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An Assessment of Solid Waste Transportation in Ado-Odo/Ota Local Government Area, Ogun State, Nigeria

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Abstract This paper examines solid waste transportation in Ado-Odo/Ota Local Government Area of Ogun State. Adequate transportation of solid waste is one of the major challenges of waste managers in Nigeria because of inherent factors ranging from dearth of transport infrastructure to poor attitude of residents. Data were collected through the aid of questionnaires, personal observations, visitations to some villages and towns as well as dumpsites. The questionnaires were divided into two parts: household respondents and solid waste management staff. The data obtained were analyzed using Descriptive Statistics, Factor Analysis and Item Analysis. From the analysis of the data obtained from household and waste management respondents the mean and standard deviation reflect high degree of correlation and concurrence. From the principal component analysis of both the household respondents and waste management staff, there are two principal factors respectively that should be given higher consideration in solid waste management in Ado-Odo/Ota Local Government Area. These factors include waste collection and disposal method, frequency of collection and reliability of waste vehicles. Based on these findings, the study concluded that attitudinal change on the part of the household, government intervention on road maintenances, and adequate maintenance of PSP vehicles will go a long way in reducing the heaps of refuse and indiscriminate dumping of solid wastes in the entire vicinity of Ado-Odo/Ota Local Government Area in Ogun State, Nigeria.

Keywords Solid Waste, Transportation, Disposal, Waste Management

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1. Introduction

Transportation is the movement of people or goods from a place of origin to a place of destination. It is an essential human activity having a major impact on their social and economic well-being. Transportation of solid waste is the act or process of conveying waste from its place of generation or temporary storage to final disposal site.

Inadequate transportation and disposal of solid waste causes nuisance and hazard to the teeming populace and lead to environmental problems. Over the last decade, the amount of municipal solid waste has been increasing steadily; it is obviously due to the impact of rapidly increasing urbanization and economic development. The effectiveness of handling waste in terms of collection and disposal through proper means of transportation remains undesirably low. The large population of people in cities and communities gave rise to indiscriminate littering and open dumps. These dumps in turn formed breeding grounds for rats and other vermin, posing significant risks to public health [9].

Solid waste management in Ogun State is characterized by insufficient coverage of the disposal coupled with inefficient method of collection of waste in which co-disposal of both municipal and hazardous waste takes place in open space, drainages and other unauthorized places that promotes indiscriminate disposal [3].

The estimated generated waste according to [11] is between 0.7 and 1.8kg per capita of waste and these are produced every day in developed cities' urban areas and approximately 0.4 to 0.9kg are produced in developing cities.

Reference [10] is of the view that solid waste in developing countries is given very low priority. Reference [8] also stated that solid waste management is given very low priority in the budget due to limited finance.

Reference [5] is of the view that there is a lack of human resources, at both the national and local levels, having the technical expertise necessary for solid waste management, planning, and operations. Furthermore, according to [1], the

social status of solid waste management workers is generally low as a result of the negative perception of the society regarding the work which involves the handling of solid waste. Such societal perception leads to low grades for the work, low self-esteem for the workers especially the garbage men and in turn produces low working ethics and poor quality of the work they carry out [5].

The collection and transportation of municipal solid waste (MSW) are those public services that have an important impact on public health and the appearance of towns and cities. Most municipalities lack efficient collection techniques and as a result, not all waste generated is collected. This further led to increasing dumpsites and abandoned waste deposits on the streets, major roads and open places in residential areas across the Local Government Area. The uncollected waste turns a breeding ground for diseases carrying organisms leading to diseases such as malaria.

