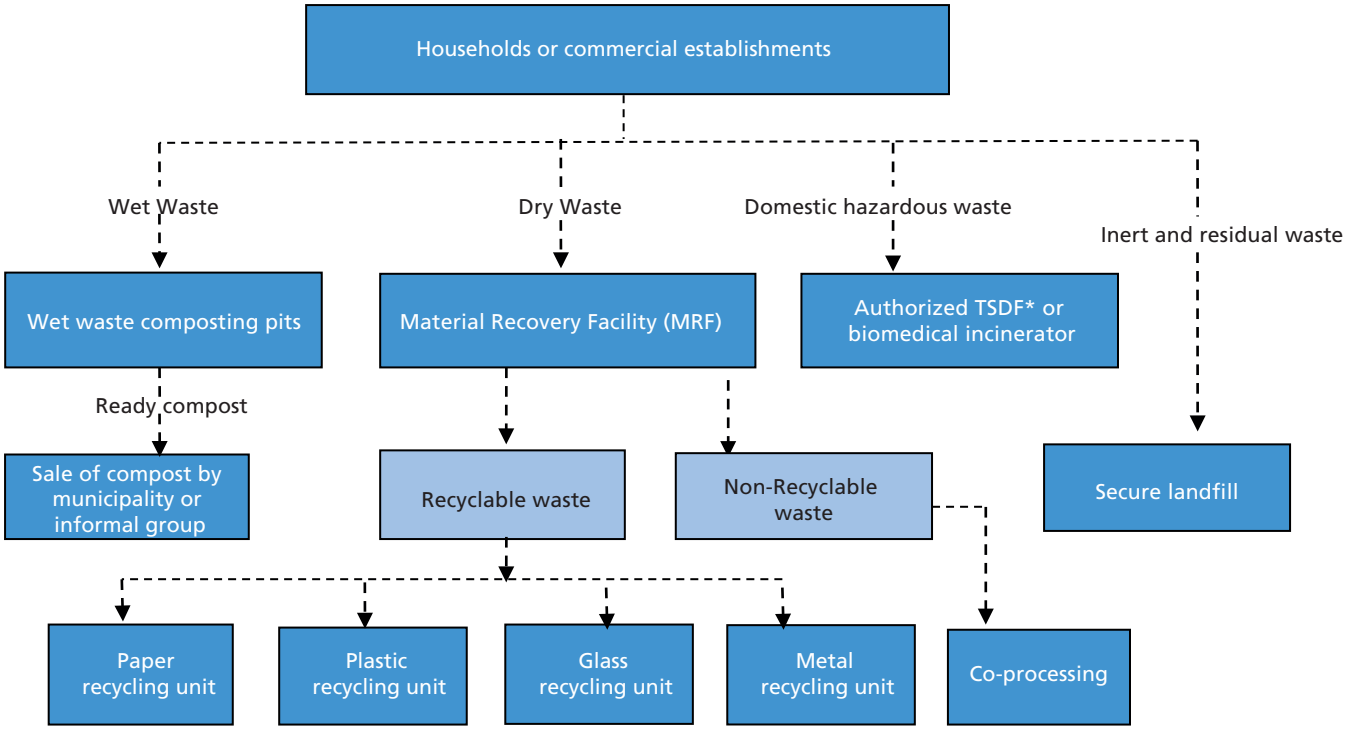
i) Once door-to-door collection of segregated waste begins, municipal council/ informal workers/volunteers to keep regular track on the percentage of segregation in each ward. This can be further monitored by having a color coded sticker mechanism mentioned in *Table 1*.
ii) The waste collectors to assist households incase they face any issues or challenges with segregation.

2.4 Collection and transportation of segregated waste

Municipal council needs to ensure provision of appropriate infrastructure to support collection of segregated waste from households. The waste collector can collect door-to-door segregated waste from households, in which a vehicle can come to a designated place for collection of segregated waste from households. The segregated waste shall then be transported to the local material recovery facility (MRF) facility or processing facility where wet waste can be further processed and dry waste shall be segregated and channelised for recycling. *Figure 2 depicts the methodology for collection and transportation of segregated waste from households.*

In case of Zanzibar, where wet waste percentage is above 80 percent, composting is the most preferred option, as there is a direct market for compost in agricultural farms (agriculture being the main occupation). In case of dry waste, the waste collectors shall handover the dry waste to the local dealer and will be incentivized for the same. For instance, in Shaurimoyo, Zanzibar, the local waste dealer takes dry waste such as PET bottles @300 Tsh/kg from the waste collector. However, the rates may vary from area to area. The non-

Figure 2: Collection and transportation of segregated waste



*TSDF: Treatment, storage and disposal facilities

Source: CSE, 2018

recyclable waste such as low value plastic (LVP), multilayered plastic (MLP) are stored in a designated area and handed over to municipal council.

2.5 Site selection and development of processing facility

Municipal councils need to select sites for building compost pits or setting up MRFs. The sites need to be built closer to the source to ensure decentralised transportation and processing. Also, the sites need to have a covered shed.

Benchmarks for an MRF: An area of approximately 350 – 400 square feet will be required for 1000 -- 1500 households each.

Benchmarks for composting area:

Shaurimoyo is an urban ward in Zanzibar, where the demonstration composting model is developed. 200 households were mapped and assuming each household generates one kg waste per day, with wet waste percentage being 86 per cent:

a) Wet waste generated for 200 HHs per day = 200 x 1 x 0.86 = 172 kg
b) Assuming the wet waste density of around 250 kg per m^3

Volume of waste generated per day for 200 HHs = 172 kg / 250 kg per m^3 = 0.69 m^3.

A compost pit with dimensions 3 feet x 5 feet x 5 feet has a volume of ~ 2.1 m^3 (0.69/2.1 = 0.33)

This wet waste quickly loses moisture and reduces to about one-third of its original volume.

c) It takes two months for waste to turn into compost, so the waste in the first pit will become compost in 60 days, after which the pit can be emptied and readied to receive more waste.

