

SOLID WASTE GENERATION AND MANAGEMENT IN NSUKKA URBAN, ENUGU STATE OF NIGERIA

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ABSTRACT

This study is to assess the amount of solid waste generated and the management techniques employed in Nsukka urban. The author also attempted to find out the type of refuse generated, the amount and the methods of disposal in a day, weekly, monthly and quarterly. The population of the study area was 309,633 at the 2006 census and 450 well structured questionnaires were administered to the residents of various occupational status, sex, marital status and age at simple random technique. The instruments and the structured questionnaires

used were validated by instrumentation and measurement expert and the average solid waste generated weekly by the residents of Nsukka urban was 4,970.83m³ at the study period. It was discovered from questionnaires that household size, distance of houses from dumping points, pattern of consumption, garbage disposal method and marital status has a great effect on the refuse generated. It was found from the study that inadequacies of collection trucks, finance and other resources led to inadequate collection and disposal of solid waste and consequent deterioration of environmental quality of the town. The Distance of dumping points from household and lack of individual and public dustbins also led to the creation of illegal dumping points especially along access roads, drainage channels and streets that litter the whole environment. Based on these findings, the author suggestion is to organize public campaigns on waste management, recycle waste, construct good drainage channels and adequately fund the agency that is responsible in solid waste management and disposal and to circulate infrastructure to enable the agency perform successfully.

INTRODUCTION

Nsukka, Nigeria has an area of 1810km² and a population of 309,633 at the 2006 census. The rapid rate of urbanization process which started sweeping across the country since the early 1960's has brought with it, its accompanying side effects. The creation of urban slums that provide housing for the labour force that serve the economic activities of the urban environment especially the industries are prominent in waste generation. The waste generated causes pollution of the urban environment without proper means of managing and disposing them (Tchobanoglous, *et al.*, 1993).

Solid wastes are unwanted materials or substances that are left or discarded after use, also included are by-products of process lines or materials that may be required by law to be disposed (Okecha, 2000). Solid waste management is explained as that discipline associated with the control of generation, storage, collection, transfer and transport, processing and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics and other environmental considerations and that is also responsive to public attitude (Ogwueleka, (2003).

Solid waste can be classified in a number of ways, on the basis of source, environmental risks, utility and physical property. On the basis of source which is commonly used, solid wastes are classified as: municipal solid wastes, industrial solid wastes, agricultural solid wastes, mining and mineral wastes, construction and demolition wastes, healthcare wastes, radioactive (Nuclear) wastes, human and animal wastes (Omofonmwan and Esegbe, 2009). The generation of solid waste from household, industries, markets, abattoir and shops result in improving the standard of living of the inhabitants.

The methods of disposing solid wastes include the following, land fill, Incineration or combustion, resource recovery and recycling, Plasma gasification, Waste to Energy (Recover Energy), and Avoidance/Waste Minimization. Recycling and composting are couple of the best methods of waste management (Adebibu, 2003).

Domestic waste management has become an area of major concern in Nigeria today. It appears to be a losing battle against the harmful consequences of unguided waste and the attainment of clean healthy environment for all Nigerians. It is common sight in Nigeria today to see heaps/accumulation of festering waste dumps in our states, urban and commercial cities (Adewole, 2009). Since the inception of Enugu State administration, there

have been concerted efforts to achieve sustainable waste management in the state. The efforts culminated in the establishment of the Enugu State Waste Management Agency (ESWAMA) in 2004. The Agency was set up to replace defunct Nsukka urban Environmental Protection Agency (NSEPA), which failed to meet the challenges of modern day waste management.

From the nature of refuse generation in Nsukka urban, the author studied how much solid waste is generated in Nsukka urban daily, monthly and annually and also the nature of solid waste generated, management and the motivation of government to management agency in carrying out their job/responsibilities with dedicated effort and without much stress, to promote healthcare and environmental development in Nsukka urban?

The objectives of the study are to assess the amount and nature of solid waste generated, disposal method used, food consumption pattern of the residents on the amount and type of refuse generated., the effect of occupational status and income on the amount of refuse generated and size of house hold on the amount of refuse generated in Nsukka urban.

