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Evaluation of Solid Waste Generated in Ahiazu Mbaise Headquarters and its Implication on Environmental Management System

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ABSTRACT

The study evaluates solid waste generated in Ahiazu Mbaise local government headquarters and its implication in environmental management system. The present waste management practices of the area was evaluated as well as its composition, solid waste produced, quantity of waste generated plus the methods of waste disposal in the headquarters. A cross sectional survey was adopted for the study in which primary representation was collected through direct field measurements to estimate quantity of waste generated for some period. The waste generated was characterized based on biodegradable and non-biodegradable. Questionnaire was administered to elicit information from the respondents. A total of 93 household were utilized to obtain information on waste generation. One way ANOVA test indicate that there is no significant difference in the quantity of waste generated among the three areas mapped out for the study.

Keywords: Environmental management, municipal solid waste, waste generation, biodegradable, non- biodegradable, Ahiazu Mbaise Local Government, Nigeria

INTRODUCTION

Solid waste can be defined for instance as a non-liquid plus non-gaseous products of human activities, considered as being unusable (Leton and Omotosho, 2004). They further stated that it could take the forms of refuse, garbage and sludge. In the same vein, Oyebode (2013) noted that, solid waste management in Nigeria has being characterized by incompetent assemblage approaches, unsatisfactory reportage of the collection structure as well as inappropriate solid waste disposal. Zerbock (2003) noted that these human activities which directly or indirectly produce waste could be agricultural, commercial or domestic waste including household organic trash, street sweepings, institutional garbage and construction wastes. Furthermore, they posited that these sources of waste are highly heterogeneous and are made up of important waste streams such include plastic, food waste, papers, metals, glass, textiles and leather.

According to Onibokun (2009) Ahiazu Mbaise Headquarters is being faced with the challenges of solid waste generation. The implication is extreme when a local government council is growing rapidly plus the wastes are not efficiently managed. In addition, Ogbonna (2007) stated that the lack of adequate data on solid waste generation has posed an ineffective planning for solid waste management in Mbaise headquarters. Similarly, Aliyu (2010) reported that, there will be a significant reduction in the quantity of solid wastes generated, if the public and the consumer oriented companies are willing to change on their own preference to conserve national resources and to hence reduce the economic problems connected with the management of solid waste. Additionally, Abila and Kantola (2013) stated, that there is a uninterrupted upsurge of municipal solid waste production by households, educational institutions etc.

One of the foremost problems of urbanization is solid waste generation. This problem has become more severe over the last twenty (20) years as reported by (Onibokun, 2009). In the same vein, (Ogbonna 2007; Nkwoacha and Ekeocha, 2009) noted that due to the increase in population, there is also an increase in waste generation rates which was orchestrated due to increasing consumption of a range of products and its associated packaging, heaps of municipal solid waste along major roads, stream channels, river banks and in open spaces are very common in Nigeria. According to Adeoye et al. (2011), the quantity as well as the composition of waste generated varies from urban areas to rural areas likewise from state to state and region to region in Nigeria. Solid waste dumped along roadsides are usually left over a long time to decompose naturally by micro-organisms, eaten by animals, picked by scavengers or washed away by the floods into the larger creek and rivers thus affecting the surface water quality (Nweke, 2000). Additionally, Ogbonna (2007) posited that lack of adequate and proper data on solid waste generation has resulted to ineffective planning for solid waste management in Mbaise headquarters. This has greatly contributed to the indiscriminate dumping of waste on the roads, stream channels, bush lands and open spaces. Hence, it has become most significant as enormous illegal dumpsite emerges on a daily basis; it is on the premises that the study was conducted to evaluate solid waste generation in Ahiazu Mbaise Headquarters and its implications on environmental management systems and make recommendations based on the findings.

