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Municipal Solid Waste Generation and Management in Enugu Urban

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ABSTRACT

This research aims to determine the quantity of solid waste generated and the management techniques employed in Enugu urban. The author also attempted to find out the type of refuse generated, the amount and the disposal methods in a day, weekly, monthly and quarterly. The population density of the study area was 1,229, 400 at the 2022 census and 1500 well-structured questionnaires were administered to the residents of various occupational status, sex, marital status and age at sample random technique. The instruments and the structured questionnaires used were validated by instrumentation and measurement expert. The average solid waste generated weekly by the residents of Enugu urban was 14,973.72 m^3 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 significant 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 suggestion is to adequately fund the agency that is responsible in solid waste management and disposal and to circulate infrastructure to enable the agency perform successfully.

Keywords: Municipal, Solid Waste, Generation, Management, Enugu Urban

1. INTRODUCTION

Enugu urban, which was founded in 1915 has land area of 578 km^2 and a population of 1,229, 400 at the 2022 census. The municipal waste generated causes pollution of the urban environment without proper means of managing and disposing them (Dickson et al, 2022). Municipal solid waste commonly known as trash or garbage consisting of everyday items that are discarded by the public. "Garbage" can also refer specifically to food waste, as in a garbage disposal; the two are sometimes collected separately (Adebibu, 2003). 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 (Kumar et al., 2016).

According to UK environmental protection act, (USEPA, 2000) waste is "any substance which constitutes a scrap material or an effluent or other unwanted surplus substance which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled". Waste can be organic or inorganic. Waste management simply means the collection, keeping, treatment and disposal of waste in such a way as to render them harmless to human and animal life, the ecology and environment generally. The generation and disposal of waste is an intrinsic part of any developing society. Waste, both from domestic and commercial sources has grown significantly in the society over the past decade. Every time a householder shops at the store, and open market he contributes to the mountain of waste. It is possible to quote figures which show that the production of waste amounts to millions of tons. The percent of Nigeria's population living in cities and urban area has more than doubled in the last 15 years (Omuta, 2005).

It was discovered in Enugu town 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 (Chukwu, 2007). 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 (Adewole, 2009).

During the course of the study, it was found that there is a defined organization that is responsible for waste disposal in Enugu town. Still the rate at which solid waste is generated in Enugu town outmatches the rate at which it is cleared and disposed of. Creating 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 Enugu city (Golledge, 2010).

One of the significant sources of environmental problems is incorrect collecting and disposing of municipal solid waste in urban areas. The waste streams originating from industrial, commercial solid waste sources differ from the hazardous substances in household waste. For example, unfortunately, municipal solid waste may be mixed with regulated medical waste. This global issue can cause real problems for many industries, such as; factories, farms, hospitals, and hotels in case of carelessness (Ogwueleke, 2009).

Domestic waste management has become a significant concern in Nigeria today. It appears to be a losing battle against the harmful consequences of unguided waste and attaining a clean healthy environment for all Nigerians (Omofonmwan and Eseigbe, 2009). It is a common sight in Nigeria today to see heaps/accumulation of festering waste dumps in our states, urban and commercial cities. Since the inception of the Enugu State administration, there have been concerted efforts to achieve sustainable waste management in the state (Omuta, 2008). The efforts culminated in the establishing of the Enugu State Waste Management Agency (ESWAMA) in 2004. This repositioning occurred to enable it to give more focused service delivery and to restore the past glory of Enugu State as an apparent city through sound waste management. ESWAMA was established to develop and implement policies on the management of solid and liquid wastes that would promote the health and well-being of the people. The residents are also required to pay approved sanitation rates through designated banks in various zones, when presented with demand notice Aguoru and Alu (2015). Municipal solid wastes heap up on the roads due to improper disposal system. People clean their own inner houses and litter their immediate surroundings which affects the community including themselves. This kinds of dumping allows biodegradable materials to decompose under uncontrolled and unhygienic conditions. This produces foul smell and breeds various types of insects and infectious organisms besides spoiling the site's aesthetics. Industrial solid wastes are sources of toxic metals and hazardous wastes, which may spread on land and can cause changes in physicochemical and biological characteristics thereby affecting productivity of soils (Agunwamba, et al, 2003).

The objectives of the study are to assess the amount and nature of municipal solid waste generated, the disposal method used, the 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 household on the amount of refuse generated in Enugu urban.

2. MATERIALS AND METHOD

This study was conducted in Enugu urban the capital city of Enugu State. The town offers accommodation to residents from all works of life. This ranges from traders, administrative staff and business man and woman.

Study area, method of data gathering and description

Enugu Urban is situated in Nigeria's geopolitical zone of the south-east. It comprises of Enugu East, Enugu North and Enugu South local government in Enugu State of Nigeria as shown in figure 1. In addition, the city grew and spread into the regions of other indigenous villages such as Ngwo, Nike, Amaechi, and others in the neighborhood. Since 1929 when it was the capital of the eastern Provinces, Enugu has served as an administrative center in various roles, and it is currently the capital of Enugu State, which it assumed since 1991 (Okeke et al, 2021). The growth of this city had been tremendous from its initial size as coal miners camp (the present-day coal camp residential neighborhood) in 1921, on an area of 151 miles (243 km) and a population of around 3,170 residents. This settlement attained a township status under Laggard's ordinance in 1917 and have grown from a population of 62,764 in 1952 to 505,280 people spreading within 18 neighbourhoods across the city in 1991 to 722,664 in 2006 census with over 159, 306 houses and projected to 1.2 million in 2022 (Federal Republic of Nigeria Official Gazette, 2007). Data collection was done using both primary and secondary sources. The major sources of data collections used in the study are physical measurement of refuse dumps and observation, surveys of households through questionnaire and waste management authority, Enugu branch.