Therefore, enough pits for a 60-day cycle need to be constructed. Since three fourths of a pit fills up in approximately one day, but the volume reduces to one-third in two-three days, number of pits required = One-third of volume of wet waste x 60 = 1/3 x .33 x 60 = 7 pits approximately.

d) Area required for one pit = 3 feet x 5 feet = 15 square feet
e) Area required for 7 composting pits for one ward = 15 square feet x 7 = 105 square feet. Thus, for 200 HHs, an area of 105 square feet is required for composting wet waste. *See Annexure 4 for details on the composting process.*

Create market linkages for compost:

The compost should be tested as per the guidelines/directions of the concerned department in Zanzibar. The compost can be marketed by the municipal council and sold to farmers and residents. Further, the Ministry of Agriculture, Natural Resources, Livestock and Fisheries can promote the compost.

2.6 Developing benchmarks and indicators

Develop indicators for measuring progress of the solid waste management work. As example, following indicators can be designed to determine the progress of the initiative.

i) Operational indicators

- Percentage of segregation (%)
- Efficiency of collection (%)
- Availability of infrastructure to support segregation
- Production of compost/biogas
- Level of engagement by local residents

ii) Environmental indicators

- Cleanliness in wards
- Diversion of waste from landfills to processing centre
- Improvement in health and sanitation status

iii) Financial indicators

- Time period in which the model shall become self-sustainable
- Incentives to waste collectors
- Profits made by selling compost
- Efficiency of user fee collection (User fee will be charged based on municipal council bye-laws)

iv) Social indicators

- Behaviour change
- Has the project generated jobs
- Upliftment and livelihood support for informal sector

2.7 Data collection and evaluation

Based on the above-mentioned indicators, data has to be collected and a report card has to be generated with the following information as given in *Table 2: Evaluation of performance.*

2.8 Rating of the project

After completion of the implementation stage, the municipal council needs to collect data and rate the project as per the report card. This data can be collected on a quarterly or a half yearly basis to rate the project. Based on the points allotted, if the score is between 55 to 80 points, then the project is successful. If the score is between 30 to 55 points, then project is partially successful, and if the score is less than 30 points, then the area needs to rework on the implementation work and improve upon the relevant parameters.

2.9 Feedback and troubleshooting

A regular feedback and grievance redressal mechanism needs to be created by the municipal council. A subjective feedback through filling of forms can be collected from stakeholders — citizens, sanitation workers, private partners, etc. Also, a monthly/quarterly review mechanism to be created by Zanzibar Environmental Management Authority (ZEMA) to review the progress of the work.

Table 2: Evaluation of performance

Operational Performance		Environmental Performance		Financial self sufficiency		Social Performance	
Segregation efficiency	**Points**	**Dumpsites and litter spots removed**	**Points**	**Financial self-sufficiency+**	**Points**	**New jobs created**	**Points**
> 95 per cent	5	100%	5	In 3 year	5	More than 100	5
80 - 99%	4	80 - 99%	4	In 3 - 5 year	4	50-99 %	3
60 - 79%	3	60 - 79%	3	> 5 years	1	Less than 50	1
40 - 59%	2	40 - 59%	2				
< 40%	1	< 40%	1				
Collection efficiency	**Points**	**Wet waste treatment**	**Points**	**Compost selling price (per kg)***	**Points**	**Income increment for waste collectors ****	**Points**
100 per cent	5	> 90 per cent	5	More than 1500 Tsh	5	More than 20 per cent	5
80 – 99 per cent	4	80 – 90 per cent	4	1000 to 1500 Tsh	3	10-20 per cent	3
60 – 79 per cent	3	60 – 79 per cent	3	Less than 1000 Tsh	1	Less than 10 per cent	1
40 – 59 per cent	2	40 – 59 per cent	2				
< 40 per cent	1	< 40 per cent	1				
Transportation efficiency	**Points**	**Dry waste recycling**	**Points**	**User fee collection**	**Points**	**Reduction in littering *****	**Points**
100 per cent	5	> 90 per cent	5	> 95 per cent	5	Completely eliminated	5
80 – 99 per cent	4	80 – 90 per cent	4	80 - 95%	4	Significantly reduced	4
60 – 79 per cent	3	60 – 79 per cent	3	60 - 79%	3	Average reduction	3
40 – 59 per cent	2	40 – 59 per cent	2	40 - 59%	2	No change	0
< 40 per cent	1	< 40 per cent	1	< 40%	1		
		Perception of residents on cleanliness***	**Points**	**Reduction in fines for littering or not segregating**	**Points**	**Source composting or biomethanization**	**Points**
		Excellent	5	100%	5	>33 per cent	5
		Very good	4	80 - 99%	4	20-33 per cent	3
		Good	3	60 - 79%	3	10-19 per cent	2
		Average	2	40 - 59%	2	5-9 per cent	1
		Poor	1	< 40%	1		
				Reduction in expenses in drain unclogging	**Points**	**Reduction in waste burning*****	**Points**
				50 per cent	5	Completely eliminated	5
				25-49 per cent	3	Significantly reduced	4
				10-24 per cent	1	Average reduction	3
						No change	0

+ Time in which break even is achieved; *Compost price will vary from place to place; **Collector is incentivized by selling collected dry waste to dealers or recyclers; ***Scores will be calculated on the basis of response gathered by survey of residents using weightage method

Source: Model Framework For Segregation, CSE, 2017

3. Cost benefit analysis

This cost–benefit analysis is based on CSE's ground-level experience in supporting the implementation of zero landfill solid waste management system in Shaurimoyo, Zanzibar under the initiative 'Waste Segregation for Clean Zanzibar'. The cost-benefit analysis is given for 200 HHs of 1000 - 1500 population and a timeframe of three years for setting up and fully operationalizing the 'segregation model' of waste management.

(A) Capital cost:

(i) Provision of one bin and two bags per households

To begin with, and in order to encourage segregation, a bin and two bags should be distributed to households. However, other commercial entities like shops, hotels, hospitals, petrol pumps, banks, public and private offices, institutions etc., will have to organize bins on their own.

