

Assessment of Solid Waste Management Strategies in Elele Community, Ikwerre Local Government Area, Rivers State, Nigeria

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Abstract

Background: Solid waste management has become the greatest problem facing many semi-urban and rural communities like Elele in Nigeria, and is fast becoming a serious health concern. The study therefore was carried out to assess the strategies developed by Elele community in solid waste management and recommend proper solid waste disposal strategies. **Materials and Methods:** The study adopted survey research method using data collected through self-administered questionnaire which were analyzed to generate data for the study. **Results and Discussions:** The result from the field research showed that majority 96.19% of the respondents have heard of solid waste, and (34.83%) of the solid wastes generated in Elele community was Garbage, composed majorly of food waste which were compostable to make local manure; 29.62% refuse waste made up of papers, plastics, cans and glass were generated. The result revealed also that dumping in open spaces (69.82%) was the most prominent disposal method practiced in Elele and only 1.09% of the population practice Land fill (Burial method). There was inadequate provision of closed top compacting trucks (29.03%) to handle refuse collection with protective measure in mind. The respondent's acknowledgement on the indiscriminate disposal of Solid waste in Elele was high (96.67%) and listed factors responsible like: lack of awareness on accepted methods of solid waste disposal (38.55%), Lack of Community Participation (16.23%), and Financial inadequacy of government (14.78%). **Conclusion:** The study revealed that dumping in open spaces (69.82%) was the most prominent disposal method, while the least was land fill practice (Burial method) 1.09%. The study recommends the participation of the Local Governments in enhancing and building the capacities of local communities to identify and promote proper waste disposal and management. In addition, develop strategies that minimize waste at household and community levels through re-use like in manure, or recycling in their vicinity.

Keywords: Solid Waste, Management, Strategies, Elele, Community, Rivers State.

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INTRODUCTION

Solid waste disposal and management is both an urban and rural problem [1]. Every person a potential generator of waste and thus a contributor to this problem [2]. Solid waste Management is therefore an important aspect of sustainable development for any

nation and especially in Nigeria [3]. It has been the consistent efforts of the Ministry of Environment and its associated regulatory bodies to ensure this is in place.

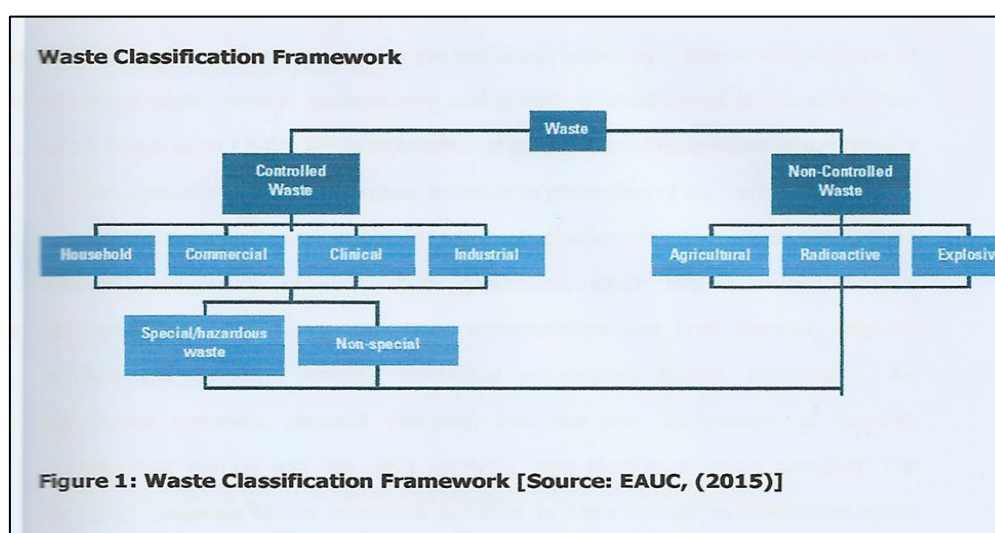
United Nations Environment Programme [4], defined wastes as substances or Objects, which are

disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law. According to Mugambwa [5] waste also refers to “an item, material or substance you as an individual consider useless at a given time and place.” A definition of Solid Waste or municipal solid waste according to Medina [6] are materials generated from the result of human daily activities resulting from areas such as households, public places, city, streets, shops, offices, hospitals and many other different industrial sectors.

In Nigeria, the increase in waste quantity and variety has been due to population growth and industrialization [7] and its basic solid waste management stem based on collection, transportation and disposal has remained highly inefficient and ineffective [8]. Waste generated per person in Nigeria has been estimated at the rate of 0.49 kg per day with households accounting for 90% of the waste [9]. This

waste has been seen to have a high organic content consistent with waste generated in developing countries such as Ghana, China and Jordan and Palestine [10-12]. The composition of waste in Nigeria suggests a recyclable content of over forty percent with recycling rate estimated at 8-22%, carried out by the informal sector [13] Other disposal options are open dumping, open burning and composting [7, 14, 15].

The principal sources of Solid Waste in an urban area are: Municipal (from street sweeping, sewage, waste from schools, markets and other institutions); Domestic (garbage, rubbish and often large waste from homes); Commercial (from stores and offices); Industrial (from manufacturing plants); Mining (from coal mining, strip mining etc.); Construction and Demolition (new construction sites, road repairs, renovation sites razing broken pavements); Agriculture [16].



