Advances in Recycling & Waste Management: Open Access

Abdulrasoul and Bakari, Adv Recycling Waste Manag 2016, 1:2

Research Article Open Access

Challenges and Problems of Solid Waste Management in Three Main Markets in Zanzibar

Awattif Aboud Abdulrasoul[1] and Said Suleiman Bakari[2]

[1]*Chief Government Chemist Laboratory Agency, Zanzibar, Tanzania*
[2]*Department of Natural Science, State University of Zanzibar, Zanzibar, Tanzania*

Abstract

A large amount of solid waste that is being generated by the Municipality, such as markets, is left generally unmanaged. The waste collection and disposal does not contend with the amount of waste generated per day as a result garbage are scattered. Market areas produce not only a large quantity of solid waste but also generate different types of waste. Because the market areas generate different types of waste, they need to be managed properly in order to avoid the detrimental effects it could have on the environment, health, and ecosystem. This paper will therefore present the challenges and problem associated with managing the solid waste generated by the three main markets (Mwanakwerekwe, Darajani and Mikunguni) which make up the Zanzibar municipality. Several methods were used to conduct this study including questionnaires, interviews and direct observations. The results of the study showed that the daily amount of solid waste generated by Mwanakwerekwe, Darajani and Mikunguni were 9,296 kg per day, 4,648 kg per day and 830 kg per day, respectively. The study also revealed several shortcomings in connection with the solid waste managements in the markets including low quality, inadequate storage and transportation facilities, an informal dump site, insufficient collection frequency of solid waste, low level of awareness and education of solid waste management and lack of enforcement of regulations by law enforcement. This study proposes several methods to improve solid waste management starting with the provision of adequate dustbins and skips, and also including an increase of collection frequency, increasing public awareness, involvement of private sector and separation of bio-degradable and non-biodegradable waste. The logical conclusion is that all the informal dump sites should be replaced by Kibele dump sites.

Keywords: Solid waste management; Market waste; Zanzibar municipality

Introduction

Solid waste management (SWM) may be defined as the discipline associated with the control of the generation, storage, collection, transfer, transport, processing and disposal of solid waste in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations, and that is also responsive to public attitudes [1]. In its scope, solid waste management includes all the administrative, financial, legal and engineering functions involved in finding a solution to all the problems of solid waste [1]. It is an essential service that is provided for the protection of the environment and public health, as well as to promote hygiene, recover materials, avoid waste, reduce waste quantities, emissions and residuals, and prevent the spread of diseases [2]. Population growth and industrialization in most Asian countries has also caused serious problems of pollution. Implementation of SWM, many countries have now benefited from recycling and reusing waste, converting it to energy.

The high rate of urbanization and population growth in most African countries has made it difficult to develop and implement effective SWM systems. In the Zanzibar municipality, it is estimated that around 216 tons per day of waste is generated and only 25% of the Municipal waste in Zanzibar is collected and transported to the disposal site [3]. The remaining 75% of the waste is left to be eaten by animals, burned, illegally dumped, or swept away by storm winds into the town where it accumulates in heaps [3].

The generated waste is growing at increasing rate and the municipal council is not able to provide service for solid waste collection due to the rapid increase in the population and urbanization. A large amount of the solid waste generated by the market areas during working hours produced different types of waste in Zanzibar municipality which is not being properly managed, and might have detrimental effects on the environment, health and ecosystem. Despite all of these problems, little is known about the challenges associated with SWM in the market area. Therefore this study was conducted to identify the challenges, problems and to recommend the appropriate methods that can be used to manage solid waste generated in the three main markets in Zanzibar municipality. Other objectives are to assess the types, quality, and quantity and identify the current method used to manage the solid waste generated.

Methodology

Study area and location

This study was conducted in three main markets of Zanzibar municipality presented in Figure 1. The Zanzibar municipality has an estimated area of 16 km^2 which included the stone town and Ng`ambo town area [3]. The existing Zanzibar municipality boundaries start from Stone town to the west, Daraja Bovu road in the east, Zanzibar International airport to the south and Mtoni road to the north [3]. The three main markets, which are Darajani, Mwanakwerekwe, and Mikunguni, were selected based on the fact, that these markets are located within township of Zanzibar and accommodate a large population. In the market areas, large amounts of solid waste are generated such as different types of fruits, vegetables, cooked food,

***Corresponding author:** Awattif Aboud Abdulrasoul, Chief Government Chemist Laboratory Agency, P Box 759, Zanzibar, Tanzania, Tel: +255773999505; E-mail: aaatiftif@gmail.com

Received February 15, 2016; **Accepted** April 04, 2016; **Published** May 11, 2016

Citation: Abdulrasoul AA, Bakari SS (2016) Challenges and Problems of Solid Waste Management in Three Main Markets in Zanzibar. Adv Recycling Waste Manag 1: 109.

