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Municipal solid waste management of Zanzibar: Current practice, the challenges and the future

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A B S T R A C T

This paper presents the current status of municipal solid waste management (MSWM) system in Zanzibar municipality. The study provides an overview with focus on different aspects of MSWM such as generation, collection and disposal, recycling, identifying the main problems and limitations that hinder improvement in the current municipal solid waste management practices and suggestion on the measures to be taken to alleviate these problems. The information was obtained from Zanzibar Municipal Council (ZMC) personnel with varying responsibilities within the system, relevant stakeholders and representative community members using questionnaire. Similarly, photograph, documentation, field and direct observation were considered to add value of information. The MSWM is still inadequate, as the average collection efficiency is only 45%-50% of mixed waste and open dumping is the prevalent method for final disposal without proper treatment creating a potential to environmental pollution and human health risks. Provision of services by the municipal authority is hindered by limited budget, inadequate technical capacity, the absence of policy, lack of comprehensive legal and regulatory framework, weak enforcement of by-laws, inadequate data on generation rate and waste characteristics, poor urban planning and infrastructures and socio-cultural patterns.

Introduction

The production of municipal solid waste is an inevitable consequence of human activity, and its management directly impacts the health of the people and environment surrounding it (Vergara, 2012). The process of Municipal Solid Waste Management (MSWM) encompasses all the function of direct waste generation, storage,

collection, source separation, processing, transport, treatment, recovery and disposal (Agamuthu, 2011). These processes have to be carried out within existing legal, social, economic efficient and environmental guidelines which are very important for the protection of public health and aesthetic and environmental reasons (Jafar et al, 2010,

Pattnaik 2010). To achieve these goals, effective and sustainable Municipal solid waste management systems must be embraced by local authorities with appropriate organizational capacity and cooperation between numerous stakeholders in the public and private sectors actors (Schubeler, 1996; Henry et al, 2005). However, management of MSW is most challenging compared with other types of wastes particularly in the developing world. The management in most cities of developing countries is highly unsatisfactory (Scheber, 1996).

Waste is a visible concern in Zanzibar. As part of the developing countries and East Africa in particular, Zanzibar experiences difficult in waste management. With population growth due to rural- urban migration and being economic center, the generation of wastes in the Zanzibar Municipality has increased (Gauff, 2005; SEZM, 2005). Currently, the daily production of the municipal waste is estimated to be approximately 300 tons (ZMC,2013). However, due to resource crunch, the municipal has capacity to collect and dispose of only 60 tons (SEZM, 2005; ZMC,2013). Zanzibar Municipal Council (ZMC) is the sole responsible body for waste management in Zanzibar and urban municipality in particular but faces many challenges in terms of human and material resources to effectively manage waste problem.

One of the fundamental problems facing Zanzibar communities is the lack of formal system for solid waste management and is more apparent in informal settlements (SEZM,2005; ZUSP,2010). Although the Zanzibar Municipal Council (ZMC) engages in collection of municipal solid waste, this service is still inadequate; a significant proportion of the population doesn't have

access to collection services (ZSDP,2005; SMOLE,2011). Thus, residents opt to dump waste on available spaces throughout the suburbs - resulting unsightly piles of waste and wind-blown litter everywhere. These piles of waste are scattered around residential areas and presents health risks, causes bad odors and surface water channels and drains to be blocked (ZUSP, 2010).

At present, there are limited studies focusing on municipal solid waste management practices in Zanzibar with particular emphasis on environmental impact rather than its detrimental effects to human health. In addition, there is lack of basic epidemiologic data on the health impact of prevailing waste management practices. Therefore, there is a need to address the municipal solid waste management issues and associated problems which may pose health risks to the Zanzibar communities. Thus, the aim of this study is to assess the current status of municipal solid waste management system and the associated health risks. The study focuses on different aspects of MSWM such as collection and disposal, identifying the main problems and limitations that hinder improvement in the current municipal solid waste management practices and suggestion on the measures to be taken to alleviate these problems.