Unit cost
- Approximate cost of a bin: 15,000 Tsh or 6.5 USD
- Approximate cost of a bag: 900 Tsh or 0.39 USD

Total cost
- Household bins (200 in number): 3,000,000 Tsh or 1320USD
- Cost of bags (400 in number): 360,000 Tsh or 158 USD

Total: Approximately 3,360,000 Tsh or 1478 USD

(ii) Construction of composting pits, fencing and platform

For 200 HHs, 6 to 7 composting pits are required for processing wet waste.
- Cost of setting up one pit with shed: 1,283,889 Tsh or 562 USD
- Total cost of construction of six pits with shed: 7,707,903 Tsh or 3374 USD
- Cost of fencing the processing area: 700,000 Tsh or 306 USD
- Cost of platform for storing waste and compost: 1822900 Tsh or 798 USD

Total approximate cost for construction of composting pits, fencing and platform: 4478 USD

Total capital cost (one time) = (i) + (ii) = 1478 + 4478 USD = 5956 USD approximately.

(B) Propagation and management support cost:

For setting-up the system and infrastructure for door-to-door propagation and to handhold the municipal council in implementation, a management and support team is required. The following costs shall be incurred for the same:

(i) Requirement of management staff

- One permanent staff shall be required on the field to monitor the progress of work and is paid by the municipal council, with a monthly salary of 550000 Tsh (242 USD) per month.

Annual management support cost: Approximately 6,600,000 Tsh or 2904 USD

Management support cost for 3 years: 19,722,727 Tsh or 8678 USD

(ii) Propagation cost and requirement of waste collectors

For 200 households, 8 waste collectors are required for door to door propagation.

- Allowance for waste collectors: 80000 Tsh/month (35 USD approximately)
- Cost of 8 collector per month: 640000 Tsh/month (282 USD approximately)
- Annual cost of 8 waste collectors = 7679545 Tsh or 3379 USD
- **Cost for 3 years for 8 waste collectors = 23,040,000 Tsh or 10,137 USD**

(iii) IEC material for propagation

For propagation and information, education and communication (IEC) material like pamphlets, stickers and its printing are required. The approximate cost of these is about: 303400 Tsh or 102 USD for a year.

Total propagation cost for 3 years: 910, 200 Tsh (400 USD)

Total propagation and management support cost = (i) + (ii) + (iii) = 43,672,927 Tsh or 19250 USD.

(C) Total approximate cost of implementation of project for three years= A+B = 5956+ 19250 = 25206 USD

(D) Revenue

In the model running at Shaurimoyo, the waste collector shall keep the money from sale of compost and dry waste. However in different municipal councils this may vary.

(i) Userfee

Ideally, the municipal council should collect user fees from every household and commercial entity. The user charges should be a part of the bye-laws of the local municipal council. The following user charges are currently applicable in ZUMC:

- From households: 3000 Tsh/HHs/month
- From commercial establishments/shops: 6500 Tsh/commercial establishment/month

However, in Shaurimoyo pilot, the municipal council has exempted the user fee to incentivize the HHs in pilot area.

(ii) Compost

- Assuming that one household generates 1 kg of wet waste per day, hence wet waste generated per month per household = 1*30 = 30 kg/hh/month
- Assuming that compost shrinks to 25% of the amount of wet waste, hence compost generated per HH per month = 25 percent of 30 kg = 7.5 kg/hh/month
- Compost generated for 200 HHs: 7.5 * 200= 1500kg/month or 1.5 tonnes/month

Assuming compost sells at 1000 Tsh/kg, hence, revenue from compost generated for 200 HH = 1000 * 1500kg/month of compost *12 = 18 million Tsh appoximately for 1 year (7920 USD approximately)

Total annual revenue (Compost) = 18 million Tsh / year or 7920 USD approximately.

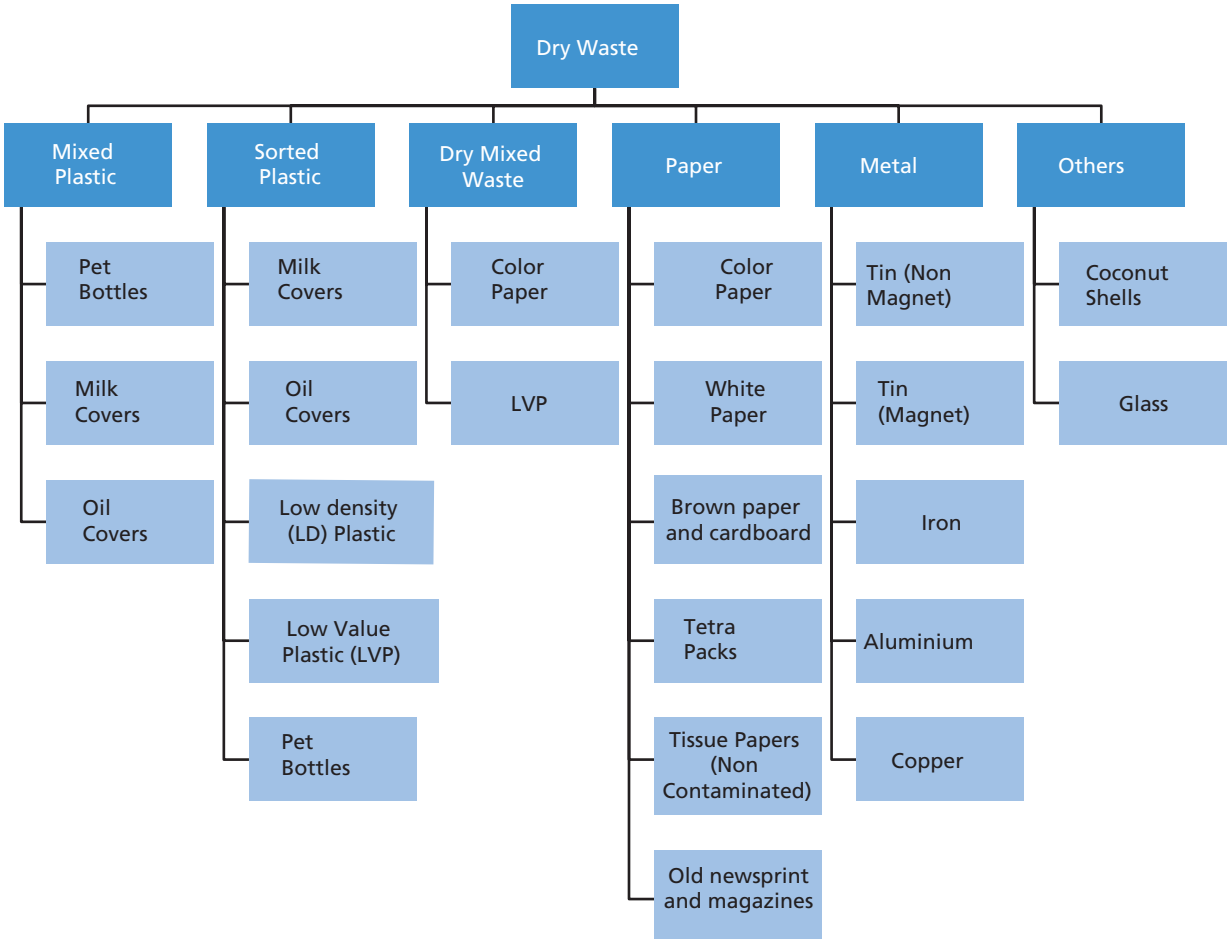
Hence, once capital, propagation and management support costs are paid, the model is financially self sufficient.