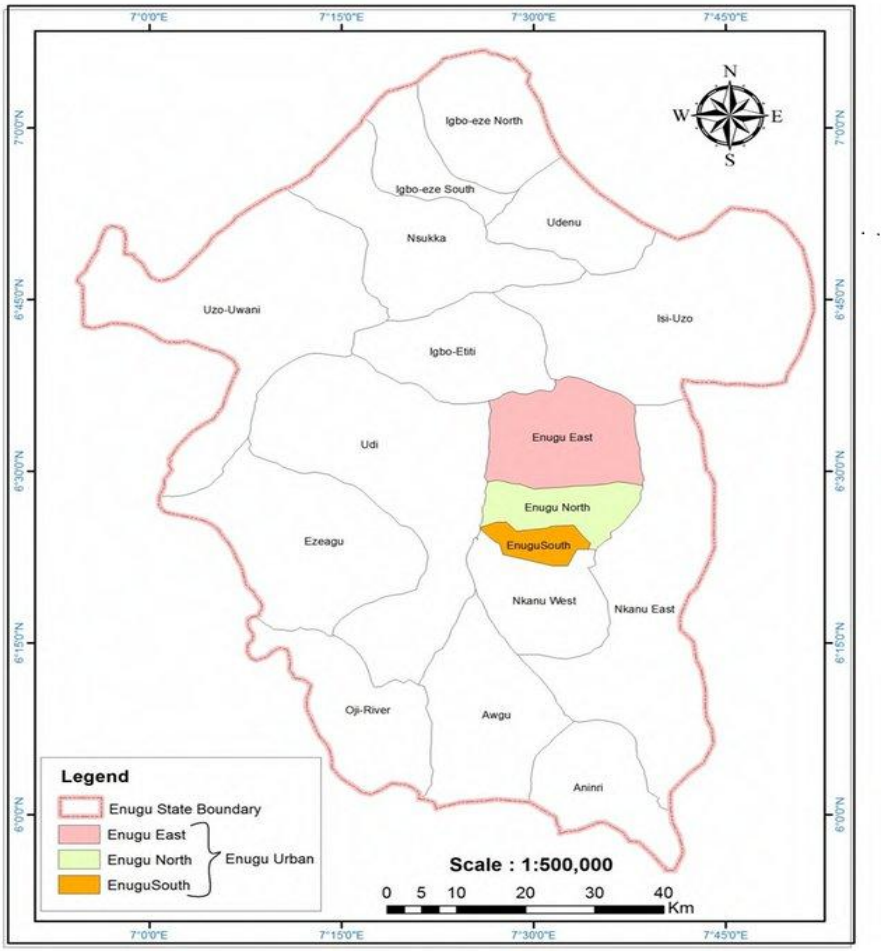

Fig 1: Map of Enugu Urban in Enugu State of Nigeria

Method of data collection

The data collection consists of physical observation, field reconnaissance survey, and sample well-structure questionnaire. The physical observation includes the physical counting and measurement of refuse dumps at designated dumping points which are both legal and illegal. The volume refuse dumps were determined by the product of the length, width and depth of refuse dump. This method 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 was used when the measurement is done with tape and equation 2 is used when the measurement is done with plainmeter (Ugwu et al, 2018).

$V = \frac{d}{3}\{ (A_1 + An) + 4(\text{even areas}) + 2(\text{odd areas})\}$……1

$V = d\{(\frac{A_1+A_n}{2}) + A_2 + A_3 + A_4 + \ldots\ldots A_{n-1}\}$……2

D = the distance between the ordinates
A= cross-sectional areas

The task of collecting household data was easier because most of the residence use containers bearing labels which indicate their capacity. The author was able to issue 1500 questionnaires to 1500 households randomly. According to Mr. Ani Paschal, an operation manager in charge of all the zone in Enugu, told the author that Enugu is a city that is made up of three local government, which include Enugu North, Enugu East and Enugu South local governments. Therefore, the author represented the local governments as region X, region Y and region Z. Each of the regions were issued 500 questionnaires randomly.

Design of sample questionnaire

The questionnaire contains the details regarding the social status of household member, demographic composition, economic and also include information on how refuse is handled at household level and information on the government's effort in combating garbage disposal and management. The author included in the questionnaire suggestions for the means of improving the environmental quality of the town.

Questionnaire administration and challenges

The administration of the questionnaire to the respondents took almost two months. The questionnaires were not to be filled by any other member of the household other than the one in charge of household refuse generation and disposal. This made the questionnaire administration a little bit difficult because most of the respondents can only be contacted on Sundays and Saturdays which are work free days. The questionnaire administrations were undertaken by the author and ten 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 five months, and an average of 80 questionnaires were administered in a week. Questionnaire administration lasted for four months and two weeks, while the field observation at dumping points took the rest of the time.