Reference [7] carried out a study on a review of local factors affecting solid waste collection in Nigeria. It was discovered that the method of waste collection adopted, and equipment used are faced with many challenges in Nigeria. Unfortunately, most of the urban areas' disposal sites are usually located outside the urban areas due to the scarcity of land. There is no fixed route map for transportation and operators; therefore, there is lack of adequate capacity to transport it. The current waste collection and transport operators are already overloaded arising from the lack of facilities and insufficient resources. To compound this problem further is the inadequate awareness of the importance of proper waste disposal, a major factor that has led waste producers to adopt bad practices, such as indiscriminate dumping of waste in water bodies, littering, burning of waste. There is a lot to be done in this regard; waste management agencies can better improve their waste management techniques to encourage citizens to adopt better waste disposal practices.

Due to increasing problem in the management of solid waste generated in most cities in the developing countries private sector participation arrangement started as a response to the failure of service delivery by the public sector. Not all generated waste is collected in the developing countries. Waste collection in developing countries ranges between 20-80%. This is because only few areas in the municipalities can easily be reached when trailers and trucks are to be used. This is because most of the streets are not designed to allow such waste collection vehicles to pass. Some streets are unpaved, narrow, sloping and slippery during the rainy seasons. In such areas the volume of waste increases and is rarely collected [4].

Reference [6], identified a lack of adequate funds as one major problem faced by waste collection agencies that result in inefficiencies in carrying out their duties. It limits their ability to purchase necessary equipment, including waste containers and collection vehicles. In Nigeria today, there are two systems of handling the waste. The first is a formal system that is managed by the government. It comprises the cities' municipalities or waste management agencies whereby they are responsible to ensure safe, reliable and cost-effective collection, transportation and final disposal of solid waste. It often requires large financial resources than in most cases allocated on the public budget, therefore, making it almost impractical to deal with based on the complexity, technicality and the problem associated with waste management.

Reference [2], stated that this type of system is frequently characterized as inefficient and expensive. The second is the informal system which engages private dealers only such as communities of scavengers and private associations. In some areas, this operation includes charging some amount of money from residents for picking up their garbage. The two systems are however seen as having very little interference and cooperation in all aspects of waste handling, making the problem of solid waste transport and management even worse and persistent.

2. The Methods

2.1. The Study Area

The area of study is Ado-Odo/Ota Local Government Area in Ogun State. Ado-Odo/Ota is one of the most populated out of 20 Local Government Area in Ogun State in the South –West region of Nigeria. Its Latitude is 6.6887 Lat (DMS) 60 41'19N and Longitude 3.2320 Long (DMS) 30 13'55E, with the estimated 2006 census population of 669,886. It was created on May 19, 1989. The Local Government Area is also on the industrial hubs with the highest concentrations of industries in Nigeria. Ado-Odo/Ota being the largest industrial area tends to have the highest number of industries in the state, with this fact, the Local Government generates the highest IGR for Ogun State. They are primarily agrarian; they produce cash crops, food crops, mineral resources, and vegetables.

Ado-Odo/Ota is one of the industrial heartlands of Ogun State located in Nigeria. The Local Government is populated mainly by the Awori people, a subset of the Yorubas and the original inhabitants of the region. It has shared a boundary with Lagos State in east and south, Yewa South and Ifo Local Government Area in the north and Ipokia LGA in the west. The other towns and cities located in Ado-Odo/Ota LGA include Ado-Odo, Agbara, Igbesa, Iju, Itele, Kooko Ebiye Town, Owode-Ijako, Ilogbo, Ijoko, Atan, Ketu-adieowe, Alapoti, Ere, Sango, Ota.

2.2 Data Collection

The study was based on primary data. The primary data that were used in the study was collected from household and waste management staff through a well-structured questionnaire.

2.3 Study Population

The population of this study consist of selected household in eight (8) towns which include: Ota, Agbara, Igbesa, Iju, Atan, Ilogbo, Ijoko, Sango and solid waste management staff

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in Ado-Odo/Ota Local Government Area in Ogun State, Nigeria.