Elele is developing from the rural to the sub-urban settlement due to the presence of the Local, State, Federal governments and private establishments in the community which has in recent times led to high influx of people from different part of the country into the community [17]. This tremendous increase in population of the community has led to increase domestic, commercial and industrial activities with the consequences of an enormous magnitude of solid waste generation, which require proper disposal strategies such as storage, collection, transportation and final disposal [18]. Disposal involves the following namely: controlled or sanitary landfill, composting, for agricultural purposes, disposal (barging) into the sea, incineration or burning, pulverization, sorting and salvaging pyrolysis, Hog feeding or crude dumping. The observed consequences of increased activities in Elele include indiscriminate waste dumping on major streets, foot paths, and markets [18]. These wastes attract flies, emit offensive odour, create breeding sites for mosquitoes, cause unsightliness and attract feeding of rats [18].

Improper refuse dumping causes all kinds of disease which poses enormous negative impact on the economy due to lost workdays, cost of treatment and mitigating activities [19]. These health effects include spread of diseases such as typhoid fever and lassa fever by flies and rodents; and malaria from mosquitoes that use waste heaps and blocked drainages as breeding grounds [19]. This is in addition to health issues resulting from direct contact with waste such as injuries, infected cuts, respiratory and skin infections [19, 20]. However, evidence from other studies indicates that the link between people working with waste having more infections is inconclusive.

There is growing menace of solid waste on the major streets and roads with no visible plan or strategy to manage it in Elele. Also, there is dearth of information on solid waste management strategies in Elele community; hence, this study was done to assess the solid waste management strategies and possible

solutions in Elele community, Ikwerre LGA, Rivers State, Nigeria.

There are existing literatures on waste management strategies, plans and actions geared towards improving the management of solid waste in locally and internally.

MATERIALS AND METHODS

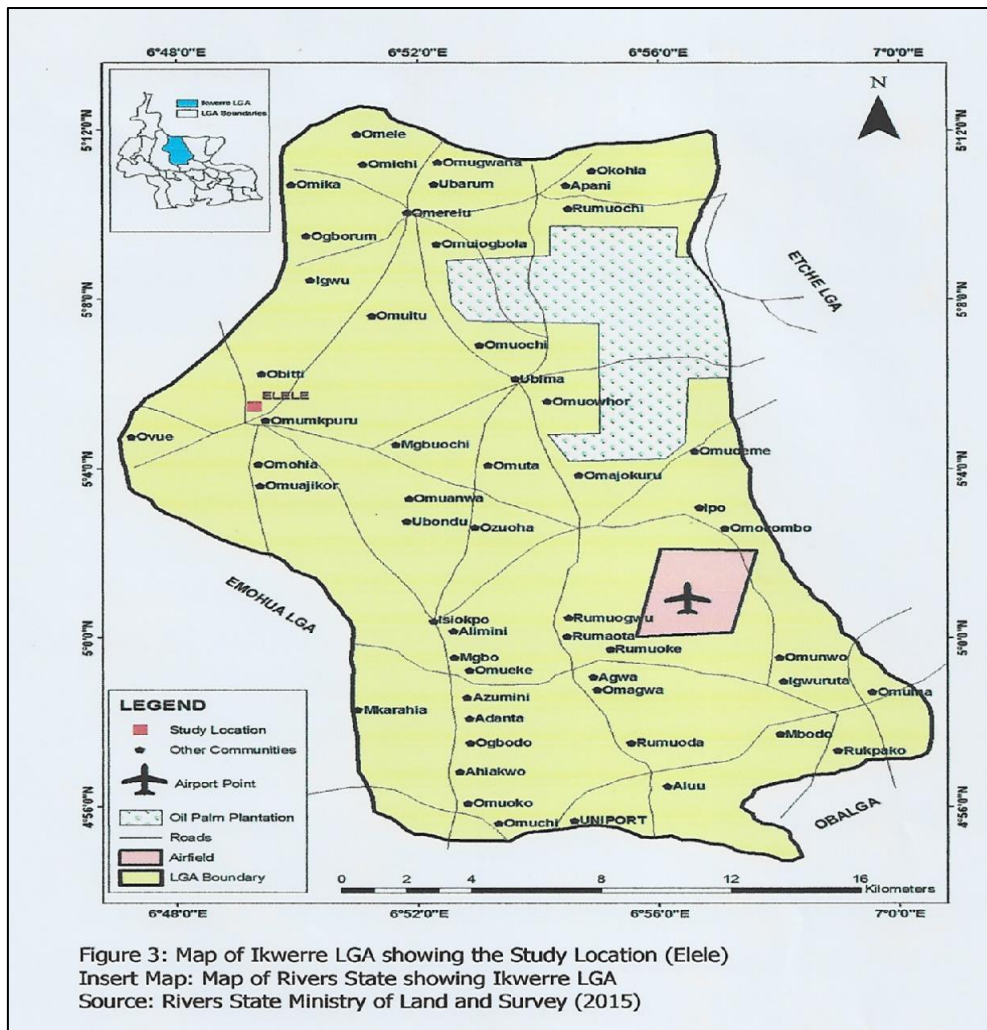
Study Design: Descriptive study design.