It is hoped that the findings of this study will help in improving the environmental quality of Nsukka urban or their satellite towns that have similar problems and also expose the problems associated with solid waste generation and management in urban environments. It will also help in giving future research studies an insight into the problems of solid waste generation and management in urban areas. The study will help in general environmental improvement of Nsukka, in particular and the entire Enugu State in general

MATERIALS AND METHODS

This study was conducted in Nsukka urban a satellite town in Enugu State. The town offers accommodation to residents from all works of life. This ranges from administrative workers, traders and business inclined residents

Study Area and Data Gathering Description

Nsukka is a town and Local Government Area of Enugu State in South-East Nigeria. Towns that share a common border with Nsukka, are Edem Ani, Alor-uno, Opi, Orba and Ede-Oballa, Obimo. Other nearby towns include Enugu Ezike, Obollo-Afor (formerly centre of the palm oil trade), Nimbo, Adani, Uzo Uwani and Mkpologwu, now also lay claim to the name Nsukka. This is because they all collectively fall into the political zoning system in

Nigeria known as Senatorial Zone. According to Benjamin Chinweike Ezema (now called Ezemmah) Nsukka is a town that is made up of three prominent communities, namely the Nkpunanor community, the Ihe n'Owerre community and the Nru community. The houses are arranged horizontally across access roads, the roads leading to the block houses form T-junctions. Most of the roads are beginning to wear out because of lack of good drainage system. Most of the gutters are constructed by individuals in order to allow free flow of water that comes from their houses, although most of them are partially blocked with refuse from the households and in turn leads to flooding during the rainy season.

Both primary and secondary sources of data were used. The three major sources of data used in this study are Enugu State Waste Management Authority, Nsukka branch, sample of surveys of households and field observation and physical measurement of refuse dumps by author.

Method of Data Collection

The method of data collection used includes field reconnaissance survey, personal observation and sample study of households with the aid of a well-structure questionnaire.

The field observation includes the physical counting and measurement of refuse dumps at designated dumping points both official and unofficial. To obtain the volume refuse dumps, the product of the length, width and depth give the figure. This is for the rectangular dumping points. The Simpson's rule of volume or the end areas formula for volumes after obtaining the measurements was used for non rectangular dumping points. Equation 1 is used when the measurement is done with tape and Equation 2 is used when the measurement is done with plainmeter.

$$V = \frac{d}{3} \{(A_1 + A_n) + 4(\text{even areas}) + 2(\text{odd areas})\} \quad (\text{Omuta, 2008}) \quad 1$$

$$V = d \left\{ \left(\frac{A_1 + A_n}{2} \right) + A_2 + A_3 + A_4 + \dots + A_{n-1} \right\} \quad (\text{Omuta, 2008}) \quad 2$$

d= the distance between the ordinates

A= cross sectional areas

The task of household collection of data was easier because most of the residence use containers bearing labels which indicate their capacity.

The author was able to issue 450 questionnaires to 450 household randomly. Nsukka is a town that is made up of three prominent communities, namely the Nkpunanor community, the Ihe n'Owerre community and the Nru community. Therefore, the author represented the areas as area a, area B and area C. Each of the areas was issued 150 questionnaires randomly.

Design of Study Questionnaire

The Questionnaire was designed in such a way as to provide information already outlined in chapter one under objectives of the study. The questionnaire comprises the information regarding the demographic composition, economic and social status of household, it also include information on how refuse is handled at household level and information on the effort of government in combating garbage disposal and management. The respondent suggestions were also sought as to the means of improving the environmental quality of the town.

Questionnaire Administration and Problems Encountered

The administration of the questionnaire to the respondents took almost a month. The questionnaires were not to be filled by any other member of the household other than the one in charge of the household refuse generation and disposal. This made the administration a little bit difficult because most of the respondents can only be contacted on Sundays and Saturdays which are work free days. The administrations of the questionnaire were undertaken by the author and four other students of Enugu State University of Science and Technology, Enugu. Before the administration of the questionnaire commenced, the author briefed the field assistant on how the questionnaires were to be administered. Data gathering lasted for two months, and an average of 70 questionnaires were administered in a week. Questionnaire administration alone lasted for a month and one week, while the field observation at dumping points took the rest of the time. An overall interview was granted to the author by the Zonal controller in Nsukka, Mr. Anddy Mbaeze and the head of operations, Mr. Emmanuel Igwe, both from Enugu State waste management authority, Nsukka branch. Information on the resources available to the zone was gathered by the author. These include manpower, both technical and administrative, as well as labourers who were directly involved to the management of solid waste in Nsukka urban.