An overall interview was granted to the author by the operation officer in charge of all zone in Enugu urban, Mr. Ani Paschal and the head of operations, Mr. Ugochukwu Nwoga, both from Enugu State Waste Management Authority, Enugu State. Information on the resources available to the zone was gathered by the author. These include workforce, both technical and administrative, as well as labourers who were directly involved to the management of solid waste in Enugu urban. Information on the staff size, availability of collection vehicles and yearly budget to purchase and maintain the refuse were also gathered. Questions were also asked about their duty roster, the volume of refuse collected and disposed on daily, weekly and monthly basis. Other information sought included the general refuse situation and the number and location of officially designated dumping depots.

3. RESULTS AND DISCUSSION

Results

The study was conducted by the author through the household members in charge of refuse generation and disposal. The data obtained from the sample questionnaires issued and personal oral interview from Enugu State Waste Management Authority, Enugu, are shown in the tables 1 to 3 and figures 2 to 11.

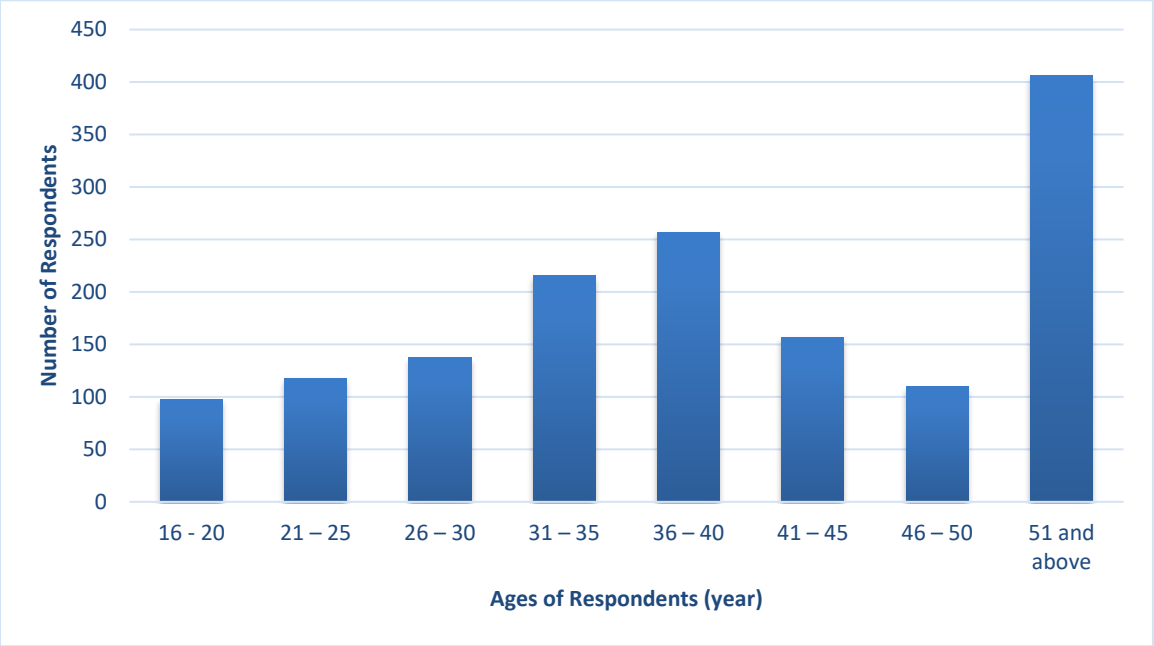

Fig. 2. Age distribution of the respondents

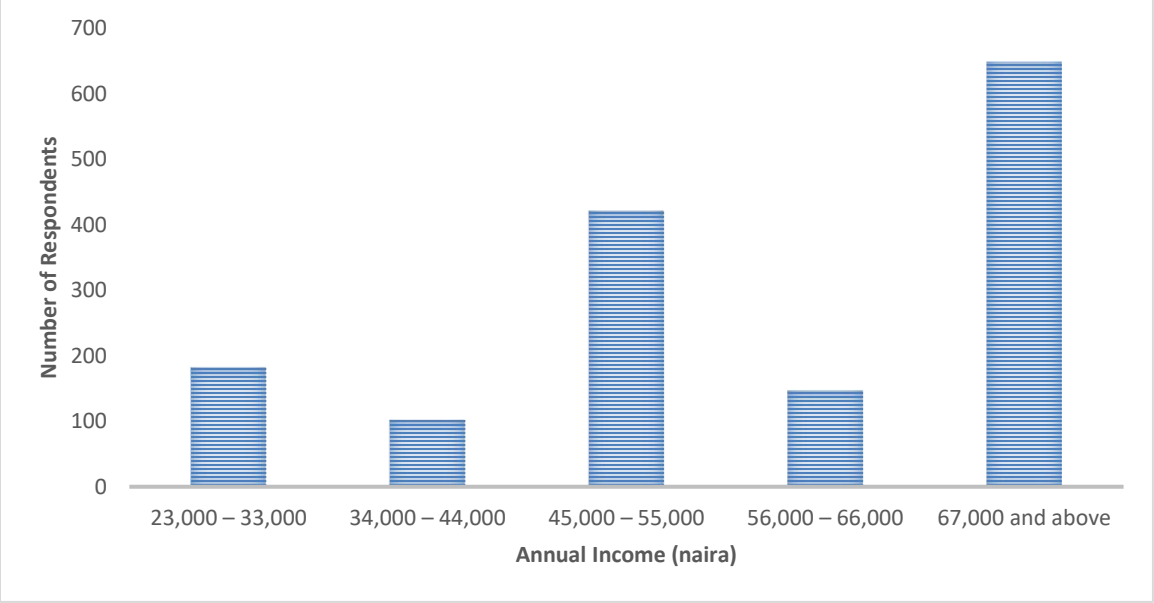

Fig. 3. Representation of the annual income of the respondents

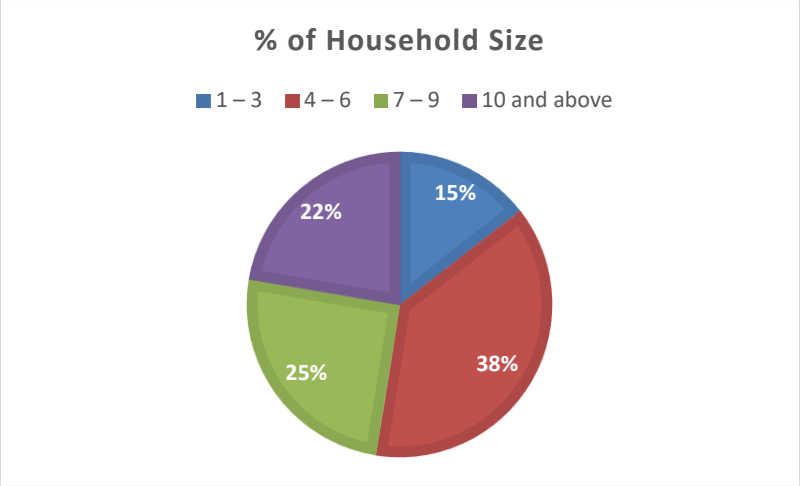

Fig. 4. Representation of household size of the respondents

Table 1: The volume of refuse at legally designated dumping points per week

Dumping points	Number of Waste bins in Dump Sites	Estimated Length (m)	Estimated Heights (m)	Estimated Volume (m^3)
Opp APC House GRA	3	21	3.5,6,	523.22
