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Location-Efficiency of Waste Collection Points Along The Obio/Akpor Stretch of Ikwerre Road, Port Harcourt, Rivers State, Nigeria

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Abstract
Rapid urbanization growth rate in cities is usually accompanied by rapid urban expansion, high consumption rate and increase in waste generation. The growth of Port Harcourt over time has been phenomenal due mainly to changes in the migration dynamics that is characteristic of the city. This study examined the locational-efficiency of waste collection points along the Obio/Apor Stretch of Ikwerre Road with a view to x-raying if their location met WHO standards. The study adopted the Mix Method Research approach since both quantitative and qualitative data were used. The sample size consists of 399 respondents residing in the different communities in the study area. Interviews were also ranted to staff of Rivers State waste management Agency (RIWAMA) and refuse contractors while analysis was achieved through the use of Geographic Information System (GIS). Findings from the research showed that the location of waste collection points in all the communities sampled are not within the WHO approved distance and this may be responsible for the dumping of refuse at road median in the area. The analysis shows the distance of waste collection points from residential buildings were above the WHO minimum distance of 2.0 – 2.2km. On the average the distance of wastes collection points to areas of residence range from 2.3-2.9 km in all sites examined. Analysis of the distance between one waste collection points to another also showed an interesting revelation as the distance between wastes points are well above WHO approved standard. The distance between wastes collection points in the study area ranges from 1.6-to 3.1 km as against the WHO standard of 1.0-1.5km. The study recommends for conscious efforts at ensuring optimal distribution of waste collection points in the study area in line with WHO minimum standard as this is the only way to stop the dumping of waste at road median and avert the negative effects of indiscriminate dumping of waste on the quality of life of residents in the study area.

Keywords: Location-efficiency, Wastes collection, Urbanization, Road Median, Receptacle, Spatial Distribution

Introduction
As the world make its leap into the urban age, greater proportion of people are expected to live within urban space especially in developing nations. Rapid urbanization growth rate in cities is usually accompanied by rapid urban expansion, high consumption rate and increase in waste generation. Of the problems facing most urban centers in the developing world, improper waste disposal and management appears to take center- stage mainly due to increased population growth, and high consumption rate. Writing on this, Sule (2004) submits that in most countries in the developing world, waste disposal and management constitutes serious problems because of the level of technology that is not sophisticated enough to handle the high rate of wastes generation.

The growth of Port Harcourt over time has been phenomenal due mainly to changes in the migration dynamics that is characteristic of the city. The presence infrastructural amenities in the city, results in situations where people move in numbers into the area in search of better living. Rapid urbanization and accumulation of people in small areal units results in very high waste generation in the area. Akin to the problem of high waste generation is low technology application in waste management and issues of unplanned urban expansion and inefficiency in the location of wastes receptacles (waste collection point) at the appropriate

points within and around the city. Inefficient distribution of waste collection points in the study area, results in situations where residents are unwilling to travel far to dispose their waste. The implication of this is reflected in indiscriminate dumping of waste on road median with attendant challenges on traffic flow.

To be sure, placing waste receptacles where they are easy to empty, rather than where they are convenient for people to use poses significant challenge in urban waste management. The location of waste receptacle ordinarily, should be within an optimal range that people are willing to travel and dispose their waste.

Although there are approved wastes collection sites (points) by the Rivers State Waste Management Agency (RIWAMA), dumping of waste at road median and junctions is currently the practice among residents in the study area. This counter-culture of dumping waste at road median seem to be gaining much acceptance, even as most waste collecting agents and contractors prefers the dumping of wastes at road median as against approved collection points.

Our surmise is that the dumping of waste at road median by residents along the Obio/Apkor stretch of Ikwerre road, in Obio/Akpor Local Government area (LGA) may be due to inefficient location of waste collection points within the area. This study therefore seeks to examine if the distribution of waste collection (receptacles) points in the study is optimal in line with WHO approved standard.

Study Area.