Study Area: The area of the study was Elele, located in the northern part of Ikwerre local government area of Rivers State, Nigeria. In terms of distance, Elele is 56.33 kilometers from Port Harcourt, capital of Rivers State, Nigeria; 54.72 kilometers from Owerri, capital of Imo State; 19.31 kilometers from Egbeda in Emohua local government area and 19.31 kilometers from Ahoada all in Rivers State. The people of Elele are mainly farmers and traders. However, a few number of the people engage in technical jobs like carpentry, automobile mechanics, bicycle repairs, tailoring, wood carving and crafts. Farming activity is one of the major economic activities in the study area. The totality of Elele people practice subsistence farming. Among the crop cultivated included yam, cocoyam, cassava, corn, and vegetables etc oil palm are also found in the area [21].

APPENDIX II: Photograph showing Refuse Heaps.



Figure 1: Refuse dump very close to living houses and blocking access road



Study Population: Elele is a cosmopolitan community with a population of over forty-five thousand people by the 1991 national census figure projected to 2002.

Sample Size and Sampling Technique

A total of 210 respondent residents in Elele were randomly selected for the study and the sampling technique adopted was simple random sampling, where respondents were selected randomly from all the sub-villages. The community is made up of four major villages as follows; Omopo, Agwugwuibo, Omokpiriku, and Mbuayim. Each of these major villages is further sub-divided into sub-villages. Ten (10) persons were randomly chosen from each of the sub-villages giving a total of two hundred and ten (210) persons.

Method of Data Collection

A structured, pretested, self-administered questionnaire was used to obtain information from respondents. The information sought included socio-demographic characteristics, their knowledge on solid waste management, and its strategies implemented and finally health issues surrounding improper waste disposal. The questionnaire contained thirty (30) questions.

Data Analysis

The data was analyzed using the statistical software package Epi-info version 6.04d from the Centre for Disease Control (CDC), USA and the world

health organization (WHO), Geneva, Switzerland. The descriptive data was presented in frequency tables with percentages. Charts were also used.

RESULT

A total of 210 respondents were recruited for the study. The age range of respondents was 17 to 62 years (mean age of 24.13 ± 9.78 years), which invariably means most of the persons interviewed were within this age group. Respondents within 19 years and below constituted the highest respondents interviewed, 117 (55.71%), followed by those within 20-30 years, 52 (24.76%). Only 11 (5.24%) were aged 51 and above (Table 1).

Males interviewed were higher in proportion than females, 119 (56.67%) against 91 (43.33%). In terms of marital status, 156 (74.29%) were single (never been married), while 48 (22.86%) are married.

The level of Education distribution is as follows: Primary Education, 2 (0.95%), Secondary Education, 141 (67.14%), Tertiary Education, 65 (30.95%), and persons that had No Formal Education were only 2 (0.95%) as does Primary Education. This proportion shows that most of the respondents have had at least a secondary level of education. For religion, 203 (96.67%) were Christians, and 2 (0.95%) were Muslims (See Table 1).

Table 1: Socio-demographic characteristics of participants

Socio-demographic characteristics	Frequency	Per cent
Age category		
≤19	117	55.7
20 - 30	52	24.8
31 - 40	17	8.1
41 - 50	13	6.2
≥51	11	5.2
Total	210	100.0
Gender		
Male	119	56.7
Female	91	43.3
Total	210	100.0
Marital Status		
Single	156	74.3
Married/Cohabiting	48	22.9
Divorced/Widowed/Separated	2	2.8
Total	210	100
Educational level		
No formal education	2	1.0
Primary	2	1.0
Secondary	141	67.1
Tertiary	65	30.9
Total	210	100.0
Religion		
Christianity	203	96.7
Islam	2	1.0
Traditional religion	5	2.3

Total	210	100.0
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Heard of solid waste (refuse, dirty) before

When respondents were asked if they've heard of solid waste, 202 (96.19%) responded positively with the answer yes, while the remaining 8 (3.81%) said no (See Table 2).

Type of solid waste known (multiple responses)

Respondents that answered 'yes' above were further asked to state the type of solid waste they know. Overall multiple responses, 34.30% knew about Garbage, 26.10% knew about Rubbish, 11.58% knew about Dead Animals, 16.70% knew about Metals and 11.36% knew about Street sweeping (See Table 2).

Type of solid waste generated in Elele community (multiple responses) When asked to state the type of solid waste generated in Elele community, 34.83% said Garbage, 29.62% said Rubbish, 8.29 said Dead Animals, 15.40% said Metals and 11.84% said Agricultural waste. (See table 1). From the result, Garbage which mainly results from the growing number in the handling, preparation and consumption of food, including food left over appears to be the major waste generated. These wastes are organic in nature and could be useful if converted to organic fertilizers.

Table 2: Knowledge on the composition of solid waste in Elele Community

Characteristics	Frequency (n)	Per cent (%)
Heard of solid waste (refuse, dirty) before		
Yes	202	(96.19)
No	8	(3.81)
Total	210	(100.0)
Type of solid waste known (multiple responses)		
Garbage (food waste inclusive)	154	(34.30)
Refuse (papers, plastic, cans and glass)	117	(26.06)
Dead Animals	52	(11.58)
Metals (Abandoned vehicles I vessels inclusive)	75	(16.70)
Agricultural wastes (dirty, leaves & debris, ash & dust)	51	(11.36)
Total	449	(100.0)
Type of solid waste generated in Elele		
Garbage (food waste inclusive)	147	(34.83)
Refuse (papers, plastic, cans and glass)	125	(29.62)
Dead Animals	35	(8.29)
Metals (Abandoned vehicles / vessels inclusive)	65	(15.40)
Street sweeping (dirty, leaves & debris, ash & dust)	50	(11.84)
Total	422	100.0