Data Presentations and Analysis

The investigation survey was conducted by the author through the members of the household in charge of the household refuse generation and disposal. The data obtained from the

questionnaires issued and oral interview from Enugu State waste management authority, Nsukka branch, are shown in the tables below.

Table 1: Size of the household of the respondents.

Household Size	Number of Respondents	Percentages (%)
1 – 3	67	14.9
4 – 6	180	40.0
7- 9	90	20.0
10 and above	113	25.1
Total	450	100

Table 2: The volume of refuse of legal designated dumping points per week.

Dumping points	Estimated Length (m)	Estimated Heights (m)	Estimated Volume (m ³)
Police Barrack GRA	20	3.5,6,5,4.7	338.75
St Theresa Junction New Ang Rd.	18	4,6,5,3	317.70
No 34 New Ang. Rd	20	4.3,6,7,4	386.88
Opp 69 Uni. Mkt Rd	16	2.4,6,4	205.06
Nru Junction	20	4.5,7,5,2	365.63
Eungu Ezike Junction	19	3.8,6,5	416.75
Motherless Baby Onuiyi	15	3.7,5,3	181.88
St Peters Echara	22	5,7,6,4	491.56
Amaozalla Appostic chur	18	5.5,6.4,4,2	284.04
Ugwuawara odenigbo	24	4,6,5,3	486.00
Total			3,474.25

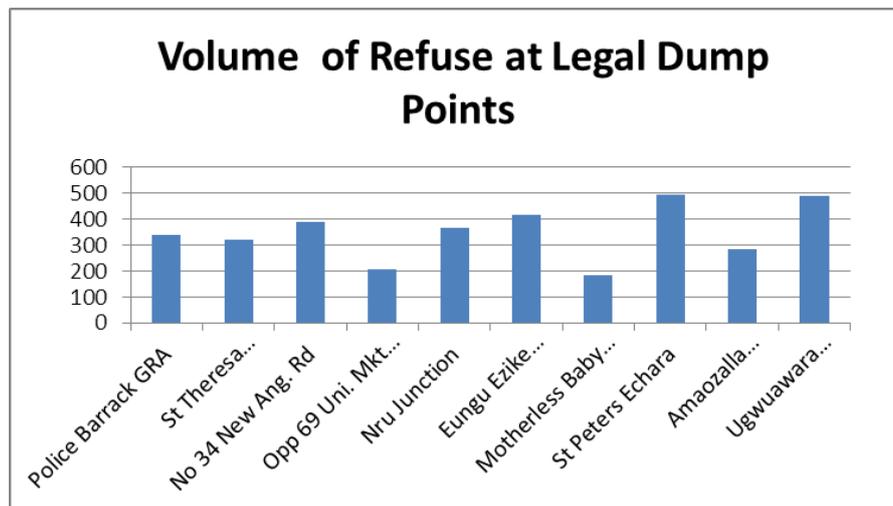
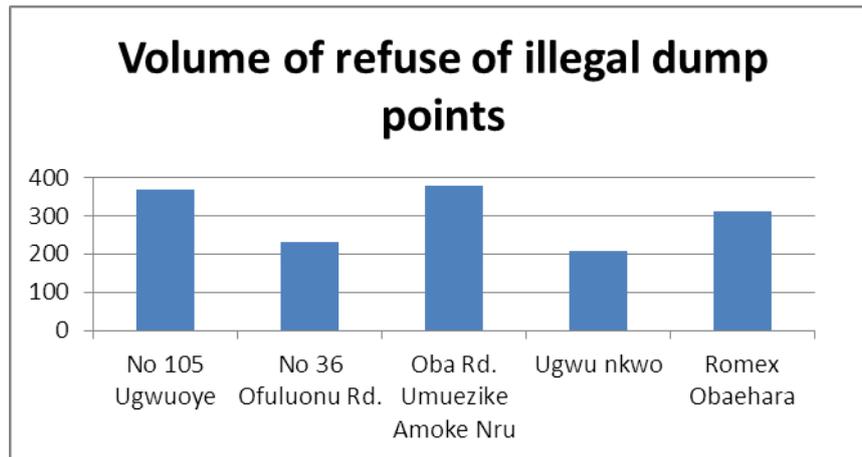


Fig 1: The representation of volume of refuse of legal designated dumping points per week.