Figure 1: Map of Zanzibar municipal area with boundaries and market locations (Source: ZMC).

plastic, glass etc. during market hours. The study was conducted for a period of one year in order to get maximum amount of SW generated within those markets.

Research methods

The study used a cross section survey to obtain required qualitative and quantitative data. The cross section study is a research that permits the use of various methods of data collection including questionnaires, interviews and direct observation. The population sample comprised two categories of respondents, category one included eight respondents of government staffs (GS) and four respondents of market leaders (ML) while category two included 183 respondents of market traders (MT) from three main markets (Darajani, Mwanakwerekwe and Mikunguni) of Zanzibar municipality. In total 195 respondents were involved in the study out of 1220 of the total population of market traders (Table 1). In this study the selection of responded was done in probabilistic way in which every individual had greater than zero probability of getting selected into a sample.

Formula used in calculating the sample size is as shown below:

$$n_o = \frac{(Z_{\alpha/2})^2 P(1-P)}{d^2} \quad (1)$$

Where:

$Z\alpha_{/2}$=Z value (e.g., 1.96 for 95% confidence level). P=percentage picking a choice (0.5), it expressed as decimal. d=confidence interval, expressed as decimal (0.04= ± 4 - 0.12= ± 12).

The corrected required sample size according to the population of this study is:

$$n = \frac{n_o}{1 + \frac{n_o - 1}{N}} \quad (2)$$

Where:

N is total population of market traders, for this case N=1220

By using an 'Equal Probability of Selection' (*EPS*) method [4], that is systematic sampling, enable to get the starting respondent from the sampling of the total 183 respondents. The set of this study has a one-in-seven probability of selection. In category one respondent were selected using purposive samplings to provide both primary and secondary sources of information, whereas respondents under category two respondents were selected using random technique to provide primary information.

Quantification of the solid waste

Generated solid waste was also calculated based on data observed from government staff and market leaders respondents using the following formula:

$$\rho = \frac{m}{v} \quad (3)$$

Where:

ρ=Density of un-compacted solid waste (332 kg/m^3 used by Zanzibar Municipal Council)

v=Volume of skips used to store solid waste (7 m^3 used by Zanzibar Municipal Council)

m=mass of Solid waste generated (kg)

Results, Discussion and Observation

Observation in the three markets

The current situation of the three markets was scrutinized by direct observation and taking photographs of each market and the information presented accurately describes the situation.

Darajani market

Darajani Market, commonly known as 'Marikiti Kuu', is the first market and has functioned since 1904. It is one of the attractive historical sites of Zanzibar Stone Town which is recognized by the United Nations as one of the world heritage sites (Figure 2). The market

S No	Market	Registered	Unregistered	Total Traders	Sample Selected
1	Darajani	109	250	359	54
2	M'kwerekwe	204	600	804	120
3	Mikunguni	40	17	57	9
Total		**353**	**867**	**1220**	**183**

Table 1: The Population Sample of the selected three markets.

is currently overloaded with traders and users, which endangers its natural beauty and environmental and aesthetic value. During the rainy season most of the waste goes into the drainage system causing a blockage of the drains due to the few available storage facilities placed near the sewage drain (Figure 3).

Most of the places inside are very dirty, they smell and are filled with flies. This study observed that not only the solid waste management is a problem but also the behavior of employees and vendors, all of which contribute to the dirtiness of the markets. Figure 4 shows the section for chicken slaughter. In this place, the surrounding area is composed of waste and it is hard to breathe due to the bad smell. This reveals that the traders and their council management are unaware of the need for proper hygiene and cleanliness in such places. It seems that special training to conduct proper hygiene and sanitation is greatly needed, as people should learn to observe cleanliness at their workplace by preventing pollution and participating in SWM activities. Figure 5 below is a garbage collection point for Darajani market. This area is surrounded by the community, shops, schools and the bus station. In most cases, the waste in this area is scattered and not transferred to the dumping site on time, thus producing bad smell which attracts flies, thereby making the environment unaesthetic and a potential danger to human health.