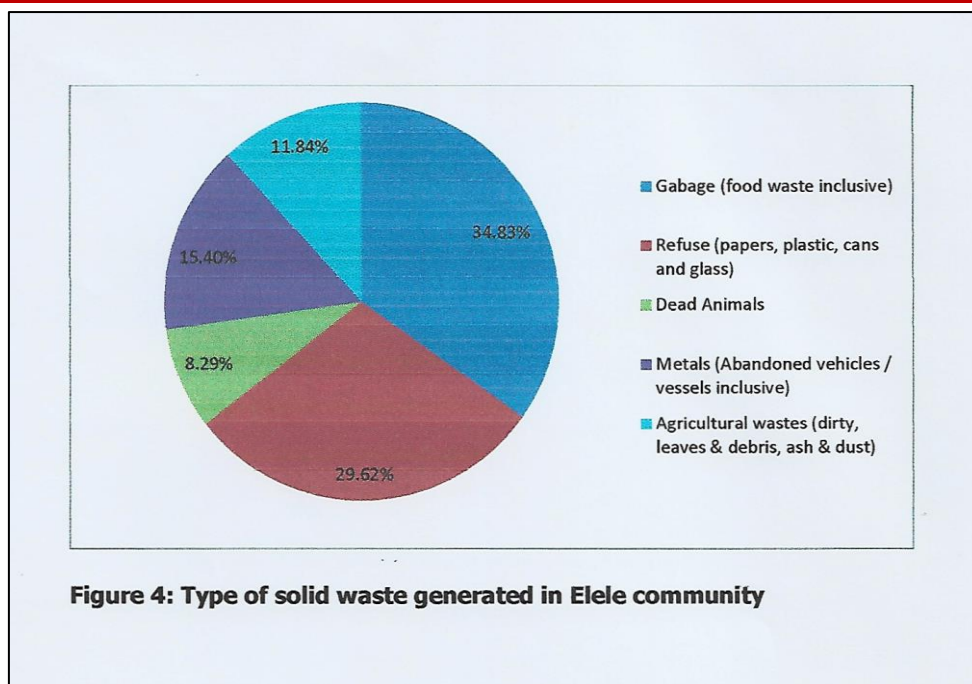


Figure 4: Type of solid waste generated in Elele community

Solid waste disposal methods currently used in Elele community (multiple responses)

From table 3, 69.82% of the population feels that wastes generated are been disposed through Dumping in Open spaces, 11.27% by a Waste collection contractor, 10.91% by Incineration/Burning, 3.27% by composting, 1.10% by landfill while 3.64% by other means which included recycling.

Dumping in Open spaces appears to be the major means of final disposal of waste in Elele community. And this method has been seen to attract and breed flies and other insects, even rodents and it emits odors.

This was followed by the Waste collection contractors. Out of the 31 responses, 22 (70.97%) said the open top trucks are used. Only 9 (29.03%) said the closed top compacting trucks are used.

Table 3: Solid waste disposal methods currently used in Elele Community

Characteristics	Frequency (n)	Per cent (%)
What solid waste disposal methods are currently used in Elele Community (multiple responses)		
Waste collection contractor	31	(11.27)
Dumping in Open spaces	192	(69.82)
Land fill (Burial method)	3	(1.09)
Composting	9	(3.27)
Incineration/Burning	30	(10.91)
Recycling	10	(3.64)
Total	275	(100.0)
Type of vehicles used	22	(70.97)
The open top trucks	9	(29.03)
the closed top compacting trucks	0	(0.0)
the pulverizing truck	0	(0.0)
the close top non-compacting trucks	31	(100.0)
Total	31	(11.27)

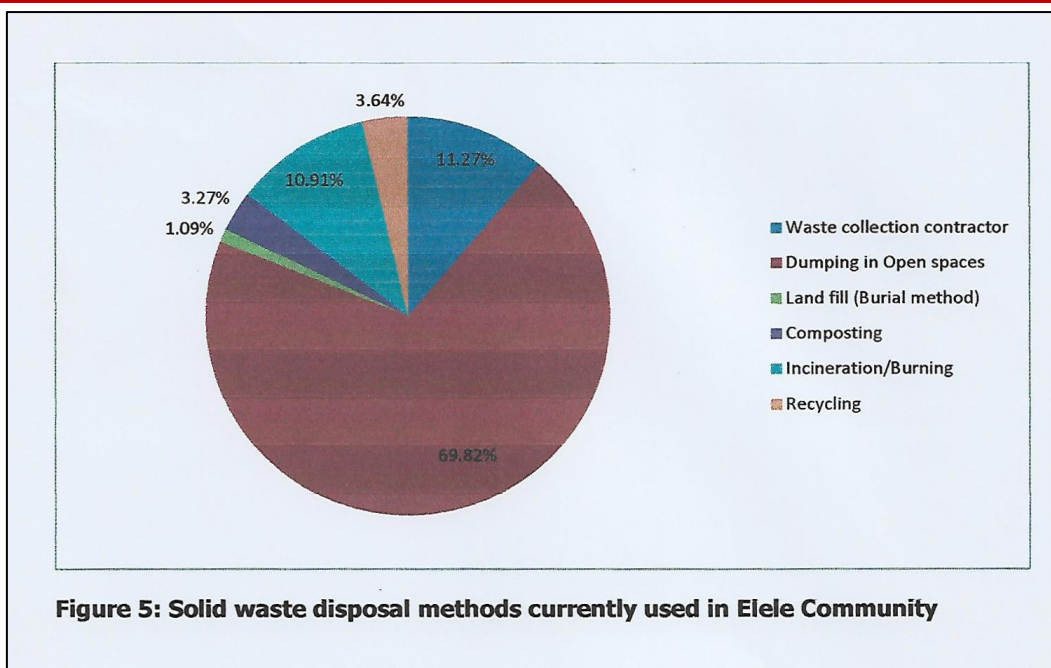


Figure 5: Solid waste disposal methods currently used in Elele Community

If they think indiscriminate disposal of Solid Waste is a problem in Elele Community and who was responsible