Beside DSTV Office GRA.	3	17	4,6,5.	324. 17
Chapel of Resurrection Gate GRA	2	15	4.3,	286.60
Laggard Avenue Junction GRA	2	16	2.4,	197.44
N0 38 Nwodo street GRA	3	21	4.5,7,	407. 54
Back of First Bank New Heaven	4	18	3.8,6,5	507.97
N0 29 Mbanefo Street New Heaven	3	15	3.7,5,	234.65
Beside New Heaven Primary School	4	19	5,7,6,4	486.08
Back of St. Paul Achara layout	5	14	5,5,6.,4,2	398.98
N0 46 Nwobodo Street Maryland	4	20	4,6,5,3	465.02
N0 20 Robinson Street Uwani	3	19	5,4.7	395.95
Beside Ejindu Pack Camp	5	25	3, 2, 3, 3, 2	609.30
Beside Albertina, Zik Avenue	2	20	6,7,	456.09
Awknanaw Boys Agbani Road	6	17	6,4, 2, 3, 4, 2	332.17
N0 8 sir Ken Nnamdi Drive Ind/layout	4	14	5,2, 6, 4	191.03
Beside IMT Industrial Centre Ind/Layout	2	21	3, 7,	342.90
N0 42 Hill View Road Ind/Layout	4	17	4 3, 4, 2	220.36
Opp ESBS Ind/layout	2	19	4, 6	228.05
National Industrial Court Ind/layout	3	17	3, 4, 2	196.93
Beside Destiny Bus stop Emene	3	23	5, 6, 4	453.96
Opp First Bank Maryland Emene	4	19	3, 2, 4, 2,	402.05
Opp St Peter College Emene	3	22	3, 4, 6	503.40
Beside 82 Divison Abakpa	2	20	4, 6,	330.60
Corner Stone Junction Abakpa	5	15	2, 3, 2, 3, 3	306.89

West Road Trans Ekulu	2	19	5, 7	229.67
N0 26 Nnamdi zik Avenue T/Ekulu	3	21	4, 3, 5	409.60
Beside Golden Pharmacy T/Ekulu	2	21	6, 7	309.30
Behind Fed Dental School T/Ekulu	3	19	5, 4, 4	331.90
N0 15 Osadebe Street Ogui New Layout	4	17	3, 2, 5, 2	220.35
Beside JAMB Office Gate Ogui New Layout	3	23	5, 6, 5	412.12
Back of UNEC stadium Ogui New Layout	3	21	5, 4, 4	428.95
Total	101	585		11,143.24

Opp – Opposite, IMT – Institute of Management and Technology, GRA – Government Reserved Area, ESBS – Enugu State Broadcasting Service, UNEC – University of Nigeria Enugu Campus, JAMB – Joint Admission and Matriculation Board.