2.4 Sampling Techniques and Sample Size

A multistage sample technique was used to select 370 household respondents and 30 waste management staff in Ado-Odo/Ota Local Government Area for the study. In the first stage, a purposive sampling technique was used to select eight towns in which the study was carried out. In the second stage, purposive sampling technique was used to select one dumpsite out of three in the study area. In the third stage, 30 waste management staff were purposively selected among waste collectors, drivers, managers, PSP operators and Ogun State Environmental Protection Agency office. Lastly, a purposive sampling technique was used to select 370 household respondents in the study area.

2.5 Analytical Techniques

Descriptive statistics was adopted in the study to analyze the socio-demographic data for the household and waste management staff. Factor analysis statistical technique was used to carry out the systematic reduction of the extracted variables that are highly correlated while item analysis was used for the Likert scale.

3. Results and Discussion

3.1 Socio-demographic Characteristics of Household Respondents

The socio-demographic of the households and waste management staff such as the age, sex, educational qualification, marital status, average monthly income, household size, employment status, and size of accommodation amongst others are being assessed to determine their effect on solid waste transportation in the study area and are shown in Fig.1.

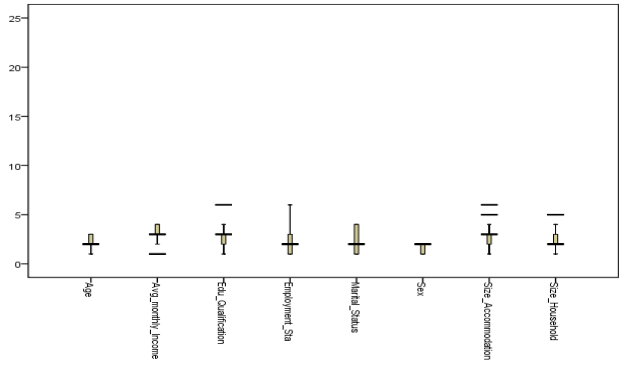

Figure 1. Boxplot Demographic representation of Household Respondents

3.2 Descriptive Statistic for waste collection disposal for household respondents

The descriptive statistics shows that the mean, standard deviation and the number of respondent's data analyzed are 304. The mean of the obtained data shown in Table 1 shows a high degree of correlation among respondents on various matter, while the standard deviation values reflects a high degree of concurrence of the data obtained.

Table 1. Descriptive Statistic

	N	Mean	Std. Deviation
Location of the Administration of questionnaires	304	3.4507	2.43954
Container type	304	2.6776	1.02511
Waste Collector	304	2.3783	0.81952
Frequency of Waste Collection	304	3.1382	1.46488
Method of Waste Disposal	304	2.7895	1.11178
Method of Waste Transportation	304	1.7730	1.13355
Attitude of Waste Collector	304	2.1283	0.63971
Perception of Waste Management	304	2.4836	0.61852
Valid N (listwise)	304		

Author's Computation, 2019

Table 2. Communalities

Variable	Initial	Extraction
Location of Administration of questionnaire	1.000	0.552
Container type	1.000	0.473
Waste Collector	1.000	0.774
Frequency of waste collection	1.000	0.672
Method of waste Disposal	1.000	0.769
Method of waste Transportation	1.000	0.721
Attitude of waste Collector	1.000	0.579
Perception of waste Management	1.000	0.461

Author's Computation, 2019

Table 2 shows the random values for extraction. This extraction values implies, the proportion of variance variables that can be explained by the factors, the data reveal that location, waste collectors, frequency of collection of waste, method of waste disposal, and attitude of waste collector has significant effect on waste collection and disposal.

Table 3. Rotated Component Matrix

	Component		
	1	2	3
Collector	0.846	0.238	0.043
Method of Transportation	-0.836	-0.148	0.009
Container type	0.639	0.123	0.223
Frequency of Waste Collection	-0.529	0.370	0.505
Attitude of Collector	0.063	0.755	0.064
Location	0.358	0.638	-0.129
Method of Disposal	0.084	-0.212	0.847
Perception of Waste Management	0.209	0.394	0.512

Author's Computation, 2019

Table 3 shows the various loading factor for the extracted components based on the data analyzed. The data below 0.5 were suppressed and the result shows that component 1 and 3 has more loading factor, this implies that they have direct impact on the analyzed data. The data were sorted by size and significant level and the Rotation converged in 6 iterations. The varimax seeks for the rotation of the original factors such that the variance of the loading is maximized.