4. Dry Waste Management

The fundamental challenge of dry waste management is to get as much out of the waste as possible. Recycling should be given preference because it not only ensures resource recovery and re-utilization, conserving precious natural resources, but also saves energy and water.

Dry waste comprises of non biodegradable components such as paper, plastic, metal, glass and others. Majority of dry waste is recyclable and the resource can be recovered from it. Dry waste has wide plethora of categories in which it is further segregated at various collection points for effective recycling. Different categories of recyclable dry waste need to be handed over to the appropriate authorized recycler or local dealer (*see figure 3: Informal categorization of dry waste*). Alternative treatment processes must only be utilized when recycling is not feasible.

Figure 3: Informal categorization of dry waste



Source: CSE, 2018

Table 3: Categories of plastic

Type	Category	Examples	Recyclable?
Thermo-plastics	PS (Polystyrene)	Foam hot drink cups, plastic cutlery, containers, and yogurt	Partially
	PP (Polypropylene)	Lunch boxes, take-out food containers, ice cream containers	Partially
	LDPE (Low-density polyethylene)	Garbage bins and bags	Partially
	PVC (Plasticised Polyvinyl chloride or polyvinyl chloride)	Juice or squeeze bottles	Yes
	HDPE (High-density polyethylene)	Shampoo containers or milk bottles	Yes
	PET (Polyethylene terephthalate)	Fruit juice and soft drink bottles.	Yes
Thermoset and others	Multi layer and laminated plastics, PUF, bakelite, polycarbonate, melamine, nylon etc.	Car parts, mattresses, circuit boards and electrical insulators	No

Source: CSE, 2018

As per ZUMC, currently, Zanzibar doesn't have any recycling centre. All glasses and PET bottles are being sold to the dealer in Dar es Salaam. For instance, in Shaurimoyo, the waste collectors get about 18400 Tsh per month from sale of dry waste. Close to 28 kg plastic (PET bottle) and 2 kg glass is collected per week. Plastic (PET bottles) is sold to the dealer @ 150 Tsh /kg while glass is sold @200 Tsh /kg.

While glass and metal are readily recycled, plastic waste poses a significant challenge in recycling because of its low density and value. There are many types of plastic (see *Table 3: Categories of plastic*). Sorting of the different types is a crucial but labour-intensive exercise, which increases the difficulties of recycling the material.

Currently, only polyethylene terephthalate (PET), high-density polyethylene (HDPE) and polyvinyl chloride (PVC) are being recycled with some efficiency in India. Polystyrene (PS), polypropylene (PP), and low-density polyethylene (LDPE) are hardly being recycled because these plastic materials get stuck in the sorting equipment in recycling facilities causing them to break or stop working. Lids and bottle tops cannot be recycled as well. This problem with recycling becomes even more prominent in case of multi-layered packaging and low-value plastics (LVPs).

5.1 Low-value plastics and multi-layered packaging

Some of the most common household packaging materials—including potato chip packets, biscuit and chocolate wrappers, and toothpaste tubes often comprise of multi-layered packaging that aren't typically recycled and generally find their way to landfills or illegal dumpsites. LVPs comprise of mostly thin-layered plastic such as carry bags for vegetables. It is very difficult to recycle both these types of plastics for various reasons.

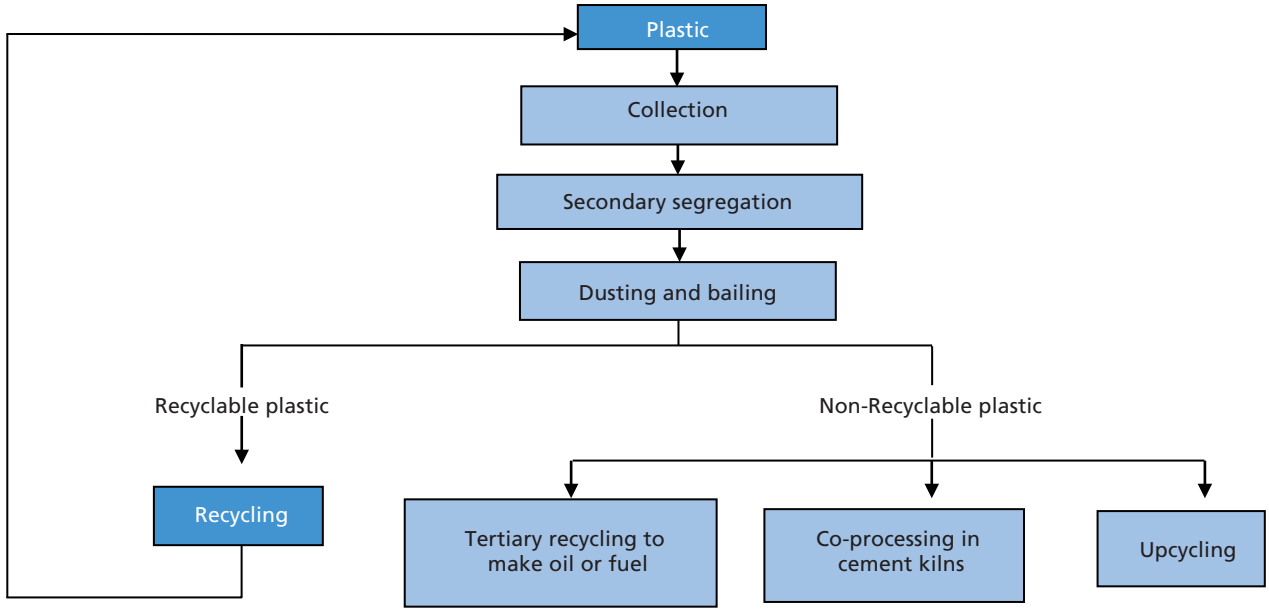
- LVPs are plastics with thickness of less than 50 microns, so the density of LVP waste is very low. Hence, it is not economically feasible to transport LVP waste and recycle it.
- For multi-layered packaging, it is extremely difficult to separate the different layers. For instance, the typical snack chip bag is made up of seven layers

of foil and plastic, making it impossible or extremely costly to separate the layers.