MATERIALS AND METHOD

The study area is Ahiazu Mbaise Headquarters situated within latitude 5º - 6º degree North and longitude 7º - 8º East. The mean monthly rainfall distribution has its peak in July and September. The mean daily maximum temperature is between 24 - 34ºC respectively, annual rainfall lies between 2000 – 2500mm while relative humidity falls between 80 – 100% (NIMET, 2000)

Research Instrument

The following methodology was utilized in the collection of data; direct field measurement on various locations mapped out for the study, on-site observation, interviews and questionnaires. The evaluation of solid waste generated in the study area was done through sorting, separation, quantification and characterization of waste generated around the region. The sorting and separation of waste in Ahiazu Mbaise was carried out in accordance to the method employed by Abu (2000) while, the area of study was first demarcated based on socioeconomic development hence, the following were considered; type of buildings, road network and socio amenities in the area (Anon, 2012a). Finally, the study area was divided into three namely; Afor-oru, Obodo Ahiara road and Afor – ogbe road.

Method of data collection

Data used for the research were from primary and secondary sources. Primary data were collected through field survey, interviews and questionnaire survey. While field survey involved visiting randomly selected households within the study area. The field survey was to help receive feedback on their willingness to participate in the research. The suitability of the study area households as points of sorting at source was also assessed. In addition, books, articles, newspapers, journals and internet sources were some of the secondary data utilized.

Sample size determination

The number of samples needed as a representation of the population and waste amount was calculated using the Sloven's formula;

$$SS = \frac{N}{1} + N(e)^2 \quad (1)$$

Where,

SS = sample size

N = population size

e = margin of error/error tolerance.

(Puopiel, 2010; Ariola, 2006)

For check other formula relating to the right sample size representative of the population equation (2) was used while for correction of the infinite population were assessed using equation (3).

Where,

P = True population of factor in the population or the expected frequency value

D = Maximum difference between the sample mean and the population mean

Z = Area under normal curve corresponding to the desired confidence level

n = Number of samples of infinite population

SS = Number of samples of finite population

A total of 558 samples were collected within the period of the survey which was far above what was statistically needed. This was done to limit the margin of error as well as close in with the mean and to ensure better accuracy.

$$n = Z \times Z\ [P\ (1 - P)/D \times D)] \quad (2)$$

$$\text{SS} = \frac{n}{[1+\left(\frac{n}{population}\right)]} \quad (3)$$

The procedure outlined by Nordtest (1995) was utilized which states that household number falls within 50 – 250.

Table 1: Number of households of the various areas

S/N	CLASS OF RESIDENTIAL AREA	SAMPLE SIZE
1	Afor-ogbe road	28
2	Afor-oru	34
3	Obod Ahiara road	31

Collection of data

The designed questionnaires were distributed to various households to fill and those who could not fill on their own, were assisted. Data obtain include the following, socio-economic standing, demographics, educational level and knowledge on waste management. Data was also collected from direct observations and field data collection using a sheet to record waste weighed after sorting into various components. Two polythene bags were supplied to each of the randomly samples households for the separation of their solid waste. Each household was given a blue polythene bag for biodegradables and a black polythene bag for non-biodegradables.

Waste from the household was collected once in a week over a period of three weeks. The waste was sorted and separated in the two polythene bags. Biodegradables include food, yard and wood waste, which was sorted into the blue polythene bag while, the non-biodegradables waste include plastics, paper, metal, leather, glass, cardboard and all other waste was sorted into black polythene bag.

Waste quantification and physical composition of MSW Analysis

The per capita generation of the waste and the total waste generation were deduced from the waste components separated. The separated waste were collected, weighed and recorded. The waste were then sorted further and separated into various components and reweighed. The per capita generation was determined as per the mixed and also the separated components using the formula:

$$\text{Per capita waste generation} = \frac{weight\ of\ MSW\ generated\ at\ the\ household}{total\ number\ of\ persons\ in\ the\ household\ X\ total\ generation\ days} \quad (4)$$

The total generation rate was obtained by multiplying the per capita generation by the total population.