The scree plot in Fig. 2 shows the three values that are above the Eigenvalue of 1while others are below the Eigenvalue of 1 and are not extracted.

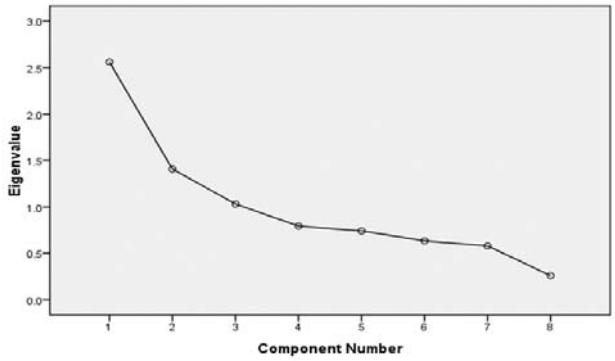

Figure 2. Scree Plot for Household Respondents

The principal component analysis of the variables gives 3 factors based on the eigenvalue of greater than one and the loading factor is greater than 0.5. Table 4 reveals the influence of the variables on solid waste transportation in Ado-Odo/Ota local government of Ogun state. From the result in table 4, the two factors labelled as waste collection method and method of waste disposal have highest number of variables among other factors and are considered to be principal factors. Their factor loading ranges from –0.529 to 0.847 which implies that clusters are sturdy.

Table 4. Summary of results with the clusters for household respondents

Creative label	Factor code	Variable	Factor loading
Waste Collection	Factor 1	Waste Collector	0.846
Method		Method of Transportation	-0.836
		Container type	0.639
		Frequency of Waste Collection	-0.529
Attitude of Collector/Location	Factor 2	Attitude of Collector	0.755
		Location	0.638
Method of waste Disposal	Factor 3	Frequency of Waste Collection	0.505
		Method of Disposal	0.847
		Perception of Management	0.512

Author's Computation, 2019

Therefore, those variables are considered very important. The clusters raised concerns about Waste Collection Method, Attitude of collector/location and method of waste disposals which generally speak to solid waste transportation.

Table 5. Factor 1 (Waste Collection Method) Household Respondents

Variable Description	Factor Loading
Waste Collector	0.846
Method of transportation	-0.836
Container type	0.639
Frequency of waste collection	-0.529

Author's Computation, 2019

In table 5 it can be seen that Waste collector have a high loading factor of 0.846 which implies that they have high impact factor on extraction of waste from the local government likewise the container type utilized in extraction of the waste is also important. Although, it can be seen from table 5 that the container type has the highest frequency which implies that it is the most utilized type of waste container but due to the health disadvantage that it poses, open container is not the most suitable type of waste container to be utilized.

Table 6. Respondents Assessment of PSP Transportation from Household

ITEM	SD		D		U		A		SA	
	F	%	F	%	F	%	F	%	F	%
Introduction of PSP has brought environmental improvement in the area	54	17.8	68	22.4	11	3.6	136	44.7	35	11.5
Cost of waste disposal charged by the PSP is too high	21	6.9	70	23.0	95	31.3	92	30.3	26	8.6
Are your street easily accessible for solid waste collection vehicle	40	13.2	103	33.9	7	2.3	99	32.6	55	17.9
PSP vehicle are too old and breakdown constantly	14	4.6	18	5.9	10	3.3	55	18.1	207	68.1
PSP operators use environmentally friendly vehicle	142	46.7	106	34.9	25	8.2	17	5.6	14	4.6
Quality of service provided is excellent	94	30.9	148	48.7	29	9.5	30	9.9	3	1.0
Number of time refuse is collected is adequate	112	36.8	134	44.1	30	9.9	24	7.9	4	1.3
Attitude of PSP worker is cordial	20	6.6	60	19.7	117	38.5	92	30.3	15	4.9
Refuse heaps all over the LGA have now disappeared	189	62.2	73	24.0	17	5.6	19	6.3	6	2.0

Author's Computation, 2019

Table 6 shows the item analysis of the assessment of PSP transportation from household respondents.

