

Municipal Solid Waste Source Identification, Characterization and Physical Composition Analysis, case Study Wolkite Town, Ethiopia

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Abstract

Solid waste, which is a consequence of day-to-day activity of human kind, needs to be managed properly. This study deals with municipal solid source identification characterization and physical composition analysis the case of wolkite town, in order to conduct this study both primary and secondary data were collected and analyzed, the Findings of this study revealed that household, hotel, and restaurant Kera, school (wolkite university) are identified as major source of solid waste. Regarding the composition /characteristic municipal solid wastes can be segmented into two major components called biodegradable and non-biodegradable and the major component of solid waste are food, festival & plastic, textile, ash & fine sand, manure, piece of wood & sugarcane byproduct, chat, leave & grass., the finding of this study recommend community awareness creation about solid waste management, apply different waste minimization mechanism and establish small scale enterprise those will collect solid waste in the town.

Keywords: key words, *solid waste, physical composition, characterization*

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1. Introduction

Having information about the sources and types of waste in an area is required in order to design and operate appropriate solid waste management systems (Tchobanoglous et al., 1993).

It comprises different materials: like dust, food wastes, packaging in the form of paper, metal, plastic or glass, discarded clothing, garden wastes, pathological waste, hazardous waste and radioactive waste (WHO, 1984).

Solid waste can be effectively collected and properly disposed. It can also be converted to useful materials by separating it into its organic and inorganic constituents. Most solid wastes in developing countries have character fermentable nature. Since it composed of organic waste, it can be used as soil fertility improvement and minor plant nutrient (Oyelola, O and Babatunde, A, 2013).

Cities are generating an ever-increasing volume of waste, the effectiveness of their solid waste collection and disposal systems are declining. In urban centers throughout African regions, less than half of the solid waste produced is collected, and 95 percent of that amount is either indiscriminately thrown away at various dumping sites on the periphery of urban centers, or at a number of so-called temporary sites, generally urban waste management has been a challenge for municipalities and urban governments in the developing world, largely due to poor infrastructure, bureaucratic competence and limited institutional capacity of the municipalities (Oyelola, O and Babatunde, A, 2013).

According to Environmental Protection Authority (EPA) and World Bank study conducted in 2004, per capita amount of waste generated in Ethiopia ranged from 0.17 to 0.48 kg/person/day that is in urban areas and the amount of solid waste generated range from 0.11 to 0.35 kg/capita/day that is in rural areas. The range depends on several factors such as income and season. The total generation of municipal solid waste in Ethiopia in 2003 is estimated to be 2.8 to 8.8 million tones. This can be split to approximately 0.6 to 1.8 million tons from rural areas and 2.2 to 7 million tons from urban areas.

Rapid increase of the rate of municipal solid waste (MSW) production and disposal is a problem that is experienced by all counties in the world (Zhen-Shan *et al.*, 2009). The generation and management of solid wastes are the problems facing both developing and developed countries. Generation of solid waste has become an increasing environmental and public health problem everywhere in the world (USAID, 2009)

City solid waste management has also a challenge for municipalities and urban governments in the developing countries. Inappropriate management of the solid waste that generated from the urban area of developing countries result in environmental pollution and also affecting the health of the people, this is because solid waste create favorable condition for the breeding of flies and rodents, so these insect are the primary carrier and dispersal agents of diseases in many developing countries in the world ((USAID, 2009)

In many of the cities in Ethiopia the municipality administration is responsible for waste collection. Despite the fact that, there is a wide variation in performance in relation to waste collection in cities of Ethiopia, it has become a common business practice to have household waste to be pre-collected by individuals who are organized through formal or informal association. The pre- collected waste is then transferred into containers then which are collected by municipalities. However, in many cities there are not enough containers to cover the population and for long periods of time vehicles are typically under maintenance or out of service. As there is very limited effort to recycle, reuse or recover the waste that is being generated (EPA, 2004).

The amount of waste that ever reaches dumps sites or landfills in Ethiopia is small fraction. a number of studies have shown that only 43% of waste in the country are properly collected and disposed in open landfills. The remaining waste is indiscriminately disposed in drainage lines, open spaces, street sides or is informally burned.

Wolekite is one of the swiftly urbanizing centers, but has been tackled with an increasingly growing urban waste generation and management problem. There are many wastes that dispose from different source and the way of management of those solid waste is poor,, thus the objective of this research is to identify the source, analyzed physical composition and characteristics of solid waste in the study area.

2. Methodologies

2.1 Research Design

The nature of research problems often dictates the methodology of the study. This study aims at

Assessing the source, physical character, generation rate and deposal system of solid waste, thus, both qualitative and quantitative information are help to better understand, explain, and interpret the source, the type, amount of solid waste in the study area. Therefore, this study were make use of Cross sectional research design, this is because the information were collected at one shot, which includes various quantitative and qualitative data sets. The qualitative approach were comprise key informants interview and focus group discussion, whereas quantitative approach were conducted through household survey. Solid waste characterization (physical component and generation rate of the solid waste).