- Since a lot of multi-layered packaging is used for food products, another hurdle for recycling is food contamination.

Several alternative methods have been developed for recycling these types of plastic wastes. *Figure 4: Plastic waste collection and treatment shows various methods of plastic waste treatment.*

Figure 4: Plastic waste collection and treatment



Source: CSE, 2018

Table 4: Tertiary recycling technologies

Process	Method	End product	Advantage
Pyrolysis	• Processing of plastic waste by thermal/catalytic depolymerization at moderate temperatures and in the absence of oxygen	Usable oil	Pyrolysis is quite different from incineration (an aerobic process). It has low emissions and greenhouse gas footprint and yields useful downstream chemical products. No dioxins are produced during pyrolysis.
Gasification	• Partial combustion at elevated temperatures • Has also proven successful for treating mixed plastic waste	Gaseous fuel (syngas) appropriate for electricity generation or conversion to a liquid fuel.	Using the syngas (synthesis gas H2/CO) is potentially more efficient than direct combustion of the original fuel because it can be combusted at higher temperatures or even in fuel cells.

Source: Adapted from Recycling of Laminated Packaging, Waste Resources and Management Programme, UK

4.1.1 Tertiary recycling into a chemical or fuel

It is the most preferred method for recycling of LVPs and multi-layered packaging. Pyrolysis and gasification are two key technologies currently used for tertiary recycling of multi-layered packaging waste.

4.1.2 Co-processing of plastic in cement kilns

Many countries practice this method of combustion as an environmentally-sound option for managing plastic wastes. In cement kiln, different kinds of hazardous and non-hazardous wastes, including plastic waste, get utilized as alternative fuel and raw materials (AFRs). During the usage of plastic wastes in cement kiln as AFRs, the material and energy value present in them gets fully utilized, saving fossil fuels as well.

4.1.3 Other uses

LVPs and multi-layered plastic can be re-utilized and recycled to even make furniture such as chairs and table, or handicraft items such as bags and home décor items. Some countries in Africa are also using plastic to make bricks to construct houses, reaping the twin benefits of re-utilization of plastic waste as well as affordable housing

5. Case study Shaurimoyo pilot area, Zanzibar

Background

On 27 January 2017, a Memorandum of Understanding (MoU) was signed between Centre for Science and Environment (CSE) and ZEMA for facilitating better solid waste management practices and policy in the autonomous island. As part of the MoU, a pilot project on waste management was launched on 6 September 2017 in Shaurimoyo, Zanzibar (3 kms away from Stonetown), a low-income area in Zanzibar. This initiative is helping transform Zanzibar into a zero landfill island by adopting a segregation incentive model which is frugal and wealth generating.

Stakeholders involved

CSE is working together with ZEMA, Department of Environment (DoE) and local municipal councils of Zanzibar to push for waste management systems by implementation of pilot and adoption of policy at national and local level.

Process

Under the pilot initiative, 200 households out of 626 in Shaurimoyo were mapped by an informal society, the Shaurimoyo Waste Management Society (SWMS), with the help of CSE and ZUMC in July 2017. The households segregate waste into wet, dry and domestic hazardous waste and place it in a bin and blue and red bags respectively.

Awareness and propagation for waste segregation

Under the pilot initiative, eight workers chosen by ZUMC from the SWMS members are responsible for door-to-door propagation amongst households, educating them on the importance of segregation. ZUMC pays a monthly salary of 80,000 Tanzanian Shilling (Tsh) (about US $35) to each society worker who is supporting this pilot.

With an initial infrastructural support from CSE, three aerobic composting pits were constructed in Santana playground (earlier a dumpsite), Shaurimoyo on September 2017, each with a capacity of 80 -100 kg. Also, one bin and two bags were distributed to these households during the launch of the pilot. Two hundred houses in the area have received bins and bags for segregation of waste and these are marked with a sticker to keep a track on the progress of segregation. The households also received pamphlets explaining the progress of segregation. Further, ZEMA is planning to set up 3 more pits in the adjacent area. The pilot is being replicated in Mpendae area in Zanzibar where wet waste from 150 HHs will be treated via composting.

Mapping of households in Shaurimoyo area

Composting pit in Shaurimoyo area

Composting pit in Mpendae area

Waste collection, transportation and processing

One tipper and wheelbarrows provided by ZUMC are used for collection of waste. The collection is generally over by 12pm and the workers then transfer the waste to the tipper which has two drums placed on it for taking the wet and dry waste. The tipper takes the segregated waste to the model composting site around 2 kilometers away. Currently, the segregation percentage is over 85-90 per cent.

About 45 -60 kg of wet waste is collected daily and sent to the model composting facility near the households. Dry waste is further segregated into PET, glass, paper and is stored in bags and given to a waste dealer. About 120 kg of dry waste is collected per month. The domestic hazardous waste is handed over to the municipality and goes to Kibele landfill. In order to incentivise households to segregate at source, the municipality has exempted user fees from the 200 households where the pilot is operational.