Experimental

Study design

This study employed a descriptive cross-sectional design that was conducted between July to November 2013. For the purpose of primary data collection, the respondents in the study were grouped into two categories as follows: (1) Zanzibar Municipal Council personnel with varying responsibilities within the municipal waste management system; (2) Stakeholders from local

government such as administrators and planners, decision makers at national level, heads of department from Environment and Water authority and Higher Educational Institutions. The respondents recruited in this study were purposely selected based on their role and relevance on Municipal Solid Waste Management issues.

Study area

The study was conducted in Zanzibar municipality (Figure1). The municipality is located in the Urban District in the Urban West Region of Zanzibar. Zanzibar is a part of the United Republic of Tanzania, off the coast of Mainland Tanzania East Africa (Unguja about 40 km and Pemba 60 km), extending between latitudes 4 degrees and 6.5 degrees south of the equator(Figure1). With respect to waste management services, the municipality is divided in four zones; Stone Town, West, North and South zone. The municipality constitutes 45 shehias and covers an area of 1,600 m² with a population of 223,033(TPHC, 2012). Shehia is a small administrative unit, which in urban areas is demarcated and in the country side consists of one or several villages(ZSDP, 2005).

Data collection

Instrumentation

Information was collected from municipal officials regarding MSWM services and practices through a semi –structured administered questionnaire. The following information is elicited in the questionnaire;

- Part A: General information and waste generation and composition
- Part B: Administration of services including collection services, frequency of collection, collection and transportation facilities(equipment and vehicles),recycling,treatment and disposal.

- Part C: Financial aspect
- Part D:Policy aspect such as MSW plans on waste reduction strategies, legal and administrative framework, enforcement measure and capability, existing guideline and standards
- Part E:Human resource capacity
- Part F:Control and monitoring of services
- Part G: Other general issues including problems, challenges and opportunity and trend in MSW
- Part H; Environmental and Health impacts from the MSW practice.

Field visit and direct observation was emphasized on collection points, collection containers, transportation equipment, disposal sites and potential public health and environmental impact. The photographs were taken on each functional element involved in MSWM.

Similarly self-administered questionnaires were used to obtain information from relevant stakeholders in this field of study. Again, questions relating to MSWM were addressed with more focus on the individual knowledge and awareness on MSWM, public health and environmental concerns, views on the importance of plans, legislations and policy coherence on MSWM as well as stakeholder cooperation, and suggestions on the alternative solutions to improve existing MSWM.

Result and Discussion

Municipal Solid Waste (MSW) generation and composition in Zanzibar Municipality

From the survey, the waste generation rate in Zanzibar Municipality was 0.5 kg/person/day resulting in a total of 216 tons of solid waste per day. Currently, it is estimated to be approximately 300 metric tons and average density from household is 0.33kg/l (ZMC, 2013).The quantity of waste generated shows a

steadily increase trend with population increase in the municipality from 120tons/day in 2001 to 216tons/day in 2005 (Gauff, 2005; SEZM; 2005).In general, the projection of population growth in the municipality by 2025 is 2.9 million with MSW generation per capita of 0.55kg/capita/day (World Bank, 2012) and therefore the waste generation is estimated to be 1,594 tons/day.Increased of municipal waste generation in many African cities was related to rapid urban population growth (Achankeng, 2003). This situation places urban councils in difficult condition as they have to develop new strategies to deal with increasing volume as well as strange variety of wastes in order to prevent adverse impact to the environment and human health (Okot-Okum,2012; Pattnaik,2010;Ogunrinola,2012).Study by Okot-Okum (2012) in East African Cities reported that by rapid urbanization caused by rural to urban migration outstretching resources has increased the waste generation.

The main component of MSW in Zanzibar Municipality is predominant biodegradable organics (86%) followed by recyclable,i.e. plastics (4%)(ZMC,2013). Other types of waste ubiquitous in small quantity are paper (2%), metals (2%), textiles (1%), cardboard 1% and glass 1% (Figure 2).The high organic content in waste stream is influenced by living standard and food habits of the inhabitants in Zanzibar to depend more on the raw and unprocessed foods such as fresh fruits, vegetable and other agricultural productsfrom which agriculture is the backbone of the Zanzibar economy. Average weight percent of plastics is found to increase due to the frequent use of bottled drinks in many occasions of town activities and due to tourism industry which is the growing sector leading to increase GDP of the country (ZHDR, 2009).