When asked if they feel indiscriminate disposal of Solid Waste is a problem in Elele

Community, 203 (96.67%) of the respondents said yes. Of that number, 38.55% thinks the lack of awareness on accepted methods of solid waste disposal

is responsible, 16.23% thinks Lack of Community Participation is responsible, 14.78% thinks both Financial inadequacy and Non — governmental involvement in solid waste disposal is responsible, 10.43% thinks Population increase is responsible. Other reasons given where Socio-cultural/political problem (4.06%), Lack of sanitation (0.58%) and Lack of refuse collectors (0.58%), See Table 4.

Table 4: Peoples’ responses towards what is responsible for the indiscriminate disposal of Solid Waste in Elele community

Characteristics	Frequency (n)	Per cent (%)
Do you think indiscriminate disposal of Solid Waste is a problem in Elele		
Yes	203	(96.67)
No	7	(3.33)
Total	210	(100.0)
What do you think is responsible for the indiscriminate disposal of Solid Waste in Elele (multiple responses)		
Lack of Community Participation	56	(16.23)
lack of awareness on accepted methods of solid waste disposal	133	(38.55)
Socio-cultural / political problem	14	(4.06)
Population increase	36	(10.43)
Financial inadequacy	51	(14.78)
Non — governmental involvement in solid waste disposal	51	(14.78)
Lack of sanitation	2	(0.58)
Lack of refuse collectors	2	(0.58)
Total	345	(100.0)

Respondent’s knowledge of existing solid waste management strategy plan in Elele community.

The results revealed that people are not aware of any Government policy or strategy towards solid

waste management in Elele community. This shows that the government will have to engage authorities involved in the development of a solid waste management strategy with full community participation to enhance its implementation.

Table 5: Respondents Knowledge of existing solid waste management strategy plan in Elele community

Characteristics	Frequency (n)	Per cent (%)
Any knowledge of existing solid waste management strategy plan in Elele community		

Yes	29	(13.81)
No	181	(86.19)
Total	210	(1000)

Solid waste management Strategy options adopted in Elele Community

Each questionnaire contained several strategy options considered good enough for effective waste management. And from the responses, the following strategies were either ranked high or low amongst the strategies effectively adopted in Elele community.

The adopted strategies showed little implementation or awareness from the respondents. Elele community promoting procedures that minimize waste at household and community levels through re-use like in manure, or recycling were only from 40 (19.05%) respondents. Elele community establishing processes for recycling of waste components like bottles, metals, glass, paper, plastic bag were only from 32 (15.4%) respondents. Elele community has established processes for composting and landfilling processes, 30 (14.29%); Elele community building capacities of community people to become aware on proper waste disposal methods were only from 26 (12.38%) respondents. Elele community establishing regulations that will help ensure effective.

Solid Waste Management and disposal processes, 31 (14.76%). Local Government in Elele creating public awareness and sensitization regularly on efficient Solid Waste Management practices, 40 (19.05%).

Government agencies in Elele ensuring effective monitoring and evaluation of Solid Waste Management practices, 39 (18.57%); Local government agencies establishing Health and management policies to help people manually sort their waste before disposal, 38 (18.10%); Local Government agencies creating collaboration with other government agencies to improve compliance with sanitary laws 57 (27.14%);

Government creating adequate dumping sites and proper drainage systems, 28 (13.33); Government providing waste bins to every house hold, 15 (0.95%); Elele community residents sunning and burning their waste, 38 (18.10%); and Charging of waste management services, 37 (17.62%).

Table 6a: Some of the Solid Waste management Strategies adopted in Elele Community

Solid Waste management Strategies	Frequency n=210	Per cent (%)
Elele community promote procedures that minimizes waste at household and community levels through re-use like in manure, or recycling		
Yes	40	(19.05)
No	170	(80.95)
Elele community has established processes for recycling of waste components like bottles, metals, glass, paper, plastic bag		
Yes	32	(15.24)
No	178	(84.76)
Elele community has established processes for composting and landfilling processes		
Yes	30	(14.29)
No	180	(85.71)
Elele community has built capacities of community people to become aware on proper waste disposal methods		
Yes	26	(12.38)
No	184	(87.62)
Elele community has Established regulations that will help ensure effective Solid Waste Management and disposal processes		
Yes	31	(14.76)
No	179	(85.24)
Local Government in Elele are creating public awareness and sensitization regularly on efficient Solid Waste Management practices		
Yes	40	(19.05)
No	170	(80.95)
Government agencies in Elele are ensuring effective monitoring and evaluation of Solid Waste Management practices		
Yes	39	(18.57)
No	171	(81.43)

Table 6b: Some of the Solid Waste management Strategies adopted in Elele Community