Mwanakwerekwe market

Mwanakwerekwe market is located about 4 km from Stone Town. This is the biggest market in Zanzibar where many people from all over the place trade their commodities. Comparatively, the issue of poor SWM is more alarming at Mwanakwerekwe market as there is a lot of scattered waste around the market (Figure 6). It is common to see improper disposing of waste in the sewage system (Figure 7). Figure 8 above shows the actual situation and poor hygienic conditions of the market and traders' working area. This shows that most of the MT has similar behavior as in Darajani market. This study suggests that there is an urgent need to provide public awareness about proper SWM and how to improve hygiene in market areas.

Mwanakwerekwe market has no proper point for garbage collection. Traders in this market and the community around the place dump their waste besides the market, as shown in Figure 9. Nevertheless, the local authority does not remove the waste from this point and take it to the main dumping site at Jumbi. Due to the improper dumping system, MT and the community sometimes dispose their waste with burning items such as burning charcoal that causes fire.

It was also described by the management that there was routine collection and transportation of solid waste from Mwanakwerekwe market to Jumbi dumping site. However, later it was decided to fill the valley beside the market by dumping the solid waste generated by the market only. This decision attracted the community residing near the market to haphazardly dispose their waste, which aggravates the hazardous potential of the area.

Mikunguni market

Mikunguni market is about 2 km from Stone Town. This is a newer market in Zanzibar municipality than Mwanakwerekwe and Darajani, although it is a bit smaller than the others (Figure 10). The hygienic situation of the market apparently is in good condition (Figure 11). The Muungano collection point (Figure 12) is about 300 metres from Mikunguni market. The community around use the same collection point for disposing of their domestic waste. The situation of this area is environmentally alarming due to the scattered solid waste as shown in Figure 12. The storage skips currently in use have the capacity of 7 m^3 (Figure 12). This seems small with respect to the solid waste generated in that area during working hours, especially when connected with infrequent collections. According to the market management, the frequency of skip collections for Mikunguni market at this area is only once a day.

In addition, this site is located near the shops and a school and is also surrounded by the community, which endangers the health of the people. The other collection point located at Mkele press is near Mikunguni market than it is to Muungano school collection point (Figure 13). However, no skip for waste collection was found during the tour of this study (Figure 13). In both cases the waste remains for a long time, spreading over the ground, attracting flies and other insects and also producing an offensive smell, which may be dangerous to human health and the environment.

Mikunguni market is comparatively cleaner than Darajani and Mwanakwerekwe markets. It was also observed that in all three markets there was lack of a water supply system and services, which resulted in poor sanitation in the area. Moreover, lack of equipment, tools, trained personnel and awareness of the solid waste management system of ML, MT and the community at large is a critical problem that has led to these markets being in a very bad condition.

The local authority has failed to institute and manage the solid waste in this market due to the following reasons:

- Monthly collection revenue from market traders is not sufficient due the fact that large numbers of MT are not registered. This causes problems in planning and managing several issues of waste management in the market areas.
- The shortage of employees due to the low salary and incentives, as well as the old age of the workers influences poor SWM in the market areas.
- The trucks coming from the country that bring commodities to the markets are not charged for solid waste services while they significantly contribute and generating solid waste in the market areas.
- A significant number of illegal vendors at Darajani market work after the market is officially closed in order to avoid charges and they produce a significant amount of solid waste.

Besides technical and financial problems in the Zanzibar municipality, there are also other problems associated with SWM, which include socio-economic ones, as well as traders' attitudes and behavior. Also the law enforcement was not applicable. Example from ZMC Act, No. 3 of 1995 under Cl 25(1) and Cl 25 (2) prohibits the haphazard disposal of solid waste, this study shows that in practice these by laws are neither observed by MT nor GS.

Assessment of the type, state and quantity of solid waste generated

As stated earlier, this study intended to assess the type, state quantity and composition of solid waste generated

Figure 2: Darajani Market.

Figure 3: Solid waste scattered around the sewage.

Figure 4: Unhygienic working place (Chicken drain at Darajani Market section) at Darajani Market.