Obio/Akpor is one of the area councils that make up the Port Harcourt Metropolis, and one of the twenty-three LGAs in Rivers State, Nigeria. It is an economic centre in the Niger Delta area of Nigeria. The LGA covers 260km^2 and a population of 464,789 Persons (National Population Commission, NPC 2006). It came into being on the 5th day of May, 1989 and has its headquarters at Rumuodamaya (Ajie & Dienye, 2014). Obio/Akpor Area Council is bounded by Port Harcourt City LGA in the South, OyigboLGA in the East, Ikwerre LGA in the North, and Emohua LGA in the West It is located within latitudes 4^{0}5'11" and 5^{o}15'45" North and longitudes 6^{o}22'25" and 8^{o}05'12" East (Ajie & Dienye, 2014).' Ikwerre Road' is a Trunk 'A' road that connects Owerri the Imo state capital with Port Harcourt linking many settlements and towns. The portion of Ikwerre Road under study is the stretch along the Obio/Apkor LGA. connecting communities such as Rumueme, Rumuokwota, Rumuigbo, Rumuokoro, Rumuodomaya and Rukpokwo. (Figure 1)

Obio/Akpor has a tropical wet climate with lengthy and heavy rainy seasons and very short dry seasons like her counterpart, Port Harcourt City LGA. The area falls within the drainage basin drained by the Ntawogba Creek, New Calabar, Amadi – Creek, the Bonny river, Fishing gate stream, Mgbodohia river, Dockyard and the Choba river (Mmom, *et al*, 2017).

Obio/Akpor LGA has a population of 268,863 persons as at the 1991 National population census. In 1999, the population grew to 329,863 persons and in 2001, it further grew to 349,059 persons while in 2006, the population was 464,789 persons (NPC, 2006). The projected population is expected to hit 1,053,903 persons in 2019 using the population exponential projection model with a growth rate of 6.5%.

The implication of this increase in population is that there is high level of consumption and subsequent high or increase in the volume of waste generated in the area.

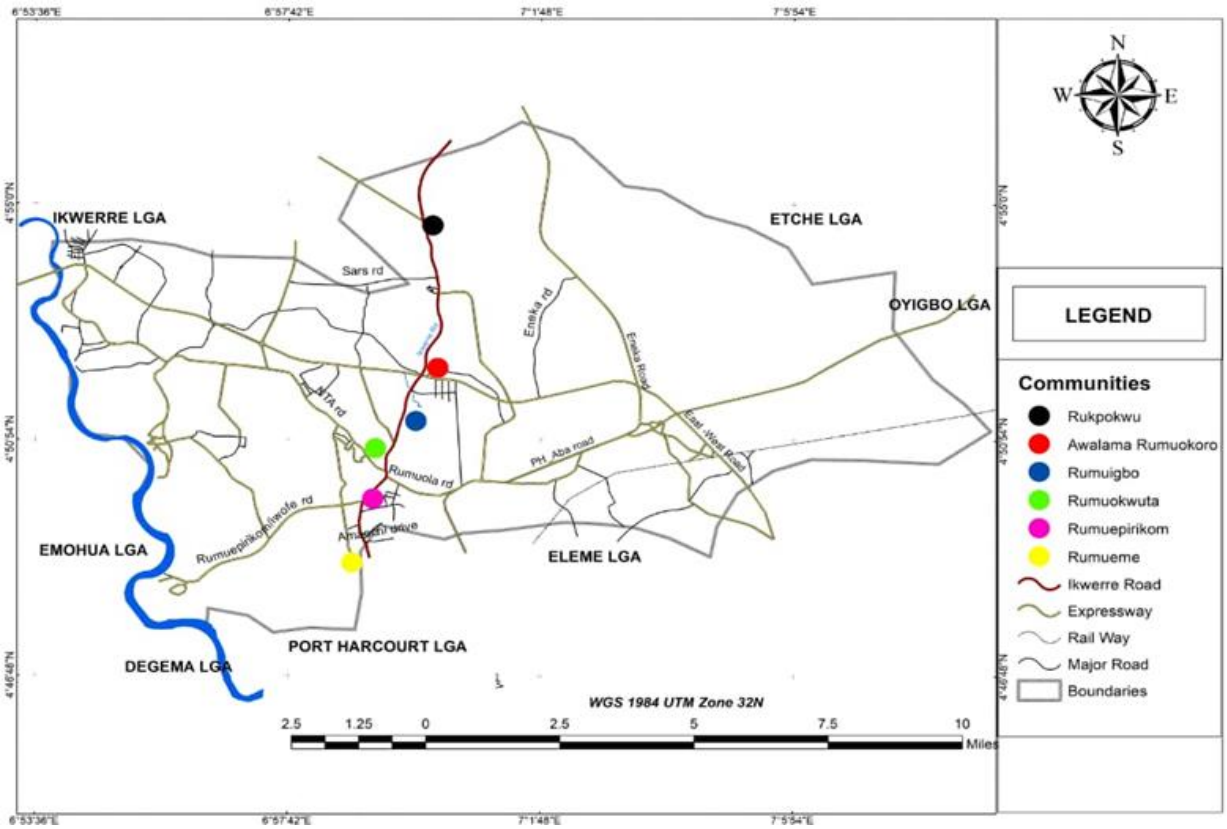

Fig. 1: Obio/Akpor showing Study Area.
Source: GIS Lab., URP Department, Rivers State University.