Solid Waste management Strategies	Frequency n=210	Per cent (%)
Local government agencies have established Health and management policies to help people manually sort their waste before disposal		
Yes	38	(18.10)
No	172	(81.90)
Local Government agencies are creating collaboration with other government agencies to improve compliance with sanitary laws		
Yes	57	(27.14)
No	153	(72.86)
Government is creating adequate dumping sites and proper drainage systems		
Yes	28	(13.33)
No	182	(86.67)
Government is providing waste bins to every house hold		
Yes	15	(0.95)
No	195	(92.86)
Elele community residents sun and burn their waste		
Yes	38	(18.10)
No	172	(81.90)
Charging of waste management services		
Yes	37	(17.62)
No	173	(82.38)

Perceived Health and physical issues (multiple responses)

Table 7 shows some of the perceived health problems associated with improper solid waste disposal in Elele community. From the table, 39.60% of the people feel indiscriminate dumping will cause malaria from mosquito bite, 21.55% are concerned about

indiscriminate dumping of refuse causing Cholera/Diarrhea through contamination of surface and underground water sources and flies, 12.54% feels it will cause Respiratory Allergies and 9.77% Lassa Fever. Another 16.54% feels refuse heaping will cause poor visibility while driving which will make drivers prone to accidents.

Table 7: Perceive Health and Physical Problem Associated with improper solid waste disposal in Elele Community

Perceived Health Issues (Multiple responses)	Frequency (n)	Per cent (%)
Malarial (Mosquito bite)	158	(39.60)
Cholera/Diarrhea	86	(21.55)
Lassa fever	39	(9.77)
Respiratory Allergies	50	(12.53)
Poor visibility prone accidents mostly from waste heaps	66	(16.54)
Total	399	(100.0)

DISCUSSIONS

The component category of the waste in this study is similar to other reports from several authors in different cities [22–26]. The result shows that Garbage recorded the highest volume of 34.83%. The high organic content suggests possible value as composting material. Composting is mainly practiced by the hotels and eateries. This process converts waste to manure for agricultural purposes. However, the benefits are mostly not achieved as segregation is mostly not practiced to remove the non-degradable materials thereby producing low quality composes.

The analysis of the type of storage and disposal Methods for waste showed that little attention was paid to proper storage and disposal as the wastes were mostly exposed in uncovered container and open spaces. The result in the study is similar to the observations of other authors [8, 27, 28].

The result shows that dumping in open spaces recorded the highest volume of 69.82%. And this method has been seen to attract and breed flies and other insects, even rodents and it emits odors, and are expected to produce health problems among the workers and handlers of waste and the general population [29]. And this method according to Hoomweg *et al.*, [26] and Longe and Kehinde [30] is a possibly avenue for poisonous contamination of underground water.

Open dump of solid waste is a common practice in Nigeria. While some employ the service of streams to transport their solid wastes out of their sight, some directly dump their solid wastes by the road sides. In some part of Nigeria, refuse is generally buried, though some careless burning is sometimes observed [31]. And this type of refuse storage, while awaiting collection, is generally poor and observation shows it generally covers one side of the road (especially those near city centres and markets) Malodours, flies arid

moisture are common observations resulting from improper storage [16]. The study revealed that the situation has not changed as refuse heaps are common sight on the roads and collection centers.

The unrestricted access to these open dumpsites by unauthorized persons like scavengers can pose serious health risk to them [32, 33]. The study also showed that waste collection contractor represented only 11.27% of the solid waste disposal methods currently experienced in Elele community and the vehicle mostly used by these contractors was the open top trucks constituting 70.97% of the type of vehicles used. Meaning the stored waste is shoveled by hand into open trucks or lorries encouraging fly-tipping. These unhygienic practices are common in other cities in Nigeria [8, 26, 34].

Some of the reasons attributed to these includes: lack of awareness on accepted methods of solid waste disposal (38.55%), Lack of Community Participation (16.23%), financial limitations (14.78%); Non- governmental involvement in solid waste disposal (14.78%), Population increase (10.43%) and Socio-cultural I political problems inclusive of corruption.

It was clear from the survey that the volume of solid waste will steadily increase in Elele community as the populace has little knowledge of any existing solid waste management strategy, 29 (13.81%), or its implementations. The results of this study are similar to those of other studies conducted in other countries [35]. The government alone does not have the ability to ensure strategies adopted are implemented. By community leaders lending their support, they'll thus enhance community participation in this respect. They can also initiate internal policies or local rules and regulations (by laws) to support clean-up campaigns, proper waste storage and separation and active participation of all the community members in Elele community. Furthermore, they can act as intermediaries between the State and the local authorities and other stakeholders to solve noncompliance of community residences [36]. In whatever way local leaders are involved, their representativeness is very crucial and influential in facilitating active and sustainable community participation in waste management.

CONCLUSION

The study showed that although the level of awareness of solid waste management collection services was fairly reasonable (11.27%) in Elele community, the percentage of those who used other indiscriminate solid waste disposal methods like open dumping was higher (69.82%). These poses risk to waste minimization since the quantity and the rate of solid wastes generation in Nigeria is outgrowing the capacity of nature to naturally absorb them, and therefore, Individual in every community in the country

has a part to play to enhance effective solid waste management strategies.

The study has also shown the need to enlighten the populace on the wealth inherent in their organic, plastic and paper wastes. Solid waste management policies and enforcement of sanitation laws in various areas in the community should be energized, and various environmental organizations and societies to do more until the dreamed clean environment becomes a reality.

RECOMMENDATIONS

Solid waste management strategies should be provided in the ready budget with a separate head for the purpose of adequate revenue allocation, implementation and monitoring.