Table 3: The volume of refuse of illegal dumping point.

Dumping points	Estimated Length (m)	Estimated Heights (m)	Estimated Volume (m ³)
No 105 Ugwuoye	18	5,6,7,8,6	366.77
No 36 Ofuluonu Rd.	15	5,6,4	231.25
Oba Rd. Umuezike Amoke Nru	18	6,7,3	378.00
Ugwu nkwo	16	4,5,6,2	208.06
Romex Obaehara	20	3,6,5,2	312.50
Total			1,496.58

**Fig 2: The representation of volume of refuse of illegal dumping points per week.****Table 4: Garbage composition of the respondents.**

Types of Garbage	Number of Respondents	Percentage (%)
Food Left over	112	24.9
Plastics	90	20.0
Leaves and Grasses	135	30.0
Tins and Metals	68	15.1
Others	45	10.0
Total	450	100

Table 5: Household size and solid waste generation per day.

Average Household Size	Average Solid Waste Generation per Day (m ³)
1	0.0123
2	0.0185
3	0.0193
4	0.0214
5	0.0266
6	0.0296
7	0.0334
8	0.0375
9	0.0423
11	0.0536
13	0.0596
15	0.0687
16	0.0732

Table 6: Consumption pattern and solid waste generation.

Food Mostly Taken	Number of Respondents	Percentages (%)
Rice	233	51.8
Cassava	113	25.1
Yam	67	14.9
Fruits and Vegetables	5	1.1
Beans	20	4.4
Others	12	2.7
Total	450	100

Table 7: Annual income level and solid waste generation per day.

Annual Income (#)	Number of Respondents	Average Volume of Solid Waste Generation per Day (m3)
18,000 – 28,000	45	0.0185
29,000 – 39,000	67	0.0264
40,000 – 50,000	68	0.0306
51,000 – 61,000	157	0.0450
62,000 and above	113	0.0350
Total	450	0.1555

Table 8: Methods of disposing garbage from respondents.

Disposing Outlets	Number of Respondents	Percentages (%)
Burning	90	20.0
Road sides	110	24.4
Central collection	187	41.6
Open Space	23	5.1
Drainage Channels	40	8.9
Total	450	100

Table 9: Collection of solid waste at central collection points by environmental protection Agency.

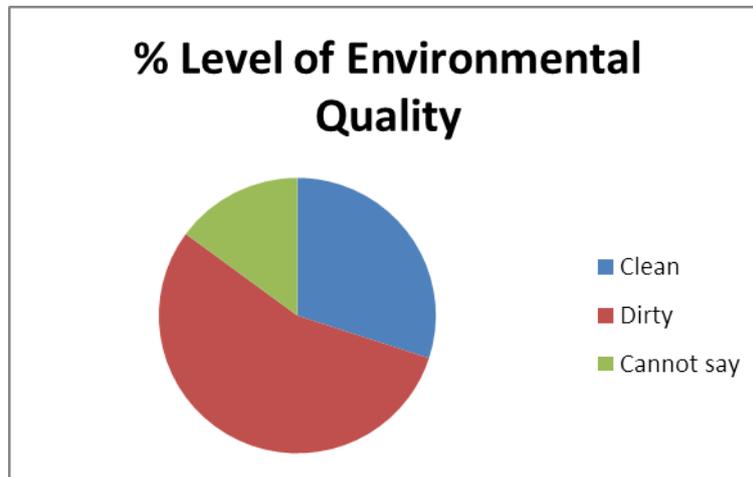
Frequency of Collection	Number of Respondents	Percentages (%)
Daily	0	0
Weekly	192	42.7
Two weeks	105	23.3
Monthly	112	24.9
Two Months	23	5.1
Quarterly	16	3.6
Six months and above	2	0.4
Total	450	100

Table 10: The responsibility of collection and disposing of waste from collection points.

Responsibility	Number of Respondents	Percentages (%)
Individual (Self)	50	11.1
Environmental Protection Agency	355	78.9
Others	45	10.0
Total	450	100

Table 11: Environmental perception of the respondents.