Table 2. The volume of refuse at illegal dumping points

Dumping points	Estimated Length (m)	Estimated Heights (m)	Estimated Volume (m^3)
Beside Ocean Oil Amechi Road	18	2,6.	374.13
Tanker pack Close to Bridge Gariki	15	5,3,4	245.89
Opp. Okonkwo Agbo Airport Road Emene	18	6,3,3	445.90
Beside Emenite Emene	16	4,5,2	205.94
N0 40 John Agbo Street Achara Layout	20	3,,5,2	339.06
Uwani General Hospital Junction	23	2, 4, 7, 3	603.95
Close to prison Gate Newmarket	19	3,3, 6	405.99
Nkpokkiti Roundabout Ogui New layout	21	2, 5, 7	498.19
Liberty Bus Stop Abakpa	23	6, 4, 4	597.49
T-Junction, back of Shoprite	13	3,3,7	123.94
Total	186		3,840.48

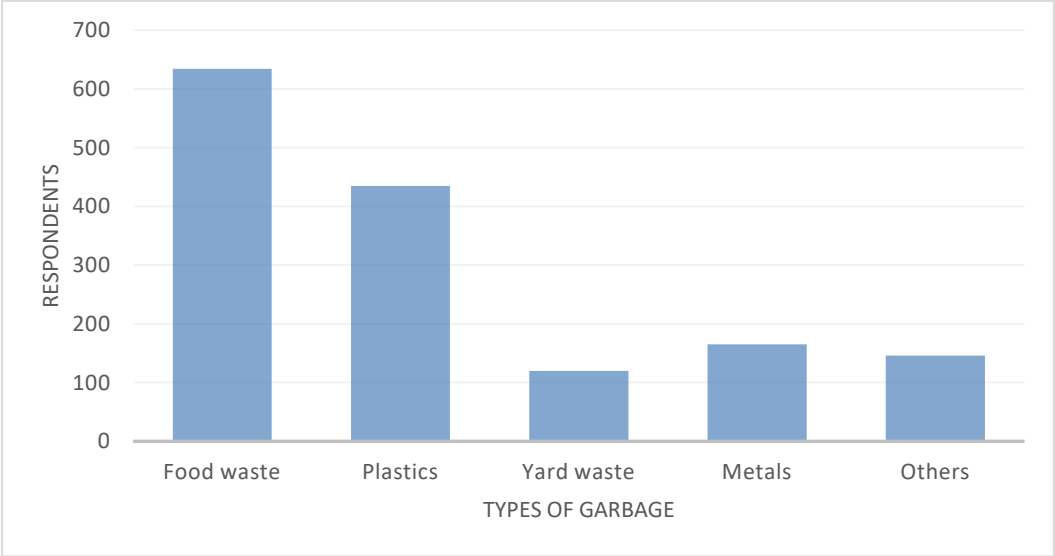

Fig 5: Representation of garbage composition of the respondents