Major outcomes

i) **Livelihood and empowerment to local community (especially women):** The pilot project has not only brought employment opportunity to the informal society but has also empowered the women workers who are majorly involved in propagation, collection and processing. The informal society is

Collection of segregated waste by Shaurimoyo waste society collectors

incentivized for their work by selling compost as well as from the sale of dry waste.

ii) **Incentives:** The first batch of compost was produced in December 2017 and till date about 500 kgs of compost has been sold @1000 Tsh/kg. To earn additional revenue, the society workers with the help of ZUMC have also started growing vegetables at the pilot site and have earned approximately 200,000 Tsh (US $ 88) from sale of vegetables. Also, PET bottles and glass are sold to waste dealers @ 150 Tsh /kg (US $ 0.066) and 200 Tsh /kg (US $ 0.088) respectively.

iv) **Rejuvenation of dumpsite:** The pilot site was earlier a dumpsite and residents often complained of stench and littering. The pilot project has converted the dumpsite into a processing facility and a learning centre where people come and learn about the model and also buy compost.

v) **Replication of pilot in different areas of Zanzibar:** *In April, 2018, construction of composting pits was done in Mpendae area in Zanzibar.* The 2 pits constructed by ZUMC shall cater to 150 households.

Future plans

CSE shall work with ZEMA and DoE to ensure adoption of policy on waste management and shall work with local municipal council on preparation of municipal byelaws to ensure segregation, recycle and reuse is adopted across the island.

Manually grinding compost and the final compost product

Vegetables plantation

Compost packet for sale

Site visit by different municipal councils officials in Zanzibar

Councilor of Shaurimoyo addressing the press

Annexures

Annexure 1: Stickers for mapping of households

Annexure 2: IEC material for propagation

Source: CSE, 2018

Annexure 3: Ward Mapping Sheet

S.No.	Name of Householder	House address	Contact number	Signature

Source: CSE, 2018

Annexure 4: Details of the composting process

i. Construction of composting pits

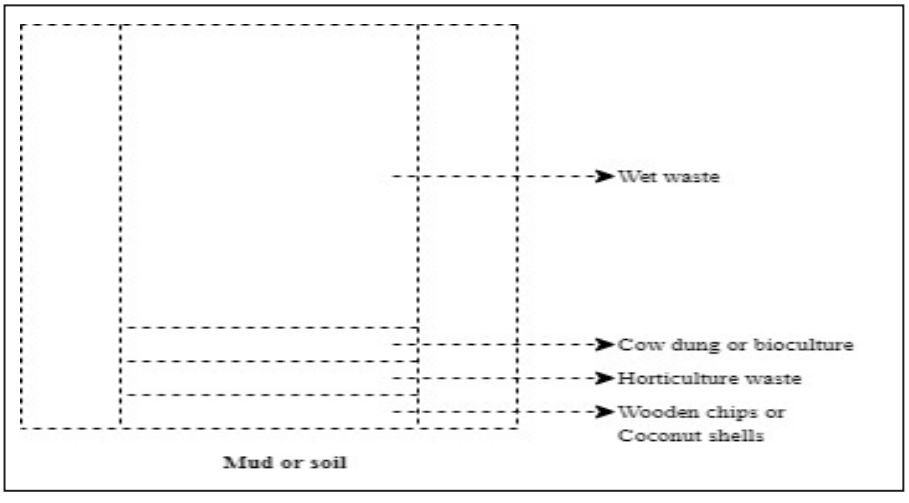
The box composting model should have three equal-sized cubical pits of size 3 feet × 5 feet × 5 feet. The sides of the pits are made using basic construction material such as bricks and cement. They are designed leaving gaps in between so that the decomposing waste receives sufficient oxygen from all sides—this is very important in order to speed up the rate of decomposition. Preferably, pits should not have a concrete or brick-lined base, to allow microbes and worms to enter the wet waste directly and facilitate faster composting. This will also help in easy absorption of leachate, making the soil adjacent to the pit healthy and fertile. Pits are provided with wide opening in the front for the convenience of workers hauling the compost out.

ii. Process of wet waste composting

Segregated wet waste can be composted aerobically. To set up the composting pits, a layer of discarded green coconut shells is arranged upside down at the bottom of the pit, to let the leachate flow out of the heap efficiently and to improve the ventilation of the heap. We could also use wooden chips as a layer. Over this, a layer of husk or horticultural waste such as dry leaves or grass is placed and on top of that a layer of cow dung is spread. This is done in order to facilitate the growth of micro-organisms which in turn increases the rate of decomposition of waste. Above this, wet waste is placed. After dumping the waste in the cubical pits, it is mixed manually after every two–five days using a shovel or a diamond fork *(See Figure: Composting pit layers).*

Wet waste is taken to the composting setup, and the pits are filled with it one by one. Once a pit is full, it is left undisturbed for decomposition. Depending on the weather, it takes around 45–60 days for the compost to get ready. Once ready, the mixture is sieved to obtain homogeneous and fine compost. The decomposition process can be enhanced by utilizing cow dung or cow urine.

Figure: Composting pit layers



Source: CSE, 2018

Cow dung helps to maintain the nitrogen balance of the mixture. Similarly, dry leaves can be mixed in to maintain the carbon level. Maintaining both carbon and nitrogen level is important for achieving optimum decomposition and obtaining good quality compost. To speed up the decomposition process, bioculture can be added to the mixture. This product also helps in reducing the smell from the decomposing waste (*See table: Specifications of organic fertilizers*).

Figure: Specifications of organic fertilizers

1.	City compost	
(i)	Moisture, per cent by weight	15 - 25
(ii)	Colour	Dark brown to black
(iii)	Odour	Absence of foul odour
(iv)	Particle size	Minimum 90 per cent material should pass through 4 mm IS sieve
(v)	Bulk density (g/cm^3)	<1
(vi)	Total organic carbon, per cent by weight, minimum	12
(vii)	Total Nitrogen (as N), per cent by weight, minimum	0.8
(viii)	Total Phosphates (as P_2O_5) per cent by weight, minimum	0.4
(ix)	Total Potash (as K_2O) per cent by weight, minimum	0.4
(x)	C:N ratio	<20
(xi)	pH	6.5 - 7.5
(xii)	Conductivity (as dsm^{-1}), not more than	4
(xiii)	Pathogens	Nil
(xiv)	Heavy metal content, (as mg/kg), maximum	
	Arsenic as (As_2O_2)	10
	Cadmium (as Cd)	5
	Chromium (as Cr)	50
	Copper (as Cu)	300
	Mercury (as Hg)	0.15
	Nickel (as Ni)	50
	Lead (as Pd)	100
	Zinc (as Zn)	1,000

Source: Biofertilizers and Organic Fertilizers in Fertilizer (Control) Order, 1985

Annexure 5: Draft Bye-laws for solid waste management

In exercise of the powers conferred by section (____) of the Municipal Act (____) and in order to implement the provisions made in the National Waste Management Strategy (____), the (____) Municipal Council, hereby makes the following bye-laws for management of solid waste, namely: -

1. Short title and commencement
   i. These bye-laws may be called the (____) Municipal Solid Waste Management Byelaws, 2018.

   ii. They shall come into force upon approval by the elected board or empowered standing committee and with effect from the date of its publication in the official gazette.