Level of Environmental quality	Number of Respondents	Percentages (%)
Clean	135	30.0
Dirty	248	55.1
Cannot say	67	14.9
Total	450	100

**Fig 3: Pie chart representation of Environmental perception of the respondents.**

ANALYSIS OF RESULTS

The data presented in table 1 was the household size of the respondents. This is to get the number of people that stay in a house and the waste they can generate. The highest percentage of household of respondents is 40.0% which fall into 4 - 6 people in a family. Then, the lowest percentage of the household of respondents is 14.9% which fall from 1 to 3 people in a family. Nsukka urban is dominated by large number of people in a house.

The amount of solid waste generated from legal and illegal dump site per week was presented in tables 2 and 3 above and figures 1 and 2 respectively. To determine the average volume of solid waste generated during the study period, measurements were taken from the dumping points and the volumes of waste generated were calculated using the end areas formula given in chapter three. It was observed by the author that the dumping points that were relatively large were the ones that were closer to the residents and those that were located in the high density areas, while those that were further away were small in size. The total volume of solid waste generated in a week in all the legal dumping points was 3,474.25m³ and the volume of solid waste generated at illegal dumping points was 1,496.58m³ as the time the study was carried out.

The data in table 4, shows the composition of solid waste generated by household and the household managers were asked to indicate the major composition of their solid waste. The highest percentage of garbage generated by the household was from leaves and grasses which is 30.0% and the lowest garbage was from others, which was 10.0%. It means that leaves and grasses constituted the solid waste generated from household in Nsukka urban.

The table 5 above shows the effect of household size on the volume of solid waste generated. Size of household of respondents has an indirect effect on the amount of solid waste generated and also has an effect on the amount of food taken and consequently the amount given out as waste. It was observed that the amount of solid waste generated by a married family was more than that generated by a single family. Household, for instance is taken to mean the number of people found in any particular house who eat from the same pot. That is the number of children both male and female and their parents. The highest number of people in a house produces the highest volume of solid waste, which is 0.0732m^3 for 16 people while the lowest size of people produces the lowest volume of solid waste, which is 0.0123m^3 for 1 person.

The type and amount of food taken by a household determines the type and amount of solid waste generated by the household. The table 6 above show the data generated on consumption pattern and solid waste generated. The consumption pattern that generates the highest solid waste according to the respondents is rice, which has 51.8% with 233 respondents and the lowest is fruits and vegetables that has 1.1% with 5 respondents. The results show that Nsukka urban ate more of rice than any other food.

To demonstrate the effect of income on the volume of solid waste generated, information was sought on the income level of respondents. The table 7 above shows the relationship between income per annual and volume of solid waste generated per household. It was obtained from the questionnaire as the average solid waste generated with the income level of the respondents. It gives significant variation in the income levels of respondents and the average volume of solid waste generated per day. The highest respondents were from 51,000 to 61,000 naira annual income level, that generate 0.0450m^3 volume of solid waste and the lowest respondents fall from 18,000 to 28,000 naira annual income level that generate 0.0185m^3 volume of solid waste.

The table 8 above show the results obtained from the respondents on the method of disposing solid waste generated. It appear that majority of the residents in Nsukka urban use roads and streets for disposing their solid waste, instead of making use of appropriate designated dumping points for the disposal of their waste. The highest percentage of disposing outlet of solid waste from respondents fall from the central collection point, which is 41.6% and the lowest fall from open space which is 5.1%. The rampant dumping of waste on roads and along streets usually results in blockage of access roads and drainage channels.

The table 9 shows how the environmental protection agency clears solid waste at the official designated dumping points. The frequency of clearing solid waste from the collection point was observed to be mostly once in every week. The management complained of lack of trucks and human resources to meet the demand of the clearance The highest percentage of the respondents which is 42.7% fall into weekly basis of clearing solid waste from dump points while 0% is the lowest percentage that fall into daily basis.

The table 10 shows who is responsible for clearing solid waste from dump points. The responsibility for the clearance of solid waste from the area, Nsukka urban, is primarily that of the Enugu State Waste management Authority. The above data shows that 78.9% of the respondents placed the responsibility on the Enugu State Waste management Authority whereas 11.1% claimed individual and 10.0% claimed others.