Where,

MSW = Municipal solid waste

The analysis of MSW was carried out through its weight plus the percentage composition of the waste and by using the formula described by ASTM (2003) method. Hence, by modification the following were adopted:

$$\text{Composition of separated waste} = \frac{weight\ of\ separated\ waste}{the\ total\ mixed\ weight\ sampled} \quad (5)$$

Separation Efficiency

The efficiency of the separation was assessed by the weight of sorted waste in the designated polythene bag provided as a percentage over the total weight of waste in the same bin as shown in equation (6)

$$\text{Separation efficiency of Bio} = \frac{weight\ of\ Bio\ in\ blue\ polythene\ bag}{total\ weight\ of\ all\ waste\ separated\ into\ blue\ bag} \times 100 \quad (6)$$

Data Analysis

The statistical package for social sciences (SPSS) 16 and Microsoft Excel were employed to analyze the data obtained. The SPSS was utilized to establish if any correlations between income levels of the three socioeconomic classes and the per capita generation and household size as well as the percentage generation of the composition of the waste stream. One way ANOVA was used to test for significant difference between the three classes. The mean value in relation to the standard error of the separation effectiveness of the waste in the three classes was determined at p=95% level of confidence (p= 0.05).

RESULTS AND DISCUSSION

The results of percentage distribution of respondents based on gender and source of knowledge on recycle and separation of waste were represented in tables 2.0 and 3.0 respectively.

Table 2.0 Percentage Distribution of Respondents Based on Gender

Gender	Frequency	Percentage
Male	32	34
Female	61	66
Total	93	100

Sources: Author field work

Table 3.0 Source of Knowledge on Recycle and Separation of Waste

Answer	Number of Respondent	Percentage
Newspaper	28	32.56
Television	11	12.79
Radio	9	10.79
Newspaper, TV, Radio	10	11.63
Radio and TV News	12	13.95
Others	16	18.6

Source: Author field work

The percentage of individuals who got their source through the newspaper was highest in table 3 with 32.56%, followed by others (18.6%), Radio and TV (13.95%), Television (12.79%), newspaper, TV and Radio (11.63%), as well as Radio (10.79%).

Table 4.0 Descriptive Statistics of the Socioeconomic Characteristics of the Respondents

Item	Number of Respondent	Percentage (%)
Have you heard or seen waste separation?		
Yes	3	3.21
No	90	96.8
Are you willing to separate your waste?		
Yes	26	27.96
No	67	72.04
Have you heard or seen waste recycling?		
Yes	7	7.53
No	86	92.47
If recycling center is established would you send waste for recycling		
Yes	21	22.58
No	72	77.42
Would you accept concept of home composting?		
Yes	24	25.81
No	69	74.19
Would you buy an extra bin for home composting?		

Yes	43	46.24
No	50	53.76

Source: Author field work

The results from table 4 shows that 3.21% have heard or seen waste separation within the specified time of this research, hence 96.8 % have not heard of waste separation. While, 27.96% are those who are willing to separate their waste and 72.04% shows no interest. 7.53% have the knowledge of recycling, while 92.47% claim no knowledge of such. 22.58% shows interest to send their waste in the recycling centre if established while 77.42% said otherwise. The result of those who would accept concept of home composting indicates that 25.81% accepted, while 74.19 rejected it. Lastly, those willing to buy extra bin for home composting shows that 46.24% accepted, while 53.76% are in opposition.