2. Every owner and occupiers of premises within the municipal council will have to abide by and to maintain the system of collection, segregation and storage of solid waste apart from having the duty to have the premises clean. Further the owners and occupiers of premises within the Municipal Council shall segregate waste under three categories:
   (a) Organic or bio-degradable wastes (called wet waste)
   (b) Recyclable or non-biodegradable wastes (called dry waste)
   (c) Domestic hazardous wastes

3. The (____) municipal council shall provide one bin for wet waste and one bag for dry waste storage to every owners and occupiers of premises within the municipal council.

4. It is provided herein that each and every owner and occupier of commercial or residential area, apartment owner/societies, co-operatives, institutions, industry etc. shall maintain 'dustbins' and bags for storing wet wastes, dry waste and storing hazardous waste.

5. The domestic hazardous waste like discarded paint drums, pesticide cans, CFL bulbs, tube lights, expired medicines, broken mercury thermometers, used batteries, used needles and syringes and contaminated gauge, etc., generated at the household level shall be stored separately in a red bag and be given to waste collector once a week. Sanitary waste to be wrapped in paper and handed over to waste collector every day.

6. The (____) Municipal Council shall bear the responsibility of collection and disposal of sanitary and domestic biomedical waste like expired medicines, broken mercury thermometers, used needles and syringes etc. to the nearest common bio-medical waste treatment facility, if any.

7. It will be the responsibility of the municipal council to provide adequate number of litter bins at commercial areas and all important public places such as places of worship, parks, and bus-stands. At each location two types of litter bins shall be provided for disposing wet wastes and dry waste.

8. In commercial areas and important public places, litter bins shall be placed every 200 meters by the (____) municipal council. In other areas they shall be placed every 500 meters.

9. For one time, (____) Municipal Council shall provide one bin for wet waste and one bag for dry waste disposal to every street vendors and hawkers.

9. It shall be the responsibility of the street vendors and hawkers to segregate waste into wet and dry and transfer the waste every day to the nearest municipal litter bin or in a collection vehicle designated by the council.

10. Slaughter waste from meat, poultry and fish shops shall be stored separately in a bin and transferred every day to the nearest municipal litter bin or in a collection vehicle designated by the council.

11. In every designated commercial area, it shall be the responsibility of the market associations or group of shop-owners to ensure that there is no littering and throwing of garbage on the roads, drains and public spaces.

12. Horticultural waste (agricultural waste, garden waste) generated in residential and commercial areas should be segregated and stored separately within the premises. It should be composted within the premises or sent to the nearest compost facility of the council.

13. The (____) municipal council shall be responsible for collection and composting of horticulture wastes from public parks and gardens. Tree leaves from trees on the roads and other public spaces shall also be collected and composted by the council.

14. It shall be the responsibility of the owner or occupier of premises to store the construction material and construction and demolition (C&D) waste within the premises.

15. In case, the construction material or C&D waste has to be stored on the road and other public spaces due to unavoidable reasons like lack of space or requirements of construction or demolition works, the owner or occupier of the premises shall take permission from the municipal council to do so. The municipal council shall charge a fee to allow storage of construction material and construction and demolition (C&D) waste on the road and other public spaces.

16. It shall be the responsibility of the owner or occupier of premises to dispose C&D waste at a place designated by the municipal council. The C&D waste can be used for filling low-lying areas, provided it is done in an environmentally safe manner and with the permission and consent of the owner of the land.

17. The (____) municipal council shall bear the responsibility of collection and disposal of C&D waste generated from its own activities and activities of other government departments working in the municipal area.

18. The (____) municipal council shall earmark a specific area for the disposal of C&D waste and other inert wastes like road sweepings at a notified dumpsite.

19. The (____) municipal council shall also ensure that inert waste collected from road sweepings, desilting of drains, digging of roads and public spaces for various activities etc. is collected and disposed in a time-bound matter at a specific site as notified. It can also use these wastes, if it deems appropriate, for filling of low-lying areas.

20. The (____) municipal council shall explore all opportunities for the gainful utilization of the C&D waste.

21. Manufacture, import, store, sell, transport, supply, possess or use any plastic bags in Zanzibar is prohibited.

22. Persons or establishments, if found to commit any of such offence shall be liable to give fine of or imprisonment of upto two years.

23. No person shall throw waste or litter at any public place. They shall use the dustbins and litter bins so provided for disposing the waste.

24. The (____) municipal council shall develop an effective collection system to collect and transfer segregated waste for processing.

25. The segregated wet waste from each house, shop, commercial areas, hotel, restaurants, street bins, educational institutes and all other generators of solid waste shall be collected by the council on a regular basis.

26. The (____) municipal council shall develop and execute a plan within three months to collect segregated wet waste and segregated sanitary waste and domestic hazardous waste every day; and segregated dry waste every alternate day.

27. Marriage/event halls shall take permission from the (____) municipal council minimum 7 working days prior to the date of event/function and shall make the arrangement for segregation and storage of waste at the place of event/function. The segregated waste shall be handed over to waste collector. The (____) municipal council can grant the permission for days, for weeks, for months or for one year. It shall charge a fee for holding the function/ event. In case of non-compliance, fine shall be levied.