The findings for waste composition are consistent to the observed phenomenon that people in the low income country produce

more food waste than paper because they cook their own food, while higher income country do not cook (Tchobanoglouset al.,1993; Khatib.I.A, 2011). Also food waste are lower in high income country because of improved food processing techniques and the increased use of food waste grinders, hence relatively high plastic and paper for food packaging characterize their waste stream.

MSW storage and handling

The study reveals that, MSW generated in Zanzibar is stored in different containers at different premises of Municipality. The council provides metal bins of 7 m³ in sizefor communal collection points. There are 42 containers available for the whole municipality. There are also open collection points on the ground called slabs (26-slabs) used around some residential areas. All of these collection points are normally placed at open space along roadside to allow accessibility of unloading waste by collection vehicles.

Within the household, the study shows that the waste generated is usually stored in plastic buckets (20 litres) and plastic sacks which later delivered in these communal collection centres by residents themselves, or they are kept outside the house for those who receive door to door collection services (Figure 3). This door to door service is mainly in Stone Town where the municipality enhances its effort on cleanliness due to its importance on tourism (BP, 2011). Outside Stone Town, the study revealed that residents use communal bins and slabs where available or they have alternative means of disposing their waste including open piles, burning, burying (Figure 3). Similarly, large plastic bins (70 litres) are commonly used at commercial areas such as shops owners and restaurants and institutions such as offices and schools which brought along roadside to facilitate their collection by municipal collection workers. Street sweepers were using trolleys for storing the waste from roadsides during cleaning.

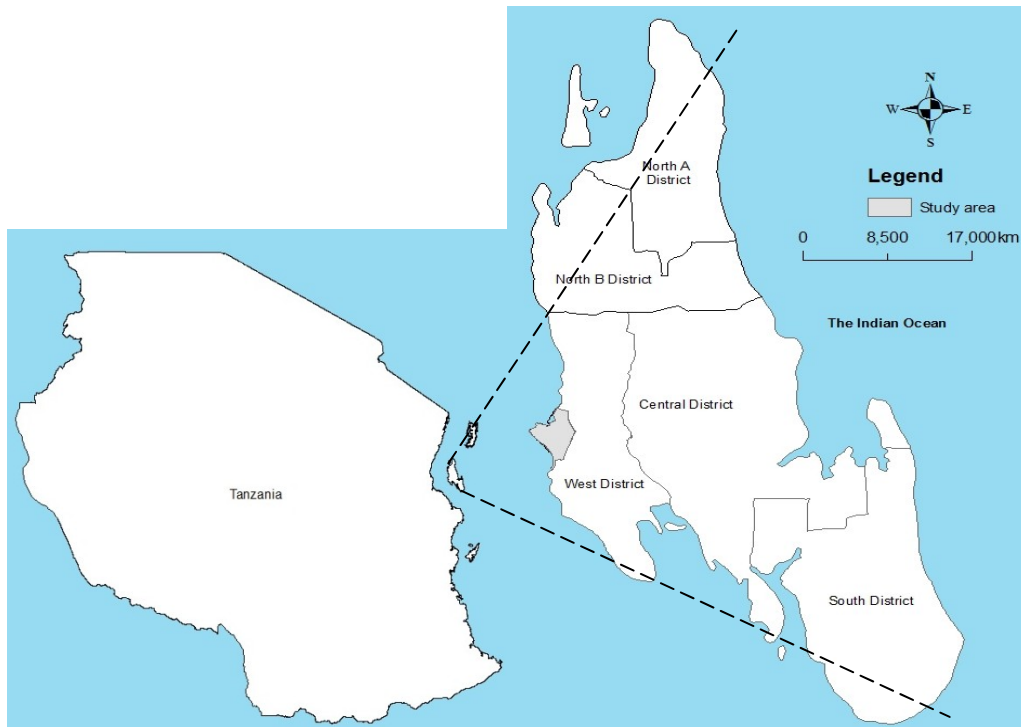


Figure.1 The location of the study area (Zanzibar Municipality)