2.2 Data Source

In order to conduct this study both primary and secondary was collected.

2.2.1 Primary Data

The primary data was collected from sample households respondents, researchers' observation, and focus group discussion and key informants interview. Secondary data were collected thorough review of all available published and unpublished documents of relevant organizations were collected.

2.3 Sampling procedure and sample size determination

This study were employ multi stage sampling technique, in order to select the sample household from Wolkite town, since wolekite town have three sub towns, these are Addise, Bekur and Gubre sub towns : thus, in the first stage three kebeles were selected from these three sub town, kebeles from each sub town were selected purposively based on the availability of solid waste, in the second stage selected kebeles were stratified in to different Mender/ village and those village that are more relevant for this study were selected

accordingly from Selam Bere kebeles three villages were selected purposively these are 'Garaba', 'Atsede' and 'Mehal tena', from Bekure kebele 'katoleke', 'Hayat/Aresema' and Barunj were selected purposely and from Gubire kebele 'megenanga' vellege were selected purposively, finally from the selected village household respondent were selected using simple random sampling technique. To determine the total number of participant during household survey the study apply the formula that is provided by (Cochran, 1977)

$$n = \frac{NZ^2PQ}{d^2(N-1) + Z^2PQ}$$

Where;

P=Housing unit variable (Residential houses)

Q=1-P (Non residential houses)

N=Total number of housing units (4809)

Z=Standardized normal valued that corresponds to 95% confidence interval equal to 1.96

d=Allowable error (5%)

Therefore, the result, n=287 of house household heads were selected from the selected kebeles.

In addition to selection of sample respondent from the three selected kebeles Hotels, restaurants, dinner and chat chewing residence were also selected purposively, subsequently they assessed and weight their daily solid waste generation rate.

2.4 Method of Data Collection

3.4.1 Socio Economic data collection

A. Questionnaire

A structured questionnaire design to collect information .from selected households to have information about their socio economic status, housing condition, onsite solid waste handling and solid waste disposal practices. Semi-structured questions will use to collect information from experts and waste water disposing institutions

B. Focus group discussion

This is arranging to supplement the data that obtain from household survey and collection of solid waste The discussions were conducted with a group of individual who are residual of welikete town that composed of different social groups. In each selected kebeles two focus group participant will be formed. A total of 6-12 people were participate in the group discussions. Checklists will be prepared to lead the discussions:

C. Key informant interviews

It was conducted with different concerned individuals at different levels. Key interviews with key informants will conducted in order to generate qualitative data. The interview were held with different experts in waste management, kebele administrations and other social institutions selected through purposive sampling

D. Field Observations

Personal observation of the facts on the ground is very important in order to gain relevant data that supplement the information that were gathered through the above instrument. Observation were done through transect walks across the selected *kebeles* The researcher were observed, how different institutions and housing units in the sample *kebeles* managing the solid waste and the solid waste deposal site of the study area.

3.4.2 Solid waste data collection

Solid waste collection and sorting were conducted from Addis Hiwot and Selam Bere and Gubire kebeles. gathering and sorting of solid wastes from the selected households were carry out for seven consecutive days, this is important in order to have an average result of the whole days of the week, in case of differences in waste generation between days, each household were give a plastic bag labeled with same with the questioner, were given for each household.

Then after seven days the solid waste ,collected from the household, were weigh, the measurement were recorded, after that solid waste collected from different household were mixed together

Finally the mixed solid waste are characterize by different group/component like plastic, food, ash, glass and ceramics, metal, paper, textile and other

2.5 Data Analysis

2.5.1 Socioeconomic Data Analysis

Data generated from household survey were analyze using descriptive statistics like mean, percentage and frequency distribution were used to analyze quantitative data. Qualitative data generated from key informant

interview, focus group discussion, field observation and secondary sources will be analyzed by narrative description.

2.5.2. Solid waste characterization analysis

2.5.2.1 Solid waste physical composition analysis

The solid waste components were determined after sorting sample solid waste into different waste streams and weighing the sorted components separately. The collected solid wastes will be divided into different components. The weight percentages (%) of domestic solid waste components will determine for decomposable (food wastes, grasses and leaf), non decomposable (plastic, paper, metal, glass, textile and Ashes and dust wastes.) The remaining waste consisting of hair, bones and small pieces of charcoal will be categorized as 'other'. So in order to determine the physical character of the solid waste each material that collected as solid waste will be weighed after the sorting. The percentage composition of each residential solid waste component generated from households will be determined by dividing the total amount of a particular solid waste type collected over a week, with the total amount of solid waste of all components within seven days and then multiplying it by 100.

$$\text{Example. Plastic (\%)} = \frac{\text{(Total amount plastic within 7 day)}}{\text{(Total amount of waste within 7day)}} * 100$$

3. RESULT AND DISCUSSION

3.1. Source of solid waste of Wolkite town

In developing solid waste management programs, it is important to identify the sources, characteristics, and quantities of solid waste. This study focuses on assessing students' awareness with regards to identifying the local sources of solid waste.