Conceptual Orientation/Literature Review

The Concept of Solid Waste

The term wastes refer to unwanted or unusable materials, any substance which are discarded after primary use (Sule, 2004), and it is considered worthless, defective and of no use. Waste that we see in our surroundings is also known as garbage. Garbage is mainly considered as a solid waste that includes wastes from market places, schools, offices, etc and this is called municipal wastes, and the wastes from industries and factories ((Muhammad, 2003).

The concept of solid waste management entails the various waste management options available in a given municipality. Waste treatment and management is as important as its collection. It deals with the processes involved in generation, deposal and management of waste (Abdul, 2010; Freduah, 2016; Barrett 1995; Foday, et.al, 2013). According to Abdul (2010), the various solid waste management options available include open waste disposal that involves burning of garbage in an open space without control from weather elements like air or wind. In this type of method, smoke is released into the environment in all uncontrolled manner.

Again, the dumps and landfill are wastes management options where locations are designated for stacking of refuse and waste materials. Better location is always selected where there is a low water table or areas where water that percolates through the dumps or landfills would observed that the landfills or dumps are also designated in a way that the slides and bottom are lined and covered with impervious materials that would not allow a leaching process to take place. The filtrate is collected at the bottom of the dumps or land fill are pumped out for biological and chemical treatment before disposing.

Socio-Spatial Entanglement Theory

This is a theory of accessibility to service developed by Schultheis Eric Welbel in 2016, at the Department of Urban Studies and Planning, Massachusetts Institution of Technology, to explain the variance in services accessibility among people. The theory assumes that spatial service accessibility factors are not entangled with one another. For instance, the ease of traveling twenty five miles to dispose waste is different for the single father receiving public assistance with no car and the single adult who has stable employment and a car. This theory was developed to understand service accessibility.

The socio-spatial entanglement theory is a way of theorizing service accessibility that accounts for the why, and how of service accessibility and posits that spatial and services accessibility factors are necessarily entangled and that these entanglements capture and explain the lived experience of service accessibility. This theory is based on applied critical realist conceptions of the ontology of the social world. Thus, the theory explains the factors and causal mechanisms that mediate service usage among the less privileged and the low income households. This theory therefore gives room for waste collectors/disposers and planners as well as decision makers to design intervention measures that target the underlying phenomena that impact service delivery in waste management.

Theory of Distance Decay Function

The theory of distance decay is a geographic theory which describes the effect of distance on cultural or spatial interactions. The distance decay effects states that the interaction between two localities decline as the distance between them increases. The frictional effect of distance is one of the major factors affecting spatial interaction. If the real world was to be limitless or without a distance, location behaviour would have been uniform and all contemporary transport systems would be redundant. There would be no need to live in towns, which is characteristic of the contemporary world would virtually disappear as individuals would search for their own place in the sum as individuals would search for their own place in the same (Mmom, 2018). Man's behaviour in space may be interpreted as a consistent attempt to minimize efforts involved in overcoming distance.

Distance is a basic geographic dimension and the distance-decay curve specifies the relationship which variable bear to distance. Distance-decay function is therefore defined as a series of rectangular co-ordinates relating to a given variable with distance, and showing greater values of spatial variable for any smaller distance than for any greater distance (Mmom, 2018). For instance, we may measure the volume of interaction or quantity of any given variable at increasing distances from a specific reference point and plot those references on a graph. When these observations are joined together with a line, one discovers that the value decreases with increase in distance. However, it is noteworthy that not all variables respond this way. There are some exceptional cases, over a specified range; we may discover some variables remaining constant, while others may increase with distance. But in most geographical studies, it is proved that spatial interactions decreases with increasing distance.

The distance decay theory is relevant to the present study as it defines the level of patronage and use of waste receptacle as a function of distance between the location of the receptacles and area of residence.