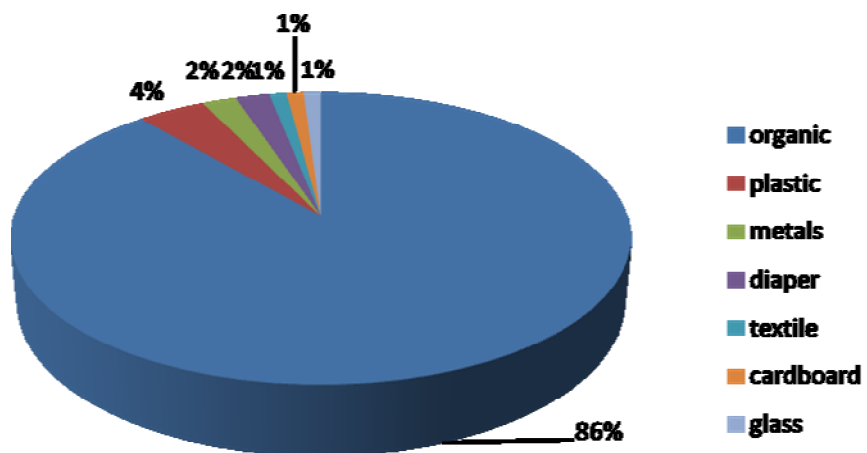


Figure.2 Municipal Solid Waste composition in Zanzibar Municipality



Figure.3 Example of plastic sacks for household storage containers (left) and communal collection containers (right)



Figure.4 Equipment used waste for collection

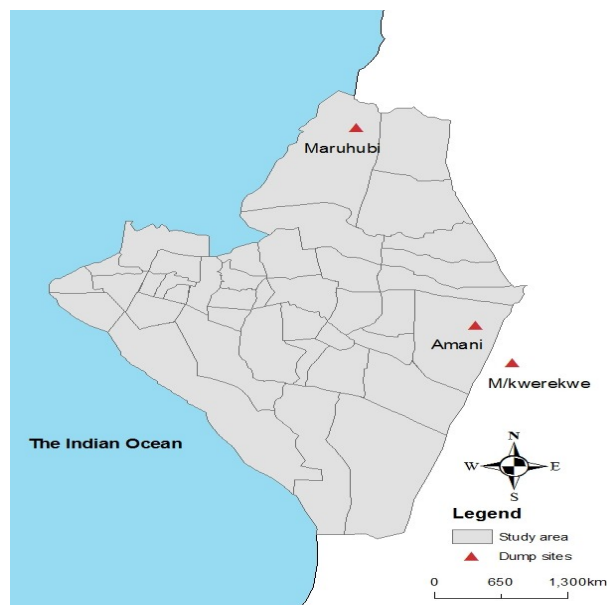


Figure.5 The location of the dumping site in Zanzibar



Figure.6 Indiscriminate dumping in residential areas

Table.1 MSW collection rate in Stone Town

	2008	2009	2010	2011	2012
MSW generation (tons/year)	87,984	91,584	95,040	98,496	101,952
Collected and disposed MSW (tons/year)	39,593	41,854	43,718	44,816	45,869

Table.2 The informal dumping sites used for waste disposal in Zanzibar Municipality

Items	Disposal site		
	Site 1	Site 2	Site 3
Name of site	Mwanakwerekwe	Amani	Maruhubi
Total area(ha)	NA	NA	NA
Year when disposal started	NA	April 2012	NA
Estimated life span remaining (year)	One month	One month	2 months
Amount of waste disposed daily(tons/day)	97-120 tons	97-120 tons	97-120 tons
Distance from collection area to the site (km)	4km	3km	3km
Disposal method	Open dumping	Open dumping	Open dumping
Existence of animal on site	Yes	Yes	Yes
Existence of waste pickers or scavengers on site	Yes	Yes	Yes
Existence of open burning on site	No	Yes	No

Note: NA –not available

MSW Collection

The average collection efficiency of generated waste in the Municipality is between 45% and 50%, while the remaining 50 to 55% is left unattended (Gauf, 2005; SEZM, 2005; Kalin, 2012; ZMC, 2013). It is locally dumped, burned, animal feeding or individually assorted for personal recycling or swept away by the rain (into the storm water channels or directly to the sea) or just accumulated in heaps in many parts of the town (BP, 2011). Table 1 indicates the collection efficiency of municipal waste in Stone Town where only 45,869 tons/year out of 101,952 tons/year half of the waste being collected and disposed in 2012. The Zanzibar Municipal Council (ZMC) under Sewerage, Drainage and Solid Waste Division is a major player of the waste management in the municipality. However, in some other parts of residential areas such as Amani, Jang'ombe and Kikwajuni, informal groups in the community are also engaged in collection process including waste pickers who find economic benefit from waste.