28. The (____) municipal council shall levy the following user fees for waste management:

S.No.	User's Category	Monthly user charge
A.	Residential	
1	Residential House (per family/flat/house)	
2	Slums and Below Poverty Line Residence	
B.	Non-residential	
1.	Street Vendor	
	a) Without structure (roadside)	
	b) With structure	
2.	Eating joints, Restaurants, Cafes, Sweet Shop, Coffee House, etc.	
3.	Meat, Fish and Poultry Shops	
4.	Other shops	
5.	Restaurant (Non AC restaurant)	
6.	Restaurant (AC restaurant)	
7.	Guest Houses	
8.	Hostels	
9.	Star hotel or equivalent hotel	
10.	Commercial offices, Government offices, Educational Institutions per unit	
11.	Banks and insurance offices	
12.	Coaching classes	
C.	Health Services Institutes (except biomedical waste)	
1.	Clinics per unit	
	Dispensaries, Laboratories	
2.	Hospitals (upto 50 beds)	
3.	Hospitals (more than 50 beds)	
D.	Others	
1.	Religious Places	Religious centres can willingly contribute to cleanliness in and around their premises
2.	Small scale industries, cottage units, workshops, petrol pumps(only non-hazardous waste)	
3.	Cold storage, godowns and storage areas where large amount of waste is generated	
4.	Marriage halls, Event halls, Exhibition and Fairs	
5.	Others	
E.	User charges for bulk collection	
1.	C&D waste	------/ tractor truck
2.	C&D waste	------/ tipper truck

29. The user fees as listed in section 28 shall be revised after every two years.

30. The user fee shall be collected one month after the passing of the byelaws in the official gazette.

31. The user fee shall be collected on a monthly basis by the council and a

printed slip will be issued by the council for payment of fee by the user listed in section 28.

32. The (____) municipal council shall make every effort to increase the awareness of people on waste management and the user fees. Proper announcement through advertisement in media, hoardings, public announcements, distribution of leaflets etc. shall be undertaken.

33. The (____) municipal council shall constitute a "waste management task force" for overseeing the successful implementation of the (____) municipal council Solid Waste Management Byelaws, (year). The Task Force shall constitute of the following:
    (a) Chairman
    (b) Mayor
    (c) Director
    (d) Two respected residents of the wards nominated, by a two-third majority vote, by the elected members from the wards

34. The waste management task force shall meet every two weeks to take stock of the implementation of the byelaws and resolve issues.

35. The (____) municipal council shall constitute a ward waste management task force in all wards of the council. This taskforce shall supervise collection, transfer and proper processing of segregated wastes. The task force shall constitute of the following:

a) Elected members from the ward
b) Ward Supervisor
c) Two respected residents of the ward nominated on consensus by the mayor

36. The ward waste management task force shall have responsibility to spread awareness for segregation at source in every ward and sensitise people through IEC.

37. The ward waste management task force shall undertake sensitization programs to inform people about the byelaws and fines or penalty for non-compliance and littering.

38. The ward waste management task force shall monitor the implementation the (____) municipal council solid waste management bye-laws, 2018 and recommend the actions that need to be taken for successful implementation of the byelaws.

39. The (____) municipal council shall be empowered to levy fine from the households, owners or occupiers of the premises for non-abidance of the byelaws and for littering in public areas. The amount of fine shall be as follows:

S.No.	Category	Amount of fine/penalty
(i)	Guest Houses, Hostel, Star hotel or equivalent hotel, Commercial offices, Government offices, Banks, Insurance offices, Educational Institutions, Clinics, Dispensaries, Laboratories, Hospitals, Cold storage, godowns and storage areas where large amount of waste is generated, Marriage halls, Event halls, Exhibition and Fairs and any other establishment where large amount of waste is generated.	1st offence – Warning 2nd offence – (----Tsh) Every subsequent offence – (----Tsh)
(ii)	Eating joints, Restaurants, Cafes, Sweet Shop, Coffee House, Meat, Fish and Poultry Shops, Coaching Classes, Petrol pumps, Small scale industries, cottage units, workshops (only non-hazardous waste) etc.	1st offence – Warning 2nd offence – (----Tsh) Every subsequent offence – (----Tsh)
(iii)	Street Vendor, with or without structure	1st offence – Warning 2nd offence – (----Tsh) Every subsequent offence – (----Tsh)
(iv)	Any other commercial establishments other than those mentioned in serial no. (i), (ii) and (iii)	1st offence – Warning 2nd offence – (----Tsh) Every subsequent offence – (----Tsh)
(v)	Households and individuals	1st offence – warning 2nd offence – (----Tsh) Every subsequent offence – (----Tsh)
(vi)	Open burning of the waste	1st offence – warning 2nd offence – (----Tsh) Every subsequent offence – (----Tsh)
(vi)	Penalty for dumping C&D waste	
A	Penalty for dumping of C&D waste on road or on public spaces by individual without prior permission	(----Tsh)/day + amount for sending municipal vehicle to lift and dispose the C&D waste
B	Penalty for dumping of C&D waste by commercial premises, industry or any other bulk generator	(----Tsh)/tonne/day + amount for sending municipal vehicle to lift and dispose the C&D waste
(vii)	Mixing of bio-medical waste in to municipal waste by hospitals, nursing homes, clinic, pathology lab etc.	1st offence – Warning 2nd offence – (----Tsh) Every subsequent offence – (----Tsh)
(viii)	Non-compliance in approval from corporation for event by Marriage halls, Event halls, Exhibition and Fairs etc.	(----Tsh)/day

41. Every violation shall be recorded and the council shall provide a slip to the violators to deposit the fine, within seven days of the violation, at an office(s) designated by the (____) municipal council for the purpose.

42. If a violator, who is the owner or occupier of a premise, fails to deposit the fine within the stipulated timeframe, then the fine plus 12 per cent annual interest rate shall be added to the property tax and recovered.

43. If an individual or street vendor is found littering on the road or other public places, a spot fine can be imposed and recovered.

44. The ward waste management taskforce shall submit a fortnightly report to the waste management task force about the violation so found and action taken.

45. The (____) municipal council shall publish a status report on the number of violations and violators, the amount of fines imposed and recovered etc. on its website every month.

46. The (____) municipal council to do information, education and communication (IEC) and awareness raising in residential and commercial areas of the island for spreading the message of segregation at source.

46. The (____) municipal council shall circulate information on the byelaws through use of newspapers, radio, hoardings and local TV channels for one month after the date of publication of the byelaws in the Official Gazette. After that, a summary of the byelaws shall be displayed at prominent public places through hoardings.

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