There is need to enhance environmental education programmes and public participation as it affects solid waste management not only through the radio, television and print media but also through grassroots enlightenment campaigns via the chiefs, community leaders.

Effective solid waste management requires the involvement, participation and cooperation of local communities and the government. Public private partnership is highly encouraged in solid waste and environmental management.

REFERENCES

1. Ugwu, C. O., Ozoegwu, C. G., Ozor, P. A., Agwu, N., & Mbohwa, C. (2021). Waste reduction and utilization strategies to improve municipal solid waste management on Nigerian campuses. *Fuel Communications*, 9, 100025.
2. Ezeudu, O. B., Agunwamba, J. C., Ugochukwu, U. C., & Ezeudu, T. S. (2021). Temporal assessment of municipal solid waste management in Nigeria: Prospects for circular economy adoption. *Reviews on environmental health*, 36(3), 327-344. Available from: <https://www.degruyter.com/document/doi/10.1515/reveh-2020-0084/html>
3. da Silva, L., Prietto, P. D. M., & Korf, E. P. (2019). Sustainability indicators for urban solid waste management in large and medium-sized worldwide cities. *Journal of Cleaner Production*, 237, 117802.
4. Ivanova, M. (2007). Designing the United Nations Environment Programme: a story of compromise and confrontation. *International Environmental Agreements: Politics, Law and Economics*, 7, 337-361. Available from: <https://link.springer.com/article/10.1007/s10784-007-9052-4>
5. Mugambwa, E. K., & Kizito, J. (2009). What is Waste Management. URL: http://www.nemaug.org/index.php?option=com_content&view=article&id,69. Available from:

- https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Mugambwa+EK%2C+Kizito+J.+What+is+Waste+Management.+URL%3A+http%3A%2F%2Fwww.nemaug.orgindex.phpoption%3D+com_content%26view%3D+article%26id.+2009%3B69&btnG=
6. Medina, M. (2002). Globalization, development, and municipal solid waste management in third world cities. *Institute of Advance Studies, Mexico*, 1-23. Available from: <https://cir.nii.ac.jp/crid/1573668925318510208>
 7. Imam, A., Mohammed, B., Wilson, D. C., & Cheeseman, C. R. (2008). Solid waste management in Abuja, Nigeria. *Waste management*, 28(2), 468-472. Available from: <https://www.sciencedirect.com/science/article/pii/S0956053X07000359>
 8. Ayotamuno, J. M., & Gobo, A. E. (2004). Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects. *Management of environmental quality: an international journal*, 15(4), 389-398. Available from: <https://www.emerald.com/insight/content/doi/10.1108/14777830410540135/full/html?src=recsys&fullSc=1&fullSc=1&mbSc=1&fullSc=1&fullSc=1>
 9. Solomon, U. U. (2009). The state of solid waste management in Nigeria. *Waste Management*, 29(10), 2787-2788. Available from: <https://www.infona.pl/resource/bwmeta1.element.elsevier-26be4fe9-a038-334e-ac34-c8af3f1b164f>
 10. Qdais, H. A. (2007). Techno-economic assessment of municipal solid waste management in Jordan. *Waste management*, 27(11), 1666-1672. Available from: <https://www.sciencedirect.com/science/article/pii/S0956053X06002418>
 11. Al-Khatib, I. A., Monou, M., Mosleh, S. A., Al-Subu, M. M., & Kassinos, D. (2010). Dental solid and hazardous waste management and safety practices in developing countries: Nablus district, Palestine. *Waste Management & Research*, 28(5), 436-444. Available from: <https://journals.sagepub.com/doi/pdf/10.1177/0734242X09337657>
 12. Fobil, J., May, J., & Kraemer, A. (2010). Assessing the relationship between socioeconomic conditions and urban environmental quality in Accra, Ghana. *International Journal of Environmental Research and Public Health*, 7(1), 125-145. Available from: <https://www.mdpi.com/1660-4601/7/1/125>
 13. Wilson, D. C., Araba, A. O., Chinwah, K., & Cheeseman, C. R. (2009). Building recycling rates through the informal sector. *Waste management*, 29(2), 629-635. Available from: <https://www.sciencedirect.com/science/article/pii/S0956053X08001918>
 14. Dauda, M., & Osita, O. O. (2003). Solid waste management and re-use in Maiduguri, Nigeria. Available from: https://repository.lboro.ac.uk/articles/conference_contribution/Solid_waste_management_and_re-use_in_Maiduguri_Nigeria/9596477/files/17236763.pdf
 15. Turan, N. G., Baki, O. G., & Ergun, O. N. (2016). Municipal Solid Waste Characteristics and Management In Sinop, Turkey. *Environmental Engineering & Management Journal (EEMJ)*, 15(1), 13-18. Available from: <http://ijehse.tums.ac.ir/index.php/jehse/article/view/209>
 16. Gobo, A. E., & Ubong, I. U. (2001). Fundamentals of... - Google Scholar [Internet]. [cited 2023 Mar 3]. Available from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Gobo%2C+A.+E.+and+Ubong%2C+I.+U.+%282001%29.Fundamentals+of+Environment+Chemistry+and+Meteorology+Tom+and+Harry+Publications+Ltd%2C+Port+Harcourt%2C+Nigeria.+233+---+241.&btnG=
 17. Elele, Nigeria - Facts and information on Elele - Nigeria.Places-in-the-world.com [Internet]. [cited 2023 Mar 3]. Available from: <https://nigeria.places-in-the-world.com/2343512-place-elele.html>
 18. Population growth and solid waste management - Google Scholar [Internet]. [cited 2023 Mar 3]. Available from: https://www.google.com/search?q=population+growth+and+waste+management&ei=MgICZNK4Ed2M9u8P-suauAQ&oq=population+increase+and+waste+mg&gs_lcp=Cgxnd3Mtd2l6LXNlcuAQARgAMgYIABAWEB4yBQgAEIYDMgUIABCGAZIFCAAQhgMyBQgAEIYDMgUIABCGAZoFCC4QkQI6BQgAEJECogsIABCABBCxAx
 19. Joseph, K. (2006). Stakeholder participation for sustainable waste management. *Habitat International*, 30(4), 863-871. Available from: <https://www.sciencedirect.com/science/article/pii/S0197397505000524>
 20. Solid waste collection health and safety risks-survey... - Google Scholar [Internet]. [cited 2023 Mar 3]. Available from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Solid+waste+collection+health+and+safety+risks-+survey+of+municipal+solid+waste+collectors.+Journal+of+Solid+Waste+Technology+and+Management+28%283%29%2C+154-160.&btnG=
 21. Elele - Population - CityFacts [Internet]. [cited 2023 Mar 3]. Available from: <https://www.city-facts.com/elele>
 22. Environmental Conditions in Cairo - MERIP [Internet]. [cited 2023 Mar 3]. Available from: <https://merip.org/1997/03/environmental-conditions-in-cairo/>
 23. Mwanthi, M. A., Nyabola, L. O., & Tenambergen, E. (1997). Solid waste management in Nairobi