Municipality utilizes primary collection system through door to door and curbside collection where the waste is directly collected from the generator to the collection point mainly large skip, as well as secondary collection from shared communal containers (metal skips) and slabs to the final disposal points. MSW is collected by ZMC employees during morning by either door to door usually at household level and mostly in Stone town Zone or curbside collection operating at shops, markets, institutions where municipal collection workers walk around street alleys to empty the storage containers into pushcart and removed into large collection containers (metal skips) which finally unloaded by trucks to the dumping site. The municipality use shared containers (communal bins) in most residential areas outside Stone Town.

For residential areas, the collection frequency varies from daily in Stone Town

(the main city in Zanzibar) to two times and once a week in other residential areas such as Amani fresh and Rahaleo where the shared containers are used as a collection point. In addition, uncontrolled proliferation of settlements and absence of paved roads in most parts of municipality is one of the factors that hinder this process because it reduces accessibility. As a result, some residential areas such as AmanikwaWazee are not reached by the collection services.

Equipment used for primary collection (i.e. collection of waste from households to communal bin or depot for subsequent collection by collection vehicles) include wheel barrow (1-wheel) and handcarts/push carts (2 wheels) (Figure 4). The study also reveals that the problems of scavengers hamper the collection process in the containers as they are salvaging for recyclables and scattering the waste around the containers creating unaesthetic environment. Scavengers are mostly children between the age of 6 to 15 years, and drug abusers. It is normally practice to the waste pickers in residential areas where no particular collection service is provided such as in AmanikwaWazee and Jango'mbe, to place the collected waste at open piles or randomly dumping the waste within neighborhoods. This creates a potential to pathogenic organisms from accumulation of wastes in their localities. During raining especially out of stone towns, people throw their waste which cause the blockage of drainage and surface water channels. This results in flooding and encourages vulnerability of infectious diseases (ZUSP, 2010; ZMC, 2013).

These results are in line with many findings obtained in the previous studies where door to door services has been found convenient to the rich neighborhoods who afford to pay, otherwise the use of communal collection points was preferred. Whenever, services is

missing, residence opt to dispose the waste in unauthorized places such as drains and gullies, burning of waste, burying in the yards which results breeding sites for disease vectors and flooding due to blockage of storm water channels which stands the public health risks. Surveys conducted by UN-Habitat show that in areas where waste is not collected frequently, the incidence of diarrhea is twice as high and acute respiratory infections six times higher than in areas where collection is frequent (UN-HABITAT, 2009).

Separation and Recycling

The study showed that, there is no source separation of waste done in the municipality at any step of the management process. Thus, the waste collected is a mixed waste of different characteristics and handled altogether to the final disposal at the open landfills/dumping sites. They also do not conduct any recycling activity, but there are local recycling agencies existing in small scale dealers such as Zanrec plastics Ltd. The data in 2010 to 2011 indicated 8.8% of materials were recyclable specifically metals and plastic bottles (ZMC, 2013). Due to limitations on penetration of markets to these agencies, the activity just goes up and down. Recovering activities is also hindered by the negative public attitude believing that scavenging of recyclables is condemned by poverty.

Transportation of MSW

The results revealed that transportation of MSW to the dumping sites is carried out by vehicles such as trucks, skips and compactors. There are three (3) open truck without tipping mechanisms, ; one (1) tractor, ; two (2) compactor trucks, ; and three (3) skip trucks all of which are used to load the waste from secondary collection

points, i.e large skip containers and open slabs. Open trucks and compactor used for open slabs and skip trucks are the one used for loading skips. However, the study shows that the transportation capacity is still inadequate, with the exception to the compactors which have been purchased recently under World Bank support, many of these vehicles are more than 10 years of age and not in good condition where in some cases, they face frequent breakdown and makes the waste condition in collection points worse.