Figure 5: Collection Centre of Darajani Market at Darajani.

Respondents' opinions type of solid waste generated: The Type of solid waste generated in the three markets of Zanzibar municipality is presented in Figure 14. About 48.1% of the MT of Darajani said that the waste generated from the markets is biodegradable waste and the remaining 51.9% said mixed waste, depending on the type of business. For the Mwanakwerekwe market, 45% of MT said that the waste is biodegradable waste while 55% of MT said mixed waste, while for Mikunguni 55.6% of MT said that the waste generated is biodegradable waste and the remaining 44.4% of MT said mixed waste. However there were no significance differences in determining the type of solid waste based on MT respondents as the P value was 0.793.

As regards GS, 75% said that the waste is biodegradable waste, while 50% of ML said that the waste generated is biodegradable waste. However there were no significance differences in determining the type of solid waste based on all respondents (MT, GS and ML) as the P value was 0.29. It has been reported by ZMC that more than 80% of solid waste generated is biodegradable in nature [5]. However, according to the

Figure 6: Solid waste scattered around Mwanakwerekwe Market.

Figure 7: Waste clogging drains at Mwanakwerekwe.

Figure 8: Poor hygienic condition of working place.

Figure 9: Unofficial dump site in the vicinity of Mwanakwerekwe market.

Figure 10: Mikunguni Market.

Figure 11: The hygeinic working place at Mikunguni market.

Figure 12: Overfilling the skip and haphazard disposal of waste at Muungano school collection point of Mikunguni market.

respondents results of this study, it was revealed that the biodegradable waste produced in market areas is more than 90%, showing a slight difference. This variation was expected as markets are more likely to produce more biodegradable waste. The type of commodities and waste produced in these markets are mostly biodegradable, which can be easily handled and used as a source of fertilizer through composting as an appropriate treatment.

State of solid waste produced: The state of solid waste produced in the markets is shown in Figure 15. About 9.3% of the MT from Darajani market revealed that the waste produced in the markets is dry, 75.9% of MT said it is wet depending on the type of business and 14.8% of MT respondents said that the waste is semi dry. However, 5% of Mwanakwerekwe MT said that the waste is dry, 20% said it is wet and the remaining 75% said semi dry. For the Mikunguni market, the traders said 66.7% of the waste is wet and 33.3% said semi dry. Usually dry solid waste in the market is waste like paper, boxes, plastics and other packaging materials, which originate from normal shops, and wet solid waste originates from wet areas like fish, meat, vegetables, fruit, etc. The GS respondents pointed out that the waste from the markets is wet, which often occurs during harvesting when various fruit such as mangoes, oranges and pineapples are harvested. According to Tubtong, the state of market waste was almost 90% (wet weight). From this statement composting could be an appropriate treatment as the waste contains enough moisture.

The quantity of solid waste generated: The graphical quantity of solid waste generated in the three markets of the Zanzibar municipality is presented in Figure 16. The study shows that 85.1% of the MT respondents generate waste below 10 Kg/MT/d, while 9.3% generate between 10 to 20 Kg/MT/d and 5.6% generate between 30 to 40 Kg/MT/d for Darajani market. In Mwanakwerekwe markets 90% of MT respondents generate waste below 10 Kg/MT/d, 5% generate between 10 to 20 Kg/MT/d and 5% generate between 30 to 40 Kg/MT/d. In Mikunguni market 100% of the MT respondents generate waste below

Figure 13: Lack of skip at collection point of Mikunguni market at Mkele press.

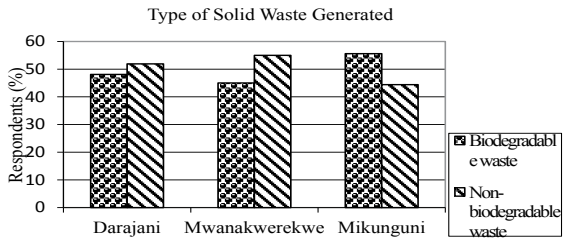

Figure 14: Types of solid waste generated in three markets of Zanzibar municipality.

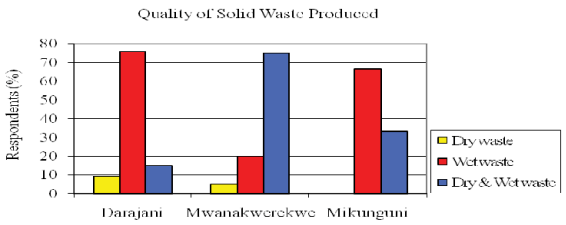

Figure 15: State of solid waste produced in markets.