The perception and the reactions of the respondents on the environment of Nsukka urban is presented in the table 11 above. Nsukka urban is rated as dirty by 55.1% respondents, while 30.0% claimed that Nsukka urban was clean and 14.9% respondents cannot say that Nsukka urban was dirty or clean. We can conclude from the table and figure above that the environmental quality of Nsukka urban was generally poor.

An oral interview was granted to the author by the management of Enugu State waste management authority, Nsukka branch. Questions were asked as regards to management techniques employed in Nsukka urban. It was gathered that Nsukka urban is not a planned city like other satellite towns but that provision are still made for collection and disposal of solid waste in the town.

According to the Enugu State waste management authority, Nsukka branch on their technique in managing solid waste in Nsukka is landfill technique. They have only 200 dustbins that

were distributed according to population density. There is a big gully at Obimo around Nsukka town but close to uzo uwani that they use as their final disposal site.

They are under staffed and also short of collection trucks that will carry the waste to the final disposal site. They hire trucks and labourers for carrying solid waste to the final disposal site.

CONCLUSIONS AND RECOMMENDATION

Urban waste management requires the concern of government, businessmen, politicians, religious organizations, civil servants, men, women, literate, illiterate, the rich, the poor and a host of other tangible and intangible groups. All these must be brought together by government policy and legislation to work together like welfare officers to control vigorously the urban waste problems.

It has been observed in Nsukka urban during a study field trip that there is indiscriminate dumping of refuse at public places such as roads and streets, blocking them partially or totally thereby inhibiting smooth traffic flow within the town. Drainage channel both natural and artificial such as river channels and gutters are blocked with refuse dumps resulting in constant accumulation of stagnant water that acts as breeding places for mosquitoes during the rainy season. The dumped refuse not only constitute an eye-sores but also release nasty smells into the air thereby polluting the environment. The aesthetic nature of the town is greatly marred by the filthy nature of the refuse.

During the course of the study, it was found that there is a defined organization which is responsible for waste disposal in Nsukka urban, but the rate at which solid waste is generated in Nsukka urban outmatches the rate at which it is cleared and disposed of. The creation of illegal dumping points has added other features to the overall landscape. The overall consequence is pollution of the urban environment and the health hazard to the inhabitants of Nsukka urban.

It was gathered from the study that the distance of dumping points from residential houses also contribute to littering of the surroundings. This is so because some households find it difficult to go that far and dispose of their solid waste. The consequence is the creation of illegal dumping points. The research has also found that the problem of refuse generation and disposal is worsened during the rainy season; this is because of lack of enough drainage

channels. The ones available are partially blocked with refuse and when it rains, water overflows, as a result of the blockage, a great amount of refuse is scattered all over the place blocking streets and access roads.

After a thorough measurement and calculation on the refuse dumps in the study areas, it has been found and concluded that an average of 4,970.83m³ of solid waste was generated weekly in Nsukka urban.

The author recommended after gathering information both from respondents through questionnaire and the management agency at Nsukka urban, the following

The introduction of public campaigns on the hazards caused by solid waste on the health of the general populace should go a long way of curbing the rate of indiscriminate littering of waste along the streets, roads and drainage channels. Government agencies and non - governmental organization should organize workshops, seminar and symposium to educate the public on the problems associated with improper solid waste management and the best way of managing and disposing their solid wastes.

It was observed that waste from food and vegetable, including grasses constitute the most solid waste generated in Nsukka urban. Compost manure is made up of organic matters and since food and vegetable wastes and grasses are easily decomposed, they should be deposited in a special place where they should be treated and used for our agricultural production as compost manure. If food and vegetable wastes, including grasses are eliminated to an extent from the environment, the problem of pollution will be reduced drastically and will result to a clean and harmless environment.

Recycling of wastes will contribute positively in combating refuse problems in our environment. It was observed from the data generated from the respondents that tins, metals and plastics constitute part of the refuse generated and if they are recycled, it will reduce pollution problem. If the problem of refuse management could be linked to our industrialization and urban agglomeration as a growing nation, it will go a long way in eliminating the scourge rather than taxes and laws that are never implemented.

To build a well coordinated drainage network that will allow easy flow of water during the rainy season and the residents should also be advised against the consequences of blocking drainage channels which will help in improving environmental quality of Nsukka urban.

Agency responsibility for solid waste management must be sufficiently supported by way of adequate funding and circulatory infrastructural improvements from government to enable the agency perform successfully.

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