Table 5 Physical Composition of Waste

Physical Composition of waste	**Class Residential Settlements**					
	Afor-Oru		Afor Ogbe		Obodo Ahiara	
Biodegradables	Wt Kg	Wt %	Wt Kg	Wt %	Wt kg	Wt %
Food Waste	1799.77	42.47	2255.93	60.79	1376.15	36.62
Yard waste	1109.29	26.18	44.3	1.19	317.5	8.45
Wood	97.8	2.31	34.9	0.94	42.1	1.12
Total	**3006.86**	**70.95**	**2335.13**	**62.89**	**1735.75**	**46.19**
Non-Biodegradable						
Paper and Cardboard						
News/office print /Cardboard	152.7	3.6	167.56	4.52	93.8	2.49
Tissue paper/ Diaper	217.9	5.14	141.3	3.81	93.5	2.49
Total	**370.6**	**8.74**	**308.86**	**8.32**	**187.3**	**4.98**
Plastics						
Plastic film/LDPE	146.4	3.45	249.02	6.71	219.6	5.84
PET	85.7	2.02	50.91	1.37	29.9	0.8
HDPE	45.5	1.07	36.2	0.97	24.5	0.65
Pure water sachet	54.65	1.29	125.31	3.38	65.5	1.74
PP	33.5	0.79	28.51	0.77	17.7	0.47
PS	32.95	0.78	15.32	0.41	4.2	0.11
PVC	11.1	0.26	6.7	0.18	8.8	0.23
Other Plastics	13.5	0.32	20.6	0.55	8.91	0.24
Total	**423.3**	**9.99**	**532.58**	**14.34**	**379.11**	**10.09**
Metal	132.9	3.14	93.25	2.51	55.6	1.48
Glass	116.4	2.75	45.7	1.23	20.6	0.55
Leather and Rubber	27.1	0.64	83	2.24	29.8	0.79
Textiles	79.8	1.88	181.22	4.88	73.6	1.96
Inert	33.2	0.78	55.5	1.49	820.8	21.84
Miscellaneous	46.7	1.1	68.3	1.84	450.7	11.99
Total	**4237.96**	**100**	**4237.96**	**100**	**4327.96**	**100**

Wt= weight, kg= kilogram, LDPE=Low density polyethylene, PET=Polyethylene terephthalate, HDPE=High density polyethylene waste, PP= Polypropylene, PS= Polystyrene, PVC= Poly vinyl chloride

The percentage by weight of the physical waste composition from the waste stream from all the randomly selected households combined over the entire period of the survey from the various classes of residential areas is shown in table 5. The waste stream from the Afor- Oru had 70.95% biodegradable waste, 8.74% paper and cardboard, plastic 9.99%, metals 3.14%, glass 2.75%, leather and rubber 0.64% and textile 1.88%, inert 0.78% as well as miscellaneous 1.10%. Furthermore, Afor-ogbe had 62.89% biodegradable waste, others include paper and cardboard 8.32%, plastics 14.34%, metals 2.51%, glass 1.23%, leather and rubber 2.24%, textile 4.88%, inert 1.49% and miscellaneous 1.84%. Obodo Ahiara road has 46.19% biodegradable waste , 4.98% paper and cardboard, 10.09% plastics, 1.48% metals, 0.55% glass, 0.79% leather and rubber, 1.96% textile, 21.84% inert and miscellaneous 11.99%. The percentage composition of biodegradables were highest for all three areas hence, leather and rubber had the lowest composition for Afor-Oru road while, glass had the lowest by weight for both Afor-Ogbe and Obodo Ahiara road. The figures shown in the table are the averages of all the samples taken, averagely the Ahiazu Mbaise has 60.01% biodegradables, plastic 11.47%, paper and cardboard 7.35%, metals 2.38%, glass 1.51%, leather and rubber 1.22%, textiles 2.91%, inert materials 8.04% and miscellaneous materials 4.98%.

Categorization of waste generated from the three areas, which involves the biodegradables and non-biodegradables indicates that the total waste load of 11,708.36 kg was weighed out of which 3757.46 kg belonged to Obodo Ahiara road, Afor-Ogbe 3712.94 kg, and Afor- Oru 4237.96 kg. it could be deduced from the result that Afor-Ogbe and Afor-Oru had more biodegradable waste due to the presence of the markets in these area. Whereas, it can be seen that biodegradable waste generated by the area decreased steadily and the non-biodegradable waste increased steadily from the Afor-Oru road to Obodo Ahiara road.