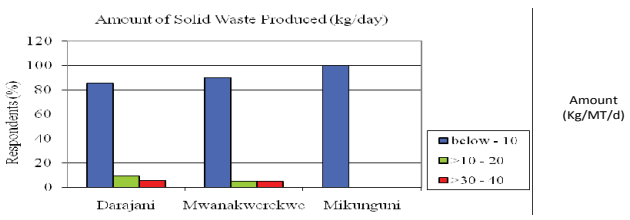

Figure 16: Amount of solid waste produced (Kg/MT/d) in markets.

10 Kg/MT/d. As shown in Figures 5 and 7 the average majority of MT (91.7%) said that they produced waste below 10 Kg/MT/d, depending on the type of business.

According to GS respondents, 2 skips are collected every day at Darajani market, the estimated waste generated at Mwanakwerekwe market fills 4 skips, each skip with a capacity of 7 m^3, and small amount of waste are generated at Mikunguni market with a capacity of 2.5 m^3. Therefore the amount of waste generated in each market was calculated using Equation 3. From the survey the result the amount of solid waste produced is 4,648 kg/day by Darajani, 9,296 kg/day by Mwanakwerekwe and 830 kg/day by Mikunguni markets. Market leaders estimated that the solid waste produced is, 4,000 kg/day, 10,000 kg/day and 1,000 kg/day at Darajani, Mwanakwerekwe and Mikunguni, respectively. The estimations given by the ML respondents were found to be within the range of the finding evaluated from the GS respondents. It is therefore clear that **the** type, state and quantity of solid waste generated from the main three markets are appropriate for production of composting manual.

The current method used to manage solid waste in the main three markets

This study also intended to identify the current method used to manage solid waste in the main three markets in Zanzibar and provide a summary in regard to the collection, transport, processing, and disposal of solid waste by the respondents.

Storage facility of the solid waste: The different kinds of storage containers used to collect the solid waste produced in these markets are shown in Figure 17. At Darajani market about 75.9% of MT use plastic containers, 11.1% use '*matenga*' and 1% put waste beneath their working platform. At Mwanakwerekwe market, 45% of MT put their waste on their working platform, 15% use plastic containers, 5% use '*matenga*', 25% use plastic bags, and 10% use metal containers. In Mikunguni market about 22.2% of MT use plastic containers, 22.2% use '*matenga*', 11.1% use plastic bags and 44.4% put waste beneath their working platform. The different kinds of storage containers used to collect the solid waste produced in these markets like plastic containers, metal containers, plastic bags, '*matenga*' (Figures 18 and 19), and put waste beneath their working platform (Figure 19). This study found that MT used their own storage facilities to keep the wastes which generally are not up to standard, some respondents had no space to store waste in the markets at all so they randomly throw the waste on the ground whereas it's not sufficient to keep the market neat.

There is a possibility for waste to enter the sewerage system, which may block the flow of waste water, hence resulting in the failure of the system, thereby endangering the health of market users. It was observed that some of the storage facilities like '*matenga*' are of a low standard as shown in Figure 18. No storage containers are provided with the result that people use different storage facilities to store waste.

Solid waste transportation vehicle: Different types of transports are used to transport the solid waste produced by the markets to the collection point and then to the disposal site. About 100% of MT from all three markets said that they use wheelbarrows to transport solid waste to the collection point while compactors and 7 ton Isuzu trucks are used to transport the waste from the markets to the dumping site.

The ML stated that they transport solid waste at the markets using wheelbarrows while compactors and 7 ton Isuzu trucks (Figure 20), are used to transport the waste from the markets to the dumping site. In contrast, the GS said that they use wheelbarrows within the market to go to the collection point and different types of vehicles are used to transport solid waste from the collection point to the disposal site. These include compactor trucks and skip Lorries.

The insufficient number of transportation facilities has greatly affected the frequency of waste collections in the market, as well as from the collection points to the dumping site. The delay in transporting the solid waste from collection points to the dumping site may lead to health problems for market users and the community around the markets. Table 2 shows the current available numbers of equipment and vehicles used by ZMC to transport solid waste. However, it was observed that the number of vehicles is not sufficient for the solid waste generated and some of these facilities are out of order.