Final Disposal and Treatment

Available data showed about 97-120 metric tons/day of mixed waste collected from different premises of municipality are disposed at Landfill (ZMC, 2013). At present, there is no permanent landfill operated in the municipality since the closure of the Jumbi central dumping site. The study showed that, the municipal waste is disposed in the open dumping without any form of treatment after collection. Table 2 indicates the informal dumping sites used for waste disposal in Zanzibar Municipality. Normally sand quarries areas are used as disposal site by municipal with the purpose of maintaining land reclamation. Field observation showed that these sites are not properly designed and there is the problem of the vicinity to the residence which is significantly public concern due to environmental nuisance, bad odor, presence of flies and rodents, and stray animals. Surrounding residents claimed that dumping should not be located to nearby them as they are the most victims suffering from dirty brought by sites. Figure 5 shows the location of these dumping sites.

Also the municipal is threatened by presence of numerous informal dumping around residential areas which is potential for

considerable environmental and health hazards to the nearby residents (figure 6). Uncontrolled dumping and improper waste handling causes a variety of health problems associated with mosquitoes, flies, rodents, contaminated water, bad odor and generally nuisance (SEZM,2005; ZUSP,2011). Contamination of water sources by municipal solid waste leads to the outbreak of communicable diseases such as cholera, typhoid and bilharzia (Vuai,2010). The observation during the study revealed that existing landfills are not corresponding to sanitary hygienic standards. Thus, Municipality authority is planning to use its new dumping site at Kibele and implementing Integrated Solid Waste Management. The site is located about 15km from urban centre with a total area of 20 hectares. The dump is supposed to start operation effectively from December, 2014 with controlled mechanisms to reduce its negative impact to the surrounding environment and human health at large. The composition data showed potential for composting as pre-treatment before landfilling which can be effective measure to mitigate Global Warming Potential of SWM and reduce demand on landfill. Zanzibar Municipal Council is planning to initiate composting plant and recycling activities at this new site; however, its source of funds depends mainly on external donors and so far has not been identified yet.

The results are consistent to those obtained from other studies which show that most low- income and lower-middle income countries dispose of their waste principally in open dumps (World Bank, 2012). This method used by majority of urban centers in Developing world is neither hygienic nor safe (Mangizvo, 2010). Disposal of solid waste on land without careful planning and management can present a danger to the

environment and impair human health (Abul, 2010). The danger of open dumps include health, hazards to scavengers at the dumpsites, ground water pollution, spread of infectious diseases, highly toxic smoke from continuously smoldering fires and foul odors from decomposing refuse (Ogwueleka, 2009).

Existing Problems

Problems encountered in MSWM services in Zanzibar Municipality are as follows:

- (a) The collection coverage of MSW in Zanzibar Municipality is still inadequate; only 45% of the municipal waste collected. Existing system appears to be incapable of coping with the waste generated which is only centralized to urban council authority. This results in the accumulation of refuse in open spaces and littering, leading to harboring of disease vectors and unhygienic aesthetically problem from unsanitary environment.
- (b) The inability to sort waste may include hazardous substances in waste stream during handling and released on the land is also one of the problems. Besides, there is no any treatment strategy done in the Zanzibar municipal waste stream.
- (c) The study reveals that informal dumping in the open land mainly old quarries is the only disposal option for waste collected by urban council. Also inappropriate disposal practices such as burning, burying and indiscriminate dumping is commonly observed in the residential areas especially areas lacking collection services. Uncontrolled disposal is potential for all kinds of environmental pollution and deleterious effects on human's health of the surroundings residents.
- (d) The health and safety of workers to handle the waste is not so much ensured because they are not provided with enough protective gears to prevent them from injuries and

being infected. Workers claim of frequent suffering from dermatological conditions, respiratory ailments, eyes problems, feet, and those who are responsible for loading the waste, backbone aches is a common problem.