Empirical Review/ Previous Studies

The issue of waste generation and management has elicited the attention of scholars. This may be due to the fact that there is hardly any human activity that does not generate waste (Brunner & Rechberger, 2014). Danbuzu et. al. (2014) For example, examined the spatial distribution of solid waste points using GIS approach in urban areas in Katsina State, Nigeria. Their findings showed that there is clustering and randomness in the distribution of waste collection point in urban areas of Kastina state. The study recommended for the creation of more authorized collection point in the medium and high density population areas as well as the use of population as a criteria for facility allocation.

Nsirim et. al. (2018) conducted a study on the assessment of Rivers state wastes management Agency (RIWAMA) communication strategies for waste management in Port Harcourt metropolis, Rivers State. Findings from the study revealed that RIWAMA's communication strategies such as launching of mobile application, use of combination of traditional and interpersonal media channels as well as social media platform were not adequate and enough to create sufficient education on waste management among members of the public. The study recommended for the development of a waste messages that go beyond merely disseminating information to defining the content of their waste management processes according to the goal and

objectives for which the agency was established.

Ayantoyinbo and Adepotu (2018**)** sought to analyze solid waste management logistics and its attendant challenges in Lagos metropolis. The objective of the study was to predict the relationship between waste management logistics and identified matrix for waste management performance of Lagos state waste management Agency (LAWMA). The result show that the volume of solid and commitment of staff are crucial to waste management and therefore recommended for turnaround and increase in waste collection points.

Methods and Materials

Research design is the strategy, structure and procedure employed in doing a research in so as to actualize its aim and objectives. This study adopted the mixed methods research approach (MMR) employing the Concurrent Triangulation Mixed Methods Design, (Creswell, 2003). The study population comprises all the people residing in the six communities/settlements along the Ikwerre road stretch in Obio/Akpor, local government area. These communities are Rumueme, Rumuprikom, Rumuokwuta, Rumuigbo, Rumuokoro and Rukpokwu.

The population of the six selected communities has a total projected population of 139,225 persons for 2019 as against 23,827persons in 1991 at 6.5 percent growth rate. Number of households in each settlement was determined by dividing the settlement population by the household mean size of 6 (NPC, 2006) and this gave a household size of 27,764. The sample size comprised of 399 respondents was gotten by employing the Taro Yamane formula. The distribution of questionnaires selected household members in each community was proportionally arrived at as shown in table 1.

Table 1: Population and Sample Size of respondents to be used for questionnaire administration in the sampled communities.

S/N	Community	Based Year Pop (1991)*	Projected Pop (2019)	Households Size	% of Population	No. of Questionnaires
1	Rumueme	3332	19,431	3,239	$\frac{3239}{27761} \text{ X} \frac{100}{1} = 11.7$	$\frac{11.7}{100} \text{ X} \frac{399}{1} = 47$
2	Rumuprikom	4066	23,711	3952	$\frac{3952}{27761} \text{ X} \frac{100}{1} = 14.2$	$\frac{14.2}{100} \text{ X} \frac{399}{1} = 57$
3	Rumukwuta	7990	46,597	7,766	$\frac{7766}{27761} \text{ X} \frac{100}{1} = 27.9$	$\frac{27.9}{100} \text{ X} \frac{399}{1} = 111$
4	Rumuigbo	8819	51,429	8,572	$\frac{8572}{27761} \text{ X} \frac{100}{1} = 30.9$	$\frac{30.9}{100} \text{ X} \frac{399}{1} = 123$
5	Rumuokoro	1293	7,540	1,256	$\frac{1256}{27761} \text{ X} \frac{100}{1} = 4.5$	$\frac{4.5}{100} \text{ X} \frac{399}{1} = 18$
6	Rukpokwu	3062	17,856	2,976	$\frac{2976}{27761} \text{ X} \frac{100}{1} = 10.7$	$\frac{10.7}{100} \text{ X} \frac{399}{1} = 43$
	Total	28,562	166,544	27,761	100	399

Source: Researcher's Computation (2020)

Since there are only six communities on the Obio/Akpor sketch of Ikwerre Road, a total census was considered to include all the six settlements along the Obio/Akpor sketch of Ikwerre Road.

All the streets in each community were identified and households listed. Simple random sampling technique was used to silent heads of households for study for questionnaire administration. To determine the distance of approved dumpsites relative to household location, a hand held GPS was used to record the coordinates while the distance in kilometer was gotten as the 'crow files' from household points to refuse dumpsites in each community of study.