Municipal solid waste contains highly heterogeneous mass of discarded materials from urban residences, commercial establishments, institutions, street sweepings, and light industrial activities

The information generated from focus group discussion participant, and key informants interviewers elucidated that Wokite town solid waste is generated from different source with different amount and kind. These are household, hotel, café & restaurant, diner, chat chewing residence, beauty salon, public service provider (university, school, and health sector), zonal prison, municipal 'Kera' Waste from market areas, shops. Different fruit remnants from roadside markets and juice houses, Passengers generating wastes like tissue paper & use and throw material.

Besides listing possible sources for solid waste, the FGD participant were requested to specify which source among they have listed, is the leading one. This study also identified the major source of solid waste of the town, thus hotels and restaurants, household, chat chewing residence 'Kera' and wolkit university are identified as one of the major source of solid waste. These are generally categories into residential areas. Commercial area, and institution are the major source of solid waste and they are contributing a lot for amount of waste increment from time to time. The above information is supported by Abebe Tegegne, 2006 stated that there are five major sources of municipal solid waste of the town. These are residential areas, commercial areas, street sweeping, institutions, and small scale industries.

3.2 Composition of Municipal Solid Waste

Municipal solid wastes can be segmented into two major components called biodegradable and non-biodegradable. The biodegradable component of municipal solid waste constitutes organic wastes such as food waste, garden waste, and agricultural waste which undergo biological degradation under controlled conditions and can be turned into compost or organic fertilizer. While non-biodegradable wastes includes inorganic materials which can't be decomposed and degraded (Solomon cheru, 2011).

The composition of a municipal solid waste stream is important for designing material recovery facilities and developing other waste minimization programs. Successful characterization depends on obtaining representative samples of the collected solid waste and making statistically precise and accurate estimates of components weights (Zeng *et al.*, 2005). Thus for this study solid waste collected from different source.

The type and component of solid waste is diverse with source, *kebeles* specifically 'mender' family size, economic status and other factors, this idea is elucidated by Tchobanoglous *et al.*, 1977 accordingly the

percentage of residence solid waste components vary with location, season, economic condition and many other factors

Components that typically make up most municipal solid waste include food wastes, paper, ash, plastic, metals, textiles, glass and ceramics, etc. this study is also support this idea, the major component of solid waste are food, festal& plastic, textile, ash & fine sand, manure , piece of wood & sugarcane byproduct, chat, leave & grass paper

The physical composition by percent of residential solid wastes of *wolkite* town extracted from 287 sample households. The percentage composition of each residential solid waste component generated from households was determined by dividing the total amount of a particular solid waste component type collected over a weak with the total amount of solid waste of all components within seven days and then multiplying it by 100.

According to the solid waste collected from *Addise Hiwote kebeles* specifically three village ie “*Catholic*”, “*Hayat* ” and “*Timekete Bahire village* ” the major compositions of household solid wastes from the studied sample respondent and As presented from the following fig food wastes and Ash& fine sand constitute 25.53% of the total household wastes by weight manure constitute 22.7%, 19% constituted a mixture of sugarcane by product, & piece of wood,, 6% constituted festal and plastics bottles and the

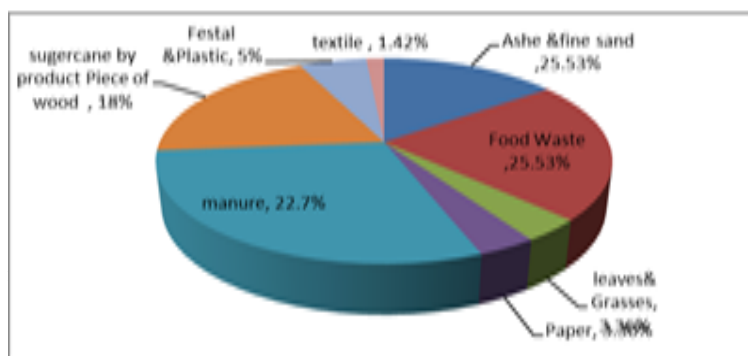


Fig 1 solid waste composition at *Addise Hiwot kebele*

Moreover the solid waste collected from *Selam Bere kebeles* were characterize, thus the result of the study showed that the major compositions of household solid wastes from the studied sample respondent from this kebeles of the total household wastes by weight are food which constitute 28.1%, Ash and fine sand constitute 24%, festal constituted about 8.77%, glass & ceramics 0.88%, chat, leaves and grasses constituted 8.77%, paper constituted 3.51%, textile constituted about 263%, the remaining waste are the a mixture of different material which were difficult to separate .