Municipal Solid Waste Management Challenges

Zanzibar Municipal Council (ZMC) as a responsible authority for management of municipal waste is facing many challenges which hamper its effort for service improvement such as follows;

(a) The inefficient collection system and disposal problem is mainly attributed by the shortage of funds to operate the waste management sector. The municipal council depends mainly on central government and donor's grant to get the fund for operation of waste management. This results to inadequate technical MSWM capacity to suit the operational requirements. In mean time, the municipal is receiving foreign aid from World Bank to support the solid waste management in its jurisdiction under Zanzibar Urban Services Project (ZUSP). However, this portion is targeted on improving facilities such as increasing the number of collection points from 42 metal bins in residential communities to 193, plastic bins for commercial waste storage and purchase of trucks to facilitate transportation. With this support, the municipal is expecting to improve its services and hence upgrade the coverage to 70%.

(b) In order to ensure proper control of waste management practices, countries need national strategies, which provide a legislative and regulatory framework within which enforcement procedures can be carried out. However, the Revolutionary Government of Zanzibar does not have an

overall national policy regarding waste management. ZMC depends on the environmental policy (2013) where waste management issues are not fully addressed. There are few acts dealing with the problem regarding waste management including Public Health act (2009) and environmental regulations such as Environmental Impact assessment of 2002 and the Banning of plastics bags of 2011. The study showed that at the Municipal level, there is only ZMC (sewerage, Drainage and Solid waste), By-Laws 2006, dealing specifically with waste management to help it to control and regulate activities taking place in its jurisdiction. Nevertheless, it has been observed that there is lack of enforcement of these laws and regulations.

(c) Lack of skilled personnel for MSWM service also a challenge to ZMC. It is only 7% of skilled professionals, the majority are laborers who engage in street sweepings, grass cutting, collection of waste to collection points, containers cleaners, supervisors and drivers transporting the waste to dumping site and big gap of technical staffs. Training of the staff was available but not in regular basis.

(d) Public participation and awareness is essential in order to achieve sustainable and effective waste management. However, people have little knowledge about waste management issues and they are not aware of the environmental and health threats associated with improper waste management practices. There is no outreach program or awareness campaigns to educate people about the importance of separating their household waste at the source and correct garbage management. The survey results from selected residential areas deemed indicated low level of segregation (8%) at the household level and usually food scraps for animal feeding.

(e) Public attitude has very positive impact on effective waste management

system when the public fully realizes its significant role on garbage management as the main generator. Local resident's willingness to source separate recyclable materials, willingness to pay for the service and their capacity to move waste to communal collection points all have an impact on the overall waste management system. However, negative public attitude is noticed which reflect their low level of willingness to participate in waste management programs. Waste is not seen as problem and this is evidenced by littering, burning of refuse and indiscriminate discharge of garbage, within residential areas which ends up in drains causing blockage. This creates a multitude of public health concerns and environmental hazards. It is a customary of the people to drop plastics bottles and cans, throwing papers and plastic films after use on the streets and roadsides. The aesthetic feeling is offended by the insightfulness of waste pile. This unhygienic scene is made more worst by the rag pickers as they scatter waste around places while collecting recyclables and presence of scavenging animals searching for food and spread the waste.

(f) Waste minimization through reuse, reduce and recycling options are very important for effective waste management. However, due to limited budget, there are no any allocations planned for the development of these alternative waste management options such as composting and recycling in the Municipality. Reuse of the products is done at individual level and mainly plastics. Recycling activity is low and operated informally and the scavengers are the main agency who salvage the valuable materials from waste either from collection containers or dumpsites There is no intensive recycling undertaken by these informal agencies, the only thing practiced is just shredding of the recyclable materials collected to reduce size, balled and shipped to Mainland for

processing. Manually sorting of the recyclable is usually carried out by scavengers from collection points or by rag pickers at the dumping sites immediately after spreading of a layer of waste. This work is done in unhygienic conditions and these sorters are vulnerable to pathogenic infections. Although these informal sectors are playing their role in waste management, their sustainability remains a question due to financial constraints, lack of support and motivation, fall of market from manufacturers and prevailing negative public attitude about scavenging of waste.

(g) Lack of adequate and up to date waste statistics data and information regarding municipal solid waste management is also a problem. The existing data for waste generation covers only Zanzibar Municipality and the analysis of waste characteristics is only known for Stown Town which has small population compared to other outskirts zones comprising Zanzibar Municipality which are more densely populated areas. The future forecasts and development plans are incomplete.