3.3. Data Presentation of Factor Analysis on Waste Management Staff

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Table 7. Descriptive Statistics of Waste Management Staff

	N	Max.	Mean	Std. Deviation
Number of Vehicle	30	3.00	1.7000	0.79438
Types of Vehicle	30	3.00	2.8667	0.34575
Ages of Fleets	30	5.00	4.6000	0.49827
Point of Collection Waste	30	7.00	3.7000	2.27657
Frequency of Waste Collection	30	5.00	4.7000	0.46609
Distance to Dump Site	30	4.00	2.4000	1.06997
Problem Evaluation of Waste Mgt	30	2.00	1.2000	0.40684
Valid N (listwise)	30			

Author's Computation, 2019

The descriptive statistics of waste management staff shows that the mean, standard deviation and the number of respondent's data analyzed are 30. The mean of the obtained data shown in Table 7 shows a high degree of correlation among respondents on various matter, while the standard deviation values reflects a high degree of concurrence of the data obtained.

Table 8. Communalities for waste management staff

	Initial	Extraction
Number of Waste Vehicle	1.000	0.467
Types of Waste Vehicle	1.000	0.757
Ages of Waste Vehicles	1.000	0.546
Point of Waste Collection	1.000	0.813
Frequency of Waste Collection	1.000	0.725
Distance to Dumpsite	1.000	0.791
Problem Evaluation of Waste Management	1.000	0.593

Author's Computation, 2019

The random values for extraction were shown in Table 8. This extraction values implies that the proportion of variance variables that can be explained by the factors, the data reveal that type of vehicle, age of vehicle, point of collection of waste, frequency of collection of waste, dumpsite distance and evaluation of problem posed by municipal solid waste evacuation has significant effect on waste collection and disposal.

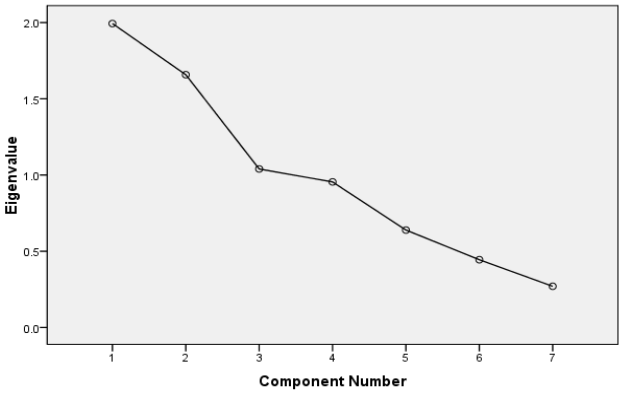
Table 9. Rotated Component Matrix for waste management

	Component		
	1	2	3
Frequency of Waste Collection	-0.848	-0.039	0.065
Point of Waste Collection	0.810	0.392	-0.051
Distance to Dumpsite	0.646	-0.604	0.095
Problem Evaluation of Waste Mgt.	0.030	0.766	0.079
Ages of Waste Vehicles	0.175	0.710	0.108
Type of Waste Vehicle	0.156	0.068	0.853
Number of Waste Vehicle	-0.349	0.086	0.582

Author's Computation, 2019

Table 9 shows the various loading factor for the extracted components based on the data analyzed. The data below 0.5 were suppressed and the result shows that component 1 and 2 have more loading factor, this implies that they have direct impact on the analyzed data. The data were sorted by size and significant level and the Rotation converged in 5 iterations. The varimax seeks for the rotation of the original factors such that the variance of the loading is maximized.