Table 6: Result of the Analysis of Variance (ANOVA)

Source of variation	*SS*	*Df*	*MS*	*F*	*P-value*	*F critical*
between groups	12599.69	2	6299.84	0.05	0.96	**3.14**
Within Groups	8669102	63	137604.8			
Total	**8681701**	**65**				

The result of the ANOVA test was conducted to text the significant difference between the wastes generated in the area. The ANOVA result shows that there is no significant difference in the quantity of waste generated among the three areas. The test statistic of 0.05 and a p-value of 0.96 which was greater than any significance level were produced. Hence, this means that there should be equal consideration in the design of waste management strategies for the various areas, as none should be considered more than the other.

Discussion

Results from the study show that food residues were on average the most abundant (58.56% food and yard waste) in Afor-Ogbe, Afor-Oru and Obodo Ahiara road respectively. This is also the case in many developing countries were buying of unprocessed food to be cooked seems to be the norm. This generates significant amounts of putrescible waste. Consequently, in developed countries buying of processed and ready to eat foods seems to be the custom, thus leading to a lower representation of food waste in household waste but a higher percentage of packaging materials. Al-Khatib et al. (2010) and Gomez et al. (2009) reported of garden and food waste as contributing to 65.1% of the total waste stream in most developing countries. Hence, 58.56% was reported in this study of the putrescible. The percentages of organic waste in municipal solid waste in selected African cities were recorded as 56% in Ibadan, Kampala 75%, Accra 85%, Kigali 94% and Nairobi 51% (Oyelola and Babatunde, 2008). The 58.56% organic waste in this study indicates that composting would be a good waste management option for the Ahiara Mbaise waste in Afor-Oru, Afor – Ogbe and Obodo Ahiara road. This is because from the study it was observed that food residues were the highest volumes of waste in the second socioeconomic class and this may be due to the large numbers of local restaurants in that community.

Since the waste produced in the area are diverse and of different forms and types, it is therefore needful that more sensitization be done for the people in the area to know how to manage their waste. This is also applicable to many developing countries that have poor waste management strategies, adopting a simple procedure will guide and assist to keep the environment hygienic always. Lastly, it was observed that some of the waste can be recycled and compostable. Similarly, Anon (1999) noted that developing countries have a high percentage of compostable organic matter in the urban waste stream ranging from 40 to 85% of the total waste. The high organic matter content (50% - 90%) makes food waste suitable for composting (Oyelola and Babatunde, 2008)

CONCLUSION AND RECOMMEDATION

Conclusion

It will be concluded that in Ahiazu Mbaise household waste were mainly food, yard waste, wood, paper, cardboard, plastics, glass, textiles, leather, rubber and metals. Biodegradables from all the three socio-economic groups were over 60% and plastics 11.74%. Solid waste within the area had an average recyclable and compostable potential. There was a poor general willingness among the inhabitants of the area to separate waste at source and to recycle and compost waste and also poor information was observed as another contributory factor as it concerns waste management.

Recommendations

It will be observed from the study that a lot of awareness needs to be created to bridge the gap between those who are educated with respect to waste management and the uneducated ones; this can be done through the media. With the purpose of improving the current waste management system and having the information presented here regarding the composition of waste in the area, it is recommended to conduct an analysis and assessment of the potential treatment options for the non-biodegradable in the waste stream of Ahiazu Mbiase, with a market oriented approach. Furthermore, effort should be devoted to obtain better estimates of the generation rate and composition of non-household waste. Other chemical analysis such as include but not limited to the following should be carried out, the determination of C,N and O content should be determined through the laboratory. Staff members of the registered waste contractors, recycling firms and relevant government agencies should be trained and retrained at intervals. The government should invest more on human capital development that guarantees sustainable waste management. Finally, to enhance the sustainability of waste management in the area, it is recommended that public awareness, funding, equipment and facilities as well as other provisions that are currently lacking especially locating of landfill/dumpsite in a specific designation that is devoid of environmental pollution.

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