- City: Knowledge and attitudes. *Journal of Environmental Health*, 60(5), 23-29. Available from: <https://search.proquest.com/openview/07b6b6909d3a787b9fdf3eb9c8ff3d74/1?pq-origsite=gscholar&cbl=34757>
24. Government of Tamil Nadu. An overview of Solid Waste Management in Tamil Nadu [Internet]. 2011 [cited 2023 Mar 3]. Available from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=An+Overview+of+Solid+Waste+Management+in+Economically+Developing+Countries.+A+Regional+Conference+on+Integrated+Solid+Waste+Management.+Cape+Town%2C+South+Africa%2C+October+25.&btnG=
 25. Abel, A. (2007). An analysis of solid waste generation in a traditional African city: the example of Ogbomoso, Nigeria. *Environment and urbanization*, 19(2), 527-537. Available from: <https://journals.sagepub.com/doi/pdf/10.1177/0956247807082834>
 26. Nabegu, A. B. (2010). An analysis of municipal solid waste in Kano metropolis, Nigeria. *Journal of Human Ecology*, 31(2), 111-119. Available from: <https://www.tandfonline.com/doi/abs/10.1080/09709274.2010.11906301>
 27. Waste Generation and Management in a Depressed Economy - Google Scholar [Internet]. [cited 2023 Mar 3]. Available from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Waste+Generation+and+Management+in+a+Depressed+Economy&btnG=
 28. Zurbrugg, C. (1999). The challenge of solid waste disposal... - Google Scholar [Internet]. [cited 2023 Mar 3]. Available from: https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q=Zurbrugg%2CC.+%281999%29.The+challenge+of+solid+waste+disposal+in+developing+countries%2C+Sandec+News+Eidgenössische+Anstalt+für+Wasserversorgung%2C+Abwasserreinigung+und+Gewässerschutz+%28eawag%29+N
 29. Adekoya, N., & Bishop, C. S. (1992). The failure of environmental health programmes in Nigeria: A concern for health planners in the developing nations. *International Journal of Environmental Health Research*, 2(4), 167-170.
 30. Longe, E. O., Longe, O. O., & Ukpebor, E. F. (2009). People's perception on household solid waste management in Ojo Local Government Area in Nigeria. *Iran J Environ Heal Sci Eng*, 6(3), 209-216. Available from: https://www.sid.ir/EN/VEWSSID/J_pdf/102620090310.pdf
 31. Igoni, A. H., Ayotamuno, M. J., Ogaji, S. O. T., & Probert, S. D. (2007). Municipal solid-waste in Port Harcourt, Nigeria. *Applied Energy*, 84(6), 664-670. Available from: <https://www.sciencedirect.com/science/article/pii/S0306261906001644>
 32. Bakare, W. (2021). Solid Waste Management in Nigeria BioEnergy Consult. BioEnergy Consult, 28(2), 1-9. Available from: <http://www.unn.edu.ng/publications/files/Solid+Waste+Management+in+Nigeria.pdf>
 33. Agunwamba, J. C. (2003). Analysis of scavengers' activities and recycling in some cities of Nigeria. *Environmental management*, 32, 116-127. Available from: <https://link.springer.com/article/10.1007/s00267-002-2874-5>
 34. Oyeniyi, B. A. (2011). Waste management in contemporary Nigeria: the Abuja example. *International Journal of Politics and Good Governance*, 2(2.2), 1-18. Available from: <http://onlineresearchjournals.com/ijopagg/art/73.pdf>
 35. Nanda, S., & Berruti, F. (2021). Municipal solid waste management and landfilling technologies: a review. *Environmental Chemistry Letters*, 19, 1433-1456.
 36. Bulle, S. (1999). *Issues and results of community participation in urban environment*. Urban Waste Expertise Program. Available from: <http://www.gdrc.info/docs/waste/003.pdf>