Figure 3. Scree Plot for waste management staff



The screen plot in Fig. 3 shows the three values that are above the Eigenvalue of 1 while others are below the Eigenvalue of 1 and are not extracted.

Table 10. Summary of Results with the Clusters for waste management staff

Creative label	Factor code	Variable	Factor loading
Environmental and frequency of collection	Factor 1	Frequency of Waste Collection	-0.848
		Point of Waste Collection	0.810
		Distance to Dumpsite	0.646
Environmental/Vehicle Challenges	Factor 2	Distance to Dumpsite	-0.604
		Problem Evaluation of Waste Mgt.	0.766
		Ages of Waste Vehicles	0.710
Vehicle specification	Factor 3	Type of Waste Vehicle	0.853
		Number of Waste Vehicle	0.582

Author's Computation, 2019

Table 10 reveals the influence of the variables on solid waste transportation in Ado-Odo/Ota local government of Ogun state. From the result in table 10, the two factors labelled as Environmental /Frequency of Collection and Environmental/Vehicle Challenges have highest number of variables among other factors and are considered to be principal factors. Their factors loading ranges from -0.848 to 0.810 which implies that clusters are down the line. Therefore, those variables are considered very important. The clusters raised concerns about Environmental/Frequency of Collection and Environmental/Vehicle Challenges which generally speak to solid waste transportation.

Table 11. Factor 1 (Environmental and Frequency of Collection)

Variable Description	Factor Loading
Frequency of Waste Collection	-0.848
Point of Waste Collection	0.810
Distance to Dumpsite	0.646

Author's Computation, 2019

In table 11, it can be seen that Point of Collection have a high loading factor of 0.810 which implies that it has high impact factor on extraction of waste from the local government likewise the distance of refuse dumpsite in extraction of the waste is also important. The negative loading factor of frequency of waste collection does not have positive influence on waste collection method although it has significant effect.

Table 12. Factor 2 (Environmental/Vehicle Challenges)

Variable Description	Factor Loading
Distance to Dumpsite	-0.604
Problem Evaluation of Waste Management	0.766
Ages of Waste Vehicles	0.710

Author's Computation, 2019

Both Problem evaluation and Ages of Vehicles in Table 12 have high impact factor and this implies that both factors have significant effect on transportation of waste in Ado Odo/Ota local government. While the negative loading factor of Distance opposed the other two variables because of the opposite sign -0.604.

Table 13. Factor 3 (Vehicle specification)

Variable Description	Factor Loading
Type of Waste Vehicle	0.853
Number of Waste Vehicle	0.582

Author's Computation, 2019

Both Type of Vehicle and Number of Waste Vehicle in Table 13 have high impact factor and this implies that both factors contribute to transportation of waste in Ado Odo/Ota local government.

Table 14. Respondents Assessment of Solid Waste Transportation from Waste Management Staff

ITEM	SD		D		U		A		SA	
	F	%	F	%	F	%	F	%	F	%
Designated refuse dumpsite is too far	9	30.0	12	40.0	-	-	5	16.7	4	13.3
Poor road network	1	3.3	-	-	-	-	-	-	29	96.7
Awareness of the program is adequate	7	23.3	3	10.0	-	-	5	16.7	15	50.0
Irregular payment by the people	-	-	2	6.7	-	-	12	40.0	16	53.3
Lack of adequate facilities/equipment	-	-	-	-	-	-	2	6.7	28	93.3
Lack of capability to maintain and repair vehicle	-	-	-	-	-	-	1	3.3	29	96.7
Lack of cooperation from waste generators	-	-	-	-	-	-	9	30.0	21	70.0
Cooperation on the part of government official					1	3.3	13	43.3	16	53.3
Lack of qualified/trained personnel	-	-	-	-	1	3.3	6	20.0	23	76.7
Lack of financial resources	-	-	-	-	-	-	4	13.3	26	86.7

Author's Computation, 2019

Table 14 shows the item analysis of the assessment of PSP transportation from household respondents.