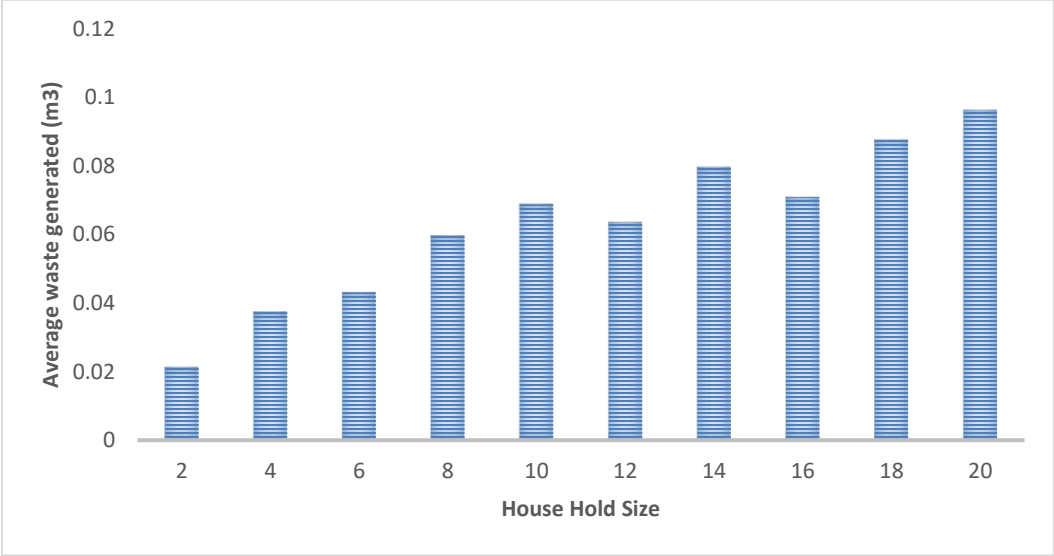

Fig 6: Household size and solid waste generation per day

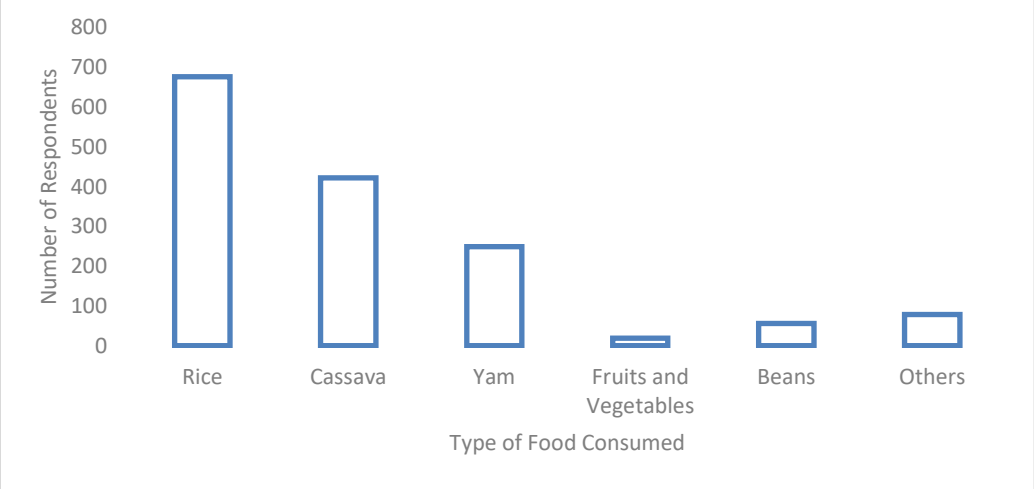

Fig 7: Consumption pattern and solid waste generation from respondents

Table 3. Annual income level and solid waste generation per day

Annual Income (#)	Number of Respondents	Average Volume of Solid Waste Generation per Day(m^3)
23,000 – 33,000	182	0.0265
34,000 – 44,000	102	0.0304
45,000 – 55,000	421	0.0354
56,000 – 66,000	147	0.0472
67,000 and above	648	0.0850
Total	1500	0.2245

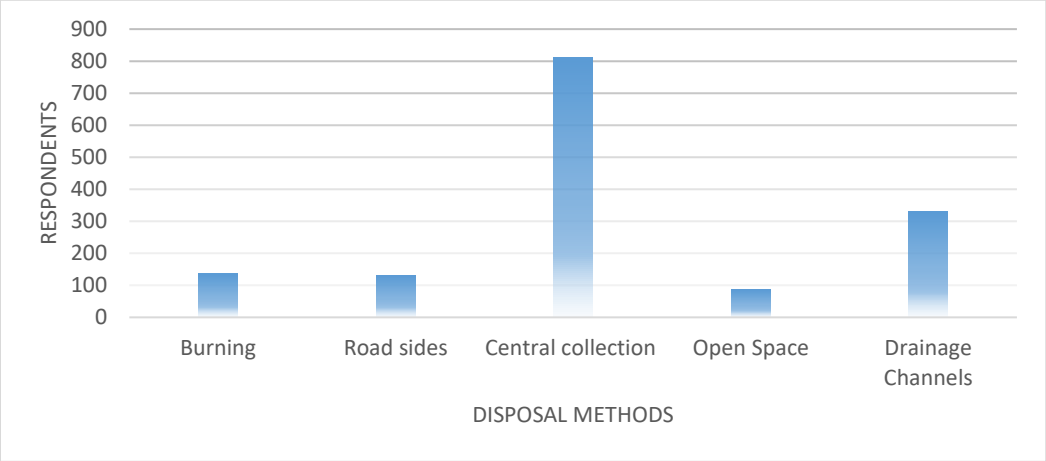

Fig. 8. Methods of disposing garbage from respondents

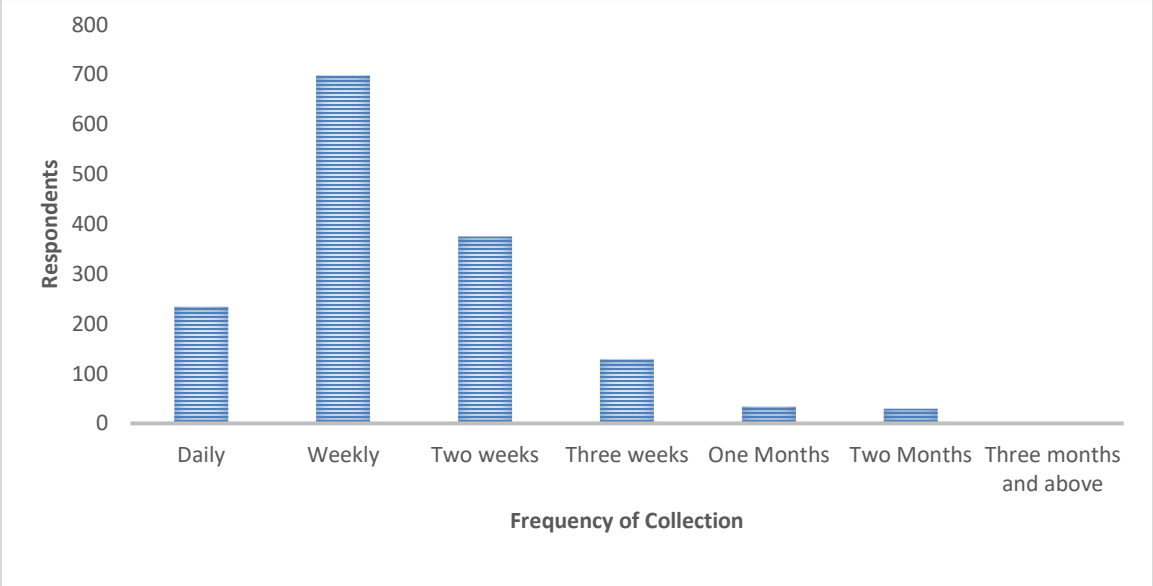

Fig 9. Solid waste collection at central collection points by Environmental Protection Agency