The future of Municipal solid waste management in Zanzibar

To achieve sustainable and effective waste management system, the municipal authority has to consider political, institutional, social, financial, economic and technical aspects of MSWM.. The following measure should be taken in order to alleviate existing problems and hence improve the municipal waste system in order to reduce negative impact on environment and public health:

(a) The municipal can improve the system by adopting integrated waste management options in its waste management plan. The waste composition data indicated high organic fraction (86%) in the waste stream. Thus, waste reduction

through composting is potential alternative if the biodegradable can be successfully separated at the source and hence reduces the volume of waste required to be landfilled.

(b) Waste reduction stimulates the development of greener technologies and reduces the need for new landfills and incinerators. Therefore, the municipal can achieve effective waste management by promoting waste separation practices, reuse and recycling. Waste separation of compostable and recyclable should be encouraged at the source and at the disposal sites. Wherever, manual sorting is adopted, care must be taken to ensure that sorters are protected from disease pathways and work in hygienic conditions.

(c) Public education and awareness: Public awareness and attitude can have impact to the people willingness to participate in MSWM issues and follow appropriate waste management practices. Therefore, to get public onboard, educational programs and awareness campaigns needs to be undertaken to educate the public about their roles, upgrade their practices and shapes public behaviour towards sustainable waste management.

(d) Formulation of national policy, comprehensive legal and institutional framework and strengthen enforcement mechanisms of laws and regulations governing various aspects of MSWM. Periodically review of existing by-laws and development of new regulations, guidelines and standards are also important.

(e) Zanzibar is still virgin in terms of research development, there is little done regarding waste management. Therefore there is a need to enhance further researches regarding MSW to be conducted in Zanzibar such as studies on MSWM characteristics by sources, by the types of wastes produced, as well as by generation rate and composition. Study also should focus more on social

dimensions such as public behavior on waste reduction activities and willingness to participate in waste management issues.

(f) Stakeholder involvement and institutional set-up: The municipal council as the only responsible authority alone can't perform the waste management functions. Active participation of different stakeholders including public, various government agencies, private sector and informal sectors is necessary. Therefore proper institutional arrangements can improve the urban services and hence increase system efficiency. Clear delineation of roles and responsibilities and awareness of the lines of accountability of the government, private sector, community and informal groups would enhance efficient and efficacies MSWM.

(g) Decentralization of services to public- private partners could increase the quality and efficiency of the collection services. Thus, the municipal should coordinate and work with private and informal sectors through NGOs and CBOs for efficiency delivery of primary collection services and community based waste management including waste reduction such as recycling. The structure should be primary collection service to be provided by the private investors for commercial places, institutions and road streets. The service in the residential areas to be delivered by the public- partnership groups such as CBOs and NGO and the municipal remains with the task of transporting waste from secondary collection points (communal bins and slabs) to the final disposal sites and their treatment. Control and monitoring of the services administered by these agency is necessary element for the system functioning.

(h) The municipal council should not only focus on cleanliness but also paying attention to environmental quality and public health concern after waste is

disposed. Safe disposal of waste is important for protection of environment and health benefits and therefore disposal sites must be sited following operating criteria of dumpsites including fencing to restrict public access and daily covering of soil materials to control disease vectors populations such as flies and rodents and environmental nuisance. Laws and regulations on waste disposal should be enacted and enforced such as fines and penalties, for improper disposal of waste including illegal dumping and burning. In a long run, the Municipality has to consider proper designing of landfill sites complying with sanitary standards such as leachate control and landfill gas emission to avoid compromising water, soil and air quality.

(i) The national budget for MSWM should be increased to enable the municipal authority to function the system effectively. The funds will increase technical capacity and enhance input to the planning, implementation and operation and monitoring of the system and its sustainability. Municipal authority could strengthen financial mechanisms through polluter-pay services and initiate developmental projects such as bio-gas production with foreign investors.

(j) There must be sustainable training of personnel to improve efficiency in the services. Direct handling of waste can result in various types of infections and chronic diseases to the workers, therefore, Municipal authority must ensure occupational health and safety measures are taken such as providing safeguard equipment to waste handlers and routine examination to check their health condition.

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