Type of vehicles/tools	Current condition		Standby	Total
	Working	Not working		
Compacters	2	2	-	4
Skip lorries	4	-	1	5
Open trucks 7 tonnes	2	-	1	3
Skips 7 m^3	85	-	108	193
Wheel loaders	1	1	-	2
Dumpers	4	-	-	4
Wheel barrows	53	-	-	53
Vacuum pressure	2	-	-	2
Waste water truck	3	-	-	3
Tata truck (Sand)	2	-	-	2
Hand carts	13	-	12	25

Table 2: The type and quantity of vehicles and other facilities available in Zanzibar. Source: Zanzibar Municipal Council.

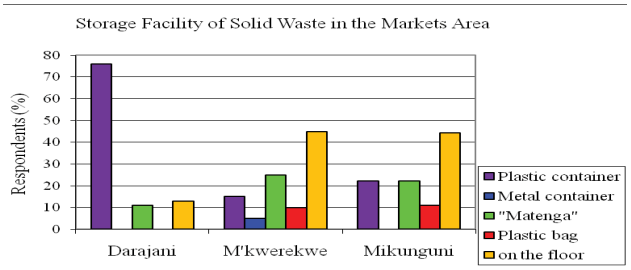

Figure 17: The storage facility used at the individual markets of Zanzibar municipality.

Figure 18: Storage facility of the solid waste at Darajani market.

Figure 19: The common storage facility of solid waste at Mwanakwerekwe market.

The frequency of transportation of solid waste in the markets

Figure 21 shows the transportation frequency of the solid waste produced in the three markets. Collection of waste differs from section to section depending upon the kind of waste produced. In Darajani market 24.1% of MT said that solid waste is transported daily from the market to the collection point, 64.8% said twice a day, 5.6% said three times a day and 5.6% said more than three times a day (others). About 40% of Mwanakwerekwe MT said that solid waste from the market is being collected once a day, 20% said twice a day, 10% said three times a day and 30% said more than three times a day, while 44.4% of Mikunguni MT said that the collections are daily and 55.6% said that they were twice a day. Others claimed solid was collected more than three times a day.

According to GS respondents, 2 skips are collected every day at Darajani market and taken to Jumbi disposal site. In previous years, waste from Mwanakwerekwe market used to be taken to Jumbi disposal site until the ZMC decided to dispose solid waste in the valley near the market. Mikunguni market uses two collection points, which are Muungano School and Mkele press. The main problem with these two collection points is that the skips are overflowing and are not towed to the disposal site. This problem causes solid waste to spread all over the place and pollute the surrounding environment, as show in Figures 10 and 12. The frequency of collections in all three markets is below the number required. This suggested that the frequency of collections and storage capacity of the containers at the collection point to the disposal site should be increased to minimize the problem (Figures 6, 7, 12, 13, 18 and 19).

The disposal site of solid waste from the markets

All MT respondents at Darajani and Mikunguni markets said that solid waste is disposed off at Jumbi, while 100% of MT at Mwanakwerekwe market said that the waste is disposed off beside the market.

In addition, other respondents (GS and ML) confirmed that the solid waste from Mikunguni and Darajani markets is disposed off at Jumbi, while waste from Mwanakwerekwe market is dumped besides the market.

This study observed that ZMC disposes all solid waste at Jumbi dump site and Mwanakwerekwe market except medical waste, where Jumbi dump site is not fenced as shown in Figure 22. It is therefore accessible to scavengers and cattle grazers. This place is not suitable for solid waste disposal, because people live near the dump site as depicted. The surrounding community has been constantly complaining about the obnoxious conditions they are facing by being near this dump. In addition, there are boreholes and wells in the vicinity of the dump, and so the water maybe seriously polluted due to leaching, which can be detrimental to the health of water users. Furthermore, uncontrolled crude dumping (Figure 22) may result in the emission of greenhouse gases, such as methane and carbon dioxide, which has a serious impact on climatic change.

Mwanakwerekwe is an informal dump site, although it is recognized by the government authority. It appears to be environmentally worse and more dangerous than the Jumbi disposal site, as it is surrounded by more communities as shown in Figure 23.