Fig. 10. Representation of the respondents on the responsibility of collection and disposing of waste from collection points

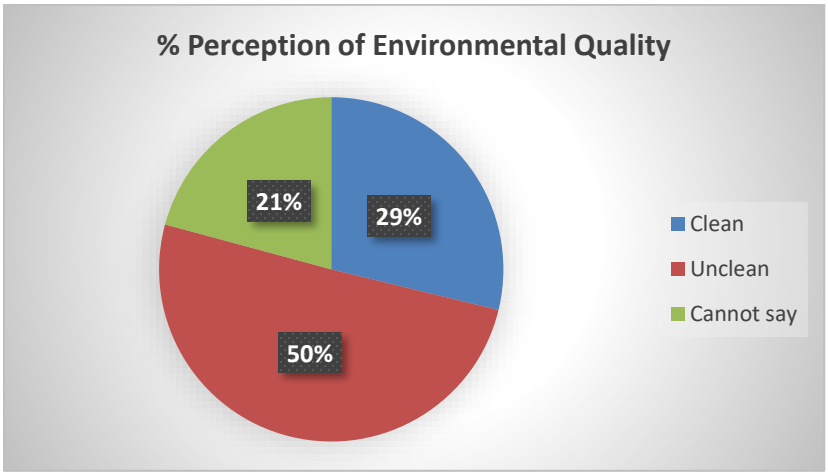

Fig. 11. Environmental perception of the respondents

Discussion

Information was obtained from both the young and old, as shown in figure 2. The age of the respondents ranges from 16 to 51, and above. From the figure 2, it could be seen that 6.5 % is the lowest respondents that belong to the age of 16 to 20 years, and the highest rate is 27.1 % which belong to 51 years and above. This shows that household managers belong to 51 years and above and they are the right people to give us correct information.

The income levels of the respondents were included in the questionnaire. It helps us to know the volume of generated waste since the level of annual income is known as presented in figure 3. The lowest percentage income generation of the respondents which is 6.8 % fall into 34,000 to 44,000 naira and the highest rate income generation of 43.2 % fall into 67,000 naira and above. Most of the household assessed were higher income generation and they are the ones that generate higher solid waste.

Information was sought on the number of people that make up a household as shown in figure 4. This is to get the number of people that stay in a house and the waste they can generate. The highest rate of household of respondents is 42.8% which fall into 4 - 6 people in a family. Then, the lowest rate of the household of respondents is 12.6 % which fall from 10 and above people in a family. Enugu city is dominated by 4 to 6 people in a house.

To determine the average volume of solid waste generated during the study period, measurements were taken from the dumping points. The volumes of waste generated were calculated using the end areas formula given in chapter three. Figures 2 and 3 show the data collected concerning observed dumping points and the estimated volume from legal and illegal dump points. The data presented above show that most of the dumping points followed by the author were relatively large dumping points. It was also observed by the author that the dumping points that are 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 11,143.24 m^3 and the volume of solid waste generated at illegal dumping points was 3,840.48 m^3 as the time the study was carried out.

To determine the composition of solid waste generated by households, the household managers were asked to indicate the primary composition of their solid waste. The data generated were presented in figure 5. The highest percentage of garbage generated by the household was from Food waste which is 42.3 % and the lowest garbage was from yard waste, which was 8.0 %. It means that Food Leftover, vegetables and fruits constituted the solid waste generated from households in Enugu Urban.

The results of house hold size and waste generated were got from questionnaires distributed to the respondents. The higher the house hold size the greater solid waste generated, which was shown in figure 6. 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 makes the highest volume of solid waste, which is 0.0963 m^3 for 20 people while the lowest size of people produces the lowest volume of solid waste, which is 0.0213 m^3 for two people.

The type, and amount of food taken by a household takes the type and amount of solid waste generated by the household. The figure 7 showed the data generated on consumption pattern and solid waste generated. The consumption pattern that produces the highest solid waste according to the respondents is rice, which has 45.1 % with 676 respondents and the lowest is fruits and vegetables with 1.3 % with 19 respondents. The results show that Enugu urban ate more 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 3 showed 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. The result showed a significant variation in the income levels of respondents and the average volume of solid waste generated per day. The highest respondents were from 67 naira and above annual income level, which generates 0.0850 m^3 volume of solid waste and the lowest respondents fell from 34,000 to 44,000 yearly income naira level that generated 0.0304 m^3 volume of solid waste.

The figure 8 presented results obtained from the respondents on the method of disposing solid waste generated. The amount of refuse dumping points observed were relatively large, and it appear that majority of the residents in Enugu urban use drainage channels 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 54.1 % and the lowest fall from open space which is 5.9 %. The rampant dumping of waste on drainage channels usually blocks access roads and drainage channels.