The Global positioning system (Garmin 76csx GPS model), Digital camera, Google Earth (Landsat imagery) and GIS software (ArcGIS 9.3 version) were used to extract settlements along the Ikwerre Road Stretch in Obio/Akpor. The extracted image was then imported into GIS 9.3 and all the coordinates of the collection/receptacles points was geo-referenced and digitized to produce a map. The coordinates of the solid waste collection/receptacle was imported into the ArcGIS 9.3 as text file, then converted to shape file to show the spatial distribution on the digital map as well as the satellite imageries too. Points (dots) was use to show solid waste collection points. The satellite imageries used for this study were acquired on the 12th August, 2020 from the USGS with a 0% cloud cover and 30m x 30m resolution using the ArcGIS 9.3. this method was considered effective as it has been used in related study by Danbuzu et al (2014).

To determine the optimum distance location for waste disposal points from residence and from one waste point to another, distance of each receptacle point were measured as the 'crow. This measured distance was then compared with the WHO approved minimum distance for locating waste receptacle.

The univariate analytical techniques of mean, median and percentages were used in data analysis. While data presentation was achieved through the use of tables, charts and graphs for easy comprehension.

Results and discussion

The socio-economic characteristics of respondents as shown in table 2 revealed that 22.0% of the respondents were between the ages of 45 – 54, those within the ages of 55-64 years and 35 – 44 years make up approximately

20.4% and 19.2% respectively. Further analysis showed that respondents between the ages of 25-34 years and 15 – 24 years make up 11.6% and 8.8% respectively while those above 65 years are 18%. The age distribution reveals that greater majority of the people are within the workforce age bracket. Having people in active age bracket portents some implications in terms of waste generation since younger people are more likely to turn out waste compared to those in the aged group. In terms of sex, 63.9% of all the people interviewed were males while 36.1% were females.

Respondents' educational status shows that 26.3% of the respondents attained education up to bachelor degree level. 26.2% have master and above while 19.8% have other added professional trainings alongside the bachelors' degree and master and above. 13.2% have the secondary school education and 9.6% was educated up to the basic level of education while 3.9% have no basic education. There were on the average, 3 persons and above (87.5%) in a house- hold in the study area with attendant implication on the quantity of generated.

Table 2: Socio-economic characteristics of Respondents.

Age	**Frequency**	**Percentage**
15 – 24 years	32	8.8
25 – 34 years	42	11.6
35 – 44 years	70	19.2
45 – 54 years	80	22.0
55 – 64 years	74	20.4
65 + years	65	18.0
Total	**363**	**100**
Sex		
Male	232	63.9
Female	131	36.1
Total	**363**	**100**
Level of Education		
Basic	35	9.6
Secondary	48	13.2
Bachelor degree	98	26.3
Master and above	95	26.2
Other professional training	72	19.8
None	14	3.9
Total	**363**	**100**
Persons per household		
One - Two	46	12.7
Three – four	249	68.8
Five and above	68	18.7
Total	363	100

Source: Researchers' Field survey, (2021)

Spatial Location /Distribution of Waste Collection Points in Along the Obio/Akpor Stretch of Ikwerre Road.

Figure 2 is the schema showing the distribution of wastes receptacles along the Obio/Akpor Stretch of Ikewrre Road. The analysis shows that there are a total of 29 dumpsites found in the area out of which 22 are approved by RIWAMA with 7 illegal dumpsites. The distributional pattern of the receptacles takes a linear pattern mostly along the route (figure 2).

Analysis of the proximity of wastes collection points from areas of residence, indicates that the distance of waste collection points from areas of residence are above the approved WHO minimum standard. Compared with WHO minimum distance of 2.0-2.2, the distance of the various waste collection points from residential buildings on the average are between 2.3km -2.9 km for all sites examined.

Analysis of the distance of one waste collection point to another also showed an interesting revelation as the distance between wastes points are well above WHO approved standard. The distance between wastes points in the study area range from 1.6-to 3.1 km as against the WHO standard of 1.0-1.5km. In terms of spread, our findings revealed that distribution of waste collection points are more concentrated in the highly populated areas in the study area.