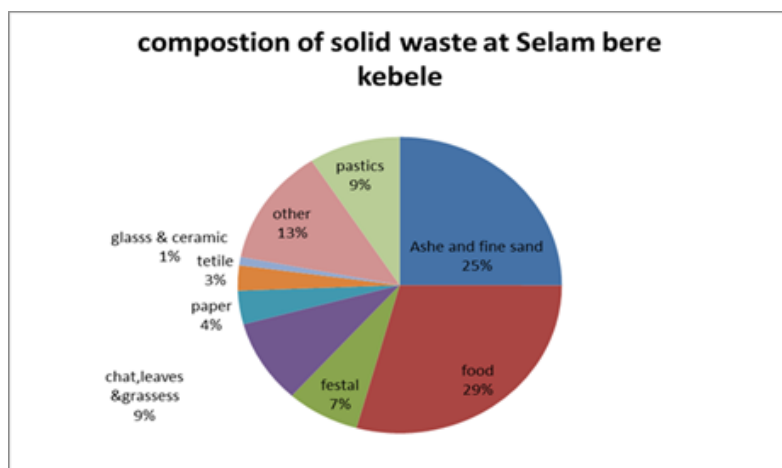


Fig 2 solid waste composition at *Selam Bere kebele, wolkite town*

Generally information that generated from the collected solid waste at household level and characterization of composition generated solid waste indicated that larger portion of the solid waste generated are food and food related which constituted 25.86% followed by ash and fine sand which constituted 24.3% , the third major kind of solid waste generated from the town at the household level is a mixture of different material named as ‘other’, then manure constituted 12.17%, chat, leaves & grasses , plastic, Festal, paper, , textile, and glass & ceramic constituted 5.7%, 5.7%, 4.2%, 3.42%, 1.9 % and 0.39% respectively.

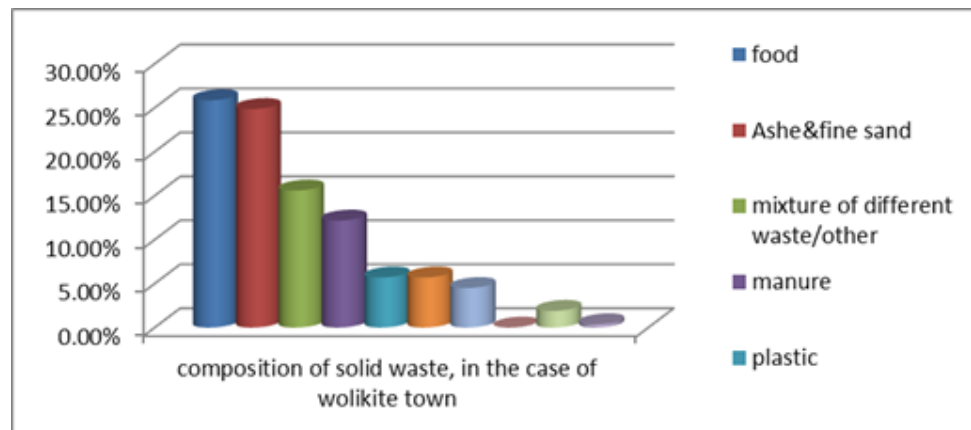


Fig 3 solid waste composition the town

5. Conclusion

Solid waste is arising from our daily life and it generated at every stage of production and development process. Solid waste that generated from different source is effecting of the environment, health of human, animal and pollutes water bodies. Thus having information about the sources, composition and amount/ generation rate of solid waste is very crucial in order to design and operate appropriate solid waste management systems. This study was identify the source, and analyzed characteristic/composition of solid waste. consequently there are a number solid waste source those contribute for *wolkite* town and these source of solid waste generation rate and type of solid waste are varying depending on the source,

according to solid waste physical compotation / characterization analysis result indicated that in wolite town larger portion of the solid waste generated are food and food related which constituted 25.86% followed by ash and fine sand which constituted 24.3% , the third major kind of solid waste generated from the town at the household level is a mixture of different material named as ‘other’, then manure constituted 12.17%, chat, leaves & grasses , plastic, Festal, paper, , textile, and glass & ceramic constituted 5.7%, 5.7%, 4.2%, 3.42%, 1.9 % and 0.39% respectively..

Based on the finding of this research the Suggested future works include In order to manage solid wastes generated from different stakeholder, it is very crucial to apply appropriate solid waste management system.

Moreover Awareness creation to the communities and different institutions about the effects of inappropriate solid waste management system is necessary.

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