It was shown in figure 9 on how the environmental protection agency clears solid waste at the official designated dumping points. The frequency of removing solid waste from the collection point was observed to be mostly once every week. From an interview with the head of operations, Enugu State waste management authority, Enugu, Mr. Ani Paschal revealed that the poor collection of the solid waste from the collection points was lack of adequate resources. According to him, there is no enough trucks and human resources to meet the demand of the clearance. It was seen from the figure 9, that the highest percentage of the respondents, which is 46.5 %, fell on the weekly basis of clearing solid waste from dump points while 0.1 % was the lowest percentage that, fell into three months and above.

The figure 10 presented who is responsible for clearing solid waste from dump points. The responsibility for the clearance of solid waste from the area, Enugu urban, is primarily that of the Enugu State Waste management Authority. The above data showed that 88.3 % of the respondents placed the responsibility on the Enugu State Waste management Authority whereas 8.5 % claimed individual and 3.2 % claimed others. Refuse clearance should be a joint responsibility of the residents of Enugu urban and the authority of the Enugu State Waste management Authority in the sense that if the residents adopt the culture of disposing their waste at appropriate dumping points instead of littering and blocking access streets, roads and drainage channels. The job will be made easier for the authorities responsible for clearance and disposal.

The perception and the reactions of the respondents on the environment of Enugu urban is presented in figure 11. Enugu city is rated as dirty by 50.4 % respondents, while 28.8 % claimed that Enugu urban was clean and 20.8 % respondents cannot say that Enugu urban was dirty or clean. We can conclude from figure 11 that the environmental quality of Enugu's Urban was generally poor.

Solid waste management in Enugu urban

An oral interview was granted to the author by the head of operations and other senior staff of Enugu State waste management authority, Enugu urban. Questions were asked as regards to management techniques employed in Enugu urban. It was gathered that Enugu urban is a planned city like other satellite towns but the building arrangement and roads did not follow Enugu urban initial plan. Provisions were made for the collection and disposal of solid waste in the city.

According to the Enugu State waste management authority, Enugu urban's technique in managing solid waste in Enugu urban is open space technique. They have about 2095 dustbins that were distributed according to population density. There is a big gully at ninety-mile road around poultry Eva Valley Enugu but close to ninety mile, Ngwo that they use as their final disposal site. They are understaffed and also short of collection trucks that will carry the waste to the final disposal site. They hire trucks and labourers for holding solid waste to the final disposal site.

Suggested ways of managing waste in Enugu urban

If the following suggestion should be followed correctly, the problem of solid waste management will be solved. They include

Financial support from the government

From the interview granted to the author from the head of operations and other senior staff of Enugu State waste management authority, Enugu branch, it was observed that insufficient fund is the major problem facing the establishment. There is no money to buy more trucks which will be used in collecting refuse from the collection centres. From the information, they have twenty compact trucks and four open trucks but only six compact and two open trucks are functional as the time this study was conducted. This made it impossible for the solid wastes to be cleared when due.

Proper education and enlightenment campaigns on the effect of poor solid waste management

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 indiscriminate littering of garbage along the streets, roads and drainage channels. Waste management authority, 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.

Formation of compost manure from the solid waste generated

It was observed that waste from food and vegetable, including plastics and polyethylene bags constitute the most solid waste generated in Enugu urban. Compost manure is made up of organic matters. Since food and vegetable wastes 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

Recycling of wastes will contribute positively in combating refuse problems to 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 issue of refuse management could be linked to our industrialization and urban agglomeration as a growing nation, it would go a long way in eliminating the scourge rather than taxes and laws never implemented.

4. CONCLUSION

It was gathered from the study that the distance of dumping points from residential houses also contributes 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 the 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 significant amount of refuse is scattered all over the place blocking streets and access roads. After a thorough measurement and calculation of the refuse dumps in the study areas, it has been found and concluded that an average of 14,973.72 m^3 of solid waste was generated weekly in Enugu urban.

After gathering information both from respondents through questionnaire and the management agency at Enugu urban, the author revealed that one single factor that was responsible for the shoddy collection of solid waste in Enugu urban was that of inconsistent attitude that is accorded the collection and clearance of solid waste. As a result of this, refuse is left to accumulate and this leads to the littering of the whole surrounding. 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.

Government must also provide congenial enabling legislations and edicts that will establish waste management agencies as Independent Waste Management Authorities which will function like a private business corporations. This will enhance its efficiency because it will aspire to break even and at the same time try to live up to expectations. Efforts should be geared towards the use of scientific techniques to develop appropriate technologies for dealing with solid waste management such as encouraging the emergences and development of industrial ecology where wastes from one activity are input of raw materials for another activity. Landfill sites should be designed and operated following W.H.O. standards.

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Author Contributions
Engr. Uche Nelson Okorie participated in distributing and collection of questionnaires from respondents, including interviewing the respondents in the field, measurement of waste at dump sites.
Engr. Prof. Brendan Eje participated in arrangement of collected data and analysis, including design of structured questionnaire.
Engr. Dr. Ugwu Kenneth Chikwado participated in distributing and collection of questionnaires, including design of structured questionnaire, measurement of waste at dump site and typesetting of the whole work.

Informed consent
Oral informed consent was obtained from individual participants included in the study.

Conflicts of interests
The authors declare that there are no conflicts of interests.

Ethical approval & declaration
Not applicable.

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All data associated with this study are present in the paper.

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