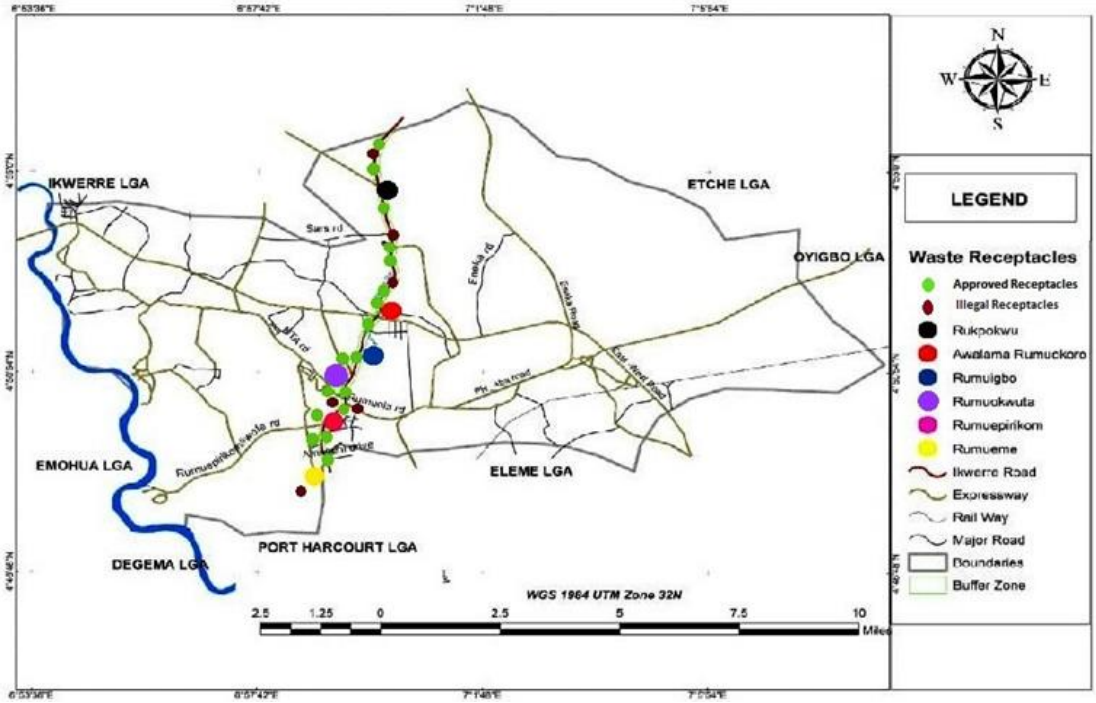

Fig. 2: Spatial Distribution of Wastes Receptacles along the Obio/Akpor LGA Stretch of Ikwerre Road
Source: Authors Field work, (2020)

The findings of this study have several implications that hinge on the sustainability and quality of life of residence in the study area. Reckless and indiscriminate solid waste disposal in the study area has a deleterious effect some of which may include the pollution of both surface and underground water, closure of roads, unpleasant and unaesthetic and nuisance.

Although increased urbanization is associated with increase in waste generation, reckless and indiscriminate dumping of waste on unapproved points including road median in the study is mainly due to inefficiency in the distribution of waste collection points and facilities in the area.

This study corroborates that of Achi et al. (2012) that linked the problem of waste management Abeokuta, Ogun State Nigeria to the inability to determine an appropriate route and proper allocation of refuse sites.

Inefficient distribution of waste collection points and indiscriminate dumping of waste along the Obio/Akpor stretch of Ikwerre Road causes tremendous and dishearten eyesore as heaps of waste adorn open spaces, along road junctions, drainages and in unapproved sites in spite of sustained efforts by RIWAMA. Exposure to waste also has health implications as repugnant odour and abusive smells and Methne (CH_4) are emitted from dump sites thereby affecting the quality of status of residents on the area.

Conclusion and Recommendation

Waste generation is part of human activity as each person in Nigeria generates at least 0.58 kg of solid waste per day (Adewumi, et al. 2005). Inefficient location of waste receptacles along the Obio/Akpor Stretch of Ikwerre Road poses serious challenges to hinges on sustainability. Poor waste management problems in the area is directly related to unsustainable methods of waste disposal, inadequate planning and inefficient location of waste receptacles all of which leads to the dumping refuse on unauthorized points and at road median.

Conscious efforts are needed to ensure optimal distribution of waste collection points in the study area in line with WHO minimum standard. Measures must be put in place to ensure that dumping of waste is restricted only to government approved sites. These are the only ways to stop the dumping of waste at road median as is currently done, and to avert the negative effects of indiscriminate dumping of waste on the quality of life of residents in the study area.

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