4. Conclusion and Recommendations

This study was conducted with the objectives of identifying the most important risk factors associated with solid waste transportation and also to reduce indiscriminate dumping of waste along the highway and the entire environment.

The outcome of the analysis shows that waste collection method, method of waste disposal, frequency of collection and environmental/vehicle challenges are considered to be the major problem with solid waste transportation in this study.

The following recommendations are made based on the findings of this study.

- The Ogun State Government Environmental Protection Agency (OGEPA), should partner with Private Sector Participant (PSP) to monitor the attitude of the waste collectors, the method of waste transportation, enforce a standard container to enable effective collection of waste and also to facilitate frequency of waste collection.
- OGEPA should empower the PSP Operators and ensure that they use environmental-friendly vehicles.
- Government should acquire new solid waste standard trucks because the existing ones are of age and frequently breakdown.
- OGEPA should take it as a point of duty to make sure that the PSP vehicles are properly and mechanically maintained before they are allowed to ply the roads.
- Government should legalize and empower the cart pushers to be able to cover the areas which the PSP operators cannot cover or reach.
- Government should help in the repair of the roads to enable the PSP operators to be effective because the bad road also contributes to the poor conditions of the vehicles.

REFERENCES

[1] Agwuwamba, J. C., "Solid Waste Management in Nigeria: Problems and Issues", Journal of Environmental Management. Vol 22, Issue 6, Pp 849–856, 1998.

[2] Gombya, S. W. and Mukunya, F., "Solid Waste Management in Kawempe Division: Issues, Challenges and Emerging Options", International Journal of Management, IT & Engineering. Vol. 7 Issue 8, Pp 39-59, 2000.

[3] Ndubuisi-Okolo P. U., Anekwe R., I. and Attah E., Y., "Waste Management and Sustainable Development in Nigeria: A Study of Anambra State Waste Management Agency", European Journal of Business and Management Vol.8, No.17, 2016.

[4] Ndum, A.N., "Bottom-Up Approach to Sustainable Solid Waste Management in African Countries", Unpublished Ph.D. Thesis, Department of Environmental Sciences, Brandensburg University of Technology, Cottbus, Germany, 2012.

DOI: 10.26552/tac.C.2020.2.3

[5] Ogawa, H., "Sustainable Solid Waste Management in Developing Countries", The 7th ISWA International Congress and Exhibition, Parallel Session 7, "International,Perspective. Onlineat: http://www.gdrc.org/uem/waste/swm-fogawa1.htm, 1996.

[6] Ogwueleka, T. C., "Municipal Solid Waste Characteristics and management in Nigeria", Iran Journal of Environmental Health Science and Engineering Vol. 6, No. 3, pp. 173-180, 2009.

[7] Olukanni, D. O., Adeleke, O. J. and Aremu, D. D., "A Review of Local Factors Affecting Solid Waste Collection in Nigeria", Pollution. 2(3). P.339-352, 2016.

[8] Omran, A. and Gavrilescu, M., "Municipal Solid Waste Management in Developing Countries: A Perspective on Vietnam", Environmental Engineering and Management Journal 7 (4), 467 -478, 2008.

[9] Tchobanoglous, G., Theisen, H. and Vigil, S., "Integrated Solid Waste Management: Engineering Principles and Management Issues", Water Science & Technology Library, 8(1), 63-90, 1993.

[10] United Nation Industrial Development Organization., "Waste Management Programme", United Nations Industrial Development Organization http://www.unido.org/doc/3765Accessed 19/01/19, 2003.

[11] World Bank., "Urban Solid Waste Management", Retrieved from World Bank web, 2011.