The local authority decided to use the valley close to Mwanakwerekwe market as a temporary dumping place. This decision was aimed at refilling the valley caused by sand mining during the construction of Michenzani development houses. However, no social and environmental impact assessments have been conducted to approve this option; with the result that many people have also been using the valley to haphazardly dispose of their waste, thus increasing environmental hazards.

There is no official dump site in Zanzibar this has led to shifting of the disposal sites since 1980s, the municipal solid waste was dumped at Mwanakwerekwe and then shifted to Jumbi while still the Mwanakwerekwe market used the same Mwanakwerekwe dump site, then from Jumbi dumped site has being shifted to Kisakasaka for a short time because this dumping sites are not well protected; there is the potential to contaminate nearby surface and ground water [6]. Now there is new allocation site at Kibele is about 20 km from Zanzibar town and has 2 watchmen. The Zanzibar Municipality already write the proposal of Zanzibar Urban Service Project under Ministry of Finance of 2012-2017 and send to the world bank for fencing the compound and training for the watchman and other staff.

Figure 20: Different transporting facilities are being used to transport solid waste from markets area to dumping site.

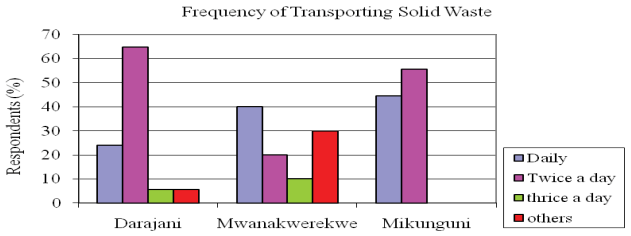

Figure 21: The Frequency of Transporting Solid Waste.

Figure 22: Unsanitary crude dumping at Jumbi dump site.

Figure 23: Unsanitary crude dumping beside Mwanakwerekwe market.

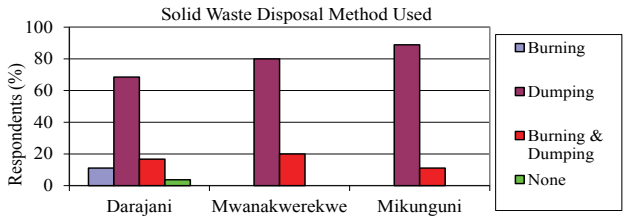

Figure 24: The Solid Waste disposal methods used.

That disposal site is already stated and the disposal waste from the rooting collection from Zanzibar municipality is about 4,800 tons per month, which is mix waste exclude hospital waste. Also there are rising of pampers and electronic equipment in the dump site but there are reduction of some inorganic waste like plastic, glass and aluminum waste which are used for recycling. Local dealer who collect plastic, aluminum cans, glass waste and send them to Dar es Salaam and In Dar es Salaam there are special dealers who send plastic and glass waste to Kenya and aluminum cans and scrapers to China.

The solid waste disposal methods used in Zanzibar

Figure 24 shows the current solid waste disposal methods used in Zanzibar. The majority of Darajani market respondents (68.5%) said that solid waste is merely dumped, while 16.7% said that it is both dumped and burnt, 11.1% said only burnt and 3.7% did not know. For Mwanakwereke market, 80% of respondents said that the solid waste is dumped, while 20% said that it is burnt and dumped. Moreover, 88.9% of Mikunguni respondents said the solid waste is dumped while 11.1% said it is both dumped and burnt. However, it was observed that burning occurred naturally due to the excessive heat generated at the dumping sites.

The open burning and crude dumping, which was observed in the field work and confirmed by the respondents, is not adequate in terms of environmental and social impacts. These practices are not environmentally acceptable because open dumping may result in the breeding of flies and vermin as well as informal waste picking or scavenging [7], which may pollute water sources. Therefore, crude and open dumping of solid waste from the markets needs to be avoided.

Summary and Conclusions

The following are the summary and conclusions of the findings which were identified during site visited and discussion with the key staff of the Zanzibar Municipal Council:

1. Collection of the waste is not adequate this is dangerous to public health and environment; the study showed that the market waste produced by the three main markets is about 15 tonnes/day in which more are organic waste; therefore it is suitable for composting.

2. All wastes are mixed and there is no sorting of biodegradable and non-biodegradable of the solid waste produced in the market area.

3. Inadequate and low standard of storage facilities combined with low frequency of solid waste collection in all three markets leads to scattering of solid waste around the market areas. This study revealed that only 44% of MT used dustbins for waste collection. Some solid waste is placed in plastic bags and bamboo basket while some is randomly disposed of and leaks into the sewerage system. Likewise, there was a scarcity of skips at Mikunguni and Darajani market collection points. There are few collections, resulting in skips overflowing due to the excessive accumulation of waste at the collection points, which have made the area a potential danger to human health and the environment.

4. The level of education and awareness regarding proper handling of solid waste for market traders and leaders is minimal. Provision of training for all stakeholders so as to understand the best way of handling solid waste including sorting practices.

5. The capacity of municipality in terms of financial and technology on waste management is limited to cope with growing solid waste generation rate. There is ineffective source of revenue which minimize financial constraints and therefore leads to improper solid waste management.

6. Lack of appropriate solid waste disposal systems includes dumps shifting, crude dumping and open burning might pose detrimental effect to the public health and impair surrounding environment at large. Also allocated very close to residential houses and local wells used as a water source. Therefore this dump may cause health problems for the nearby communities if the situation is not controlled.

7. There is no policy and sufficient bylaws and regulation on solid waste management that can be used to govern solid waste management in sustainable manner. Lack of SW sector analysis which could assist in identifying responsibility of individual organization for establishment of sustainable solid waste management resulting into haphazardly of solid waste disposal. It was observed that existing by-laws governing SWM are not well understood by the stakeholders (market traders, market leaders and Government staff).

8. Lack of community awareness lead on improper handling of solid waste management.

9. Large numbers of MT are not yet registered resulting to poor fund collection for the solid waste services. Also the traders coming from the countryside that bring commodities to the markets are not charged for solid waste services.

Recommendations

1. The study observed that there is no sorting of solid waste in the three markets in Zanzibar municipality, and so the separation of solid waste should be considered from the point source, Apparently, there is an urgent need to increase the number of facility to collect waste around the market as well as the number of the collections. In order to overcome the problem, two movable plastic bins with a bigger volume are enough to separate biodegradable and non-biodegradable solid waste.

2. An adequate number of skip containers (7 m^3) must be provided at the collection centre, along with frequent collections. Alternatively trolleys of a bigger size of about 18 m^3 could be placed to collect the solid waste, since they could also be easily transported to the dumping site. The study recommended that the new disposal site at Kibele area should be equipped with proper solid waste disposal facilities include sanitary land fill. Composting is a preferable recommendation for the high amount of biodegradable waste generated by the market. The compost could be very useful for making agriculture and urban gardening productive and non-biodegradable solid waste should be collected, segregated and transported to recycling centers.

3. Involvement of the private sector in SWM is of paramount importance, it is therefore highly recommended that they should

be involved in collection, transportation and treatment processes such as composting and recycling.

4. The ZMC should be responsible for propagating the awareness among the market traders, market leaders and Government staff of SWM through intermittent seminars, workshops, posters, radio/TV programmes and training.

5. Environmental study must be carried out at Mwanakwerekwe dump site to assess both the environmental and social impacts to highlight the impact of using this area as a disposal site. However, for the time being, the best approach is to stop using this area and instead reinstate the previous routine of picking up the waste and disposing of it at the Kibele dumping site.

6. This study recommended that the Jumbi Dump site should be closed permanently for the disposal of solid waste together with the community around there.

References

1. Tchobanoglous G, Hilary T, Samuel AV (1993) Integrated Solid Waste Management: Engineering Principles and Management Issues. New York, McGrown Hill, USA.
2. NEMC (2004) The Environmental Management Act.
3. Zanzibar Municipal Council (2009) Plan for the Year 2010/2015. Zanzibar, Zanzibar Municipality Council.
4. Black K (2004) Business Statistics for Contemporary Decision Making Fourth (Wiley Student Edition for India eds), Wiley-India.
5. Zanzibar Municipal Council (2009) Pilot Business Plan in Municipality of Zanzibar, Zanzibar, Division of Sewerage, Drainage and Solid Waste.
6. Vuai SAH (2010) Characterization of MSW and related waste-derived compost in Zanzibar municipality. Waste Manag Res 28: 177-184.
7. Ogawa H (2000) Sustainable Solid Waste Management in Developing Countries. Geneva, World Health Organization.