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Penalty Point System (PePS) Adaptation for Solid Waste Assessment in Cross River State, Nigeria

Josiah Nwabueze Obiefuna[1], Caroline Josiah Obiefuna[1]

1 University of Calabar

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Abstract

Waste generation in major urban centres in Nigeria appears to be on the increase due to increased consumption occasioned by rapid urbanization. Unfortunately, appreciable efforts are only being made in few urban areas with regards to monitoring this occurrence for the purpose of control and sanitation planning. This paper adapted and applied the novel Penalty Point System (PePS) as a methodology to investigate environmental pollution consequences of solid waste in Nigeria, using Calabar municipality, Cross River State as a case study. The objectives were to demonstrate the use of Penalty Pont System (PePS) as a tool for pollution (solid waste) assessment, unravel the environmental pollution consequences of improper solid waste management in Calabar Municipality, investigate various systems of solid waste disposal and management in Calabar Municipality, determine the relationship that exists between solid waste disposal problem and environmental sanitation and render viable recommendations for the purpose of reduction in the amount of solid waste generated and the need for proper management. Data for the study included a catalogue of the number of waste dumps in drainage systems and uncollected waste sites as well as responses to 200 copies of administered questionnaire. The penalty point system was used to allocate penalties to the defaulting locations for uncollected waste sites and dump-in drainages. It was discovered that Akim and Big Qua earned the highest penalty points of 120 each, amounting to 40 percent of the study area. This attribute clearly qualifies both districts as the poorest with regard to urban environmental sanitation. Further analysis was done using the Chi-squate statistics. Findings show that solid waste management system has a great effect on the quality of the environment that is possible in urban areas. It was therefore recommended that as a long-term measure, the government should enforce, support and sustain environmental education which is needed to promote manufacturing technologies that would enhance the production of consumer goods using low waste-generating practices.. Again, the government should provide access roads that are free from surface damage.

Josiah Nwabueze Obiefuna[1,*] and **Caroline Josiah Obiefuna**[2]

[1] *Department of Geography and Environmental Science, Faculty of Environmental Sciences, University of Calabar, P.M.B. 1115, Calabar-Nigeria. ORCID: 0000-0003-2426-082X*

[2] *Department of Educational Foundations, Guidance and Counselling, Faculty of Education, University of Calabar, P.M.B. 1115, Calabar-Nigeria.*

*Correspondence: JoeObiefuna@Unical.edu.ng, JoeObiefuna@GMail.com

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1. Introduction

Generally, there are varied definitions of the concept of solid waste as given by[1][2][3] to include a form of matter and/or any material that has definite weight, volume and size, or as non-liquid, non-soluble materials ranging from municipal garbage to industrial wastes that contain complex and sometimes, hazardous substances, and also include liquids and gasses in containers. In addition, it was also seen as materials that are no longer valuable to the person who is responsible for them, and it is not intended to be discharged through a pipe.

The deterioration of Nigeria's urban environment in terms of irresponsibly dumped and accumulated solid waste is most apparent in growing cities today. The main cause of the problem is usually poor environmental conditions that can be ascribed to improper management of solid wastes. According to Sule [4], proper management of solid waste is a key to environmental sanitation.

Generally, improper management of waste is one of the major factors in environmental degradation, leading to air quality degradation and pollution [5][6][7][8][9][10]. It contributes to the destruction of the physical and aesthetic value of the environment as witnessed in most growing cities in Nigeria. According to Sule [11] the problem is enhanced by low-level, rudimentary and unscientific technology, which is generally regarded as not sophisticated enough to handle the volume of waste generated by cities.

It is obvious that as long as a man uses resources, waste is inevitable. The Author[12] stated that "anything modern man touches turns to waste product sooner or later". Various human activities create vast amounts of waste products and pollutants. The release of these materials into the environment sometimes causes serious health problems and may interfere with the proper use of land and water resources.

Presently, the disposal problem constitutes major urban environmental paralysis, a clog in the wheel of progress, which influences urban environmental purity and sanitation in Nigeria. The scenery in most urban cities like Lagos, Aba and Calabar in terms of uncontrolled dumping of uncollected solid wastes approximates an aesthetic disaster.

As a reference to population, most of these cities are characterized by a population in excess of available services for solid waste disposal. Often, a divergence exists between the increasing demand for sanitation in a growing population and the capacity of the local government to provide these services. The gap, therefore, accounts for the increasing volume of solid waste generated in most cities in Nigeria, particularly, the Calabar Municipality.

Besides, the United Nations Centre for Human Settlements,[13] puts it that rapid population growth and uncontrolled industrial development are seriously degrading the urban environment in many countries of the developing world and that in 1990, 600 million people were estimated to have lived and suffered in such cities due to poor environment. They suffered dehumanizing conditions like inadequacies in sanitation, solid waste disposal, vector control, poor health care, and lack of good or clean water.

Today, the problem is more serious and has been seen as taking a new dimension as the known traditional ways of life are being overhauled with modern ways embraced. The “wages” are apparent on roadsides, open drains, liters in open places, paper waste in the market and residential points, and auto-scraps dumped anywhere, anyhow and anytime throughout the urban centres in Nigeria.

To add to this, the case of electronic waste often called e-waste cannot be ignored or overlooked. It includes scrap television sets, radio, computer peripherals and accessories (mouse, keyboard, and printers) as well as other hardware forms. They contribute their quota to physical degradation and destruction of the aesthetic value of the environment when they are dumped or burnt in open spaces.

Therefore, the role of everyday behaviour in waste generation and reduction should be considered central to solving problems associated with increasing waste and the cost of their disposal [14]. This is because of the clear-cut connection between “today’s everyday activities and the quality of life that is possible for now and the future generations”.

So, to construct a sustainable society that can provide for the physical, aesthetic and other needs of the local residents while reversing the trends of increased pollution and environmental degradation, it is necessary to start changing the conventions of societies.

Calabar Municipality with high population growth from 150,000 inhabitants[15] to 320,862 inhabitants according to 1991 population census of Nigeria has been described as a fast growing centre with high concentration of rural–urban migrants with desire for sophisticated consumption. The population pressure with the desire for advanced or sophisticated consumption is the very cause of solid waste generation and the disposal problem that now faces the municipality.

Besides the population and consumption pattern problem is also the ‘just throw away’ syndrome or habit of the inhabitants of the municipality. Also, there is a common problem of children and adults as well, indiscriminately discharging tons of municipal wastes into the drainage system at any sight of rainfall. As if this is not enough, bags of refuse are left on the highways, major streets and roads as being witnessed along Akim, Etta-Agbor, University of Calabar staff village and the Marian area. This is becoming the major factor of urban environmental decay affecting Calabar Municipality.

In addition, the level of awareness, knowledge or literacy level has a role to play. The refusal of households to own trash cans and, as the case may be, pay disposal tariffs is perceived to be directly related to their level of awareness and education, as well as their understanding of the subject of waste disposal and management.

However, the majority of the inhabitants responsible for this awful act are said to be poor, uneducated, uninformed and backward people, who neither regard the environment in their dealings nor know the consequences of their various

actions. As a “pay-back,” the city continues to suffer from uncollected solid wastes which consequently block the streets and drains, breed and harbours flies, rats, mosquitoes and as well, degrading the aesthetic and general nature of the environment with its human health impacts. It is believed that this study will create awareness and bring solutions to these unethical, unfriendly and environmental maltreatment.

1.1. The objectives of this study are:

1. To demonstrate the use of the Penalty Pont System (PePS) as a methodology for pollution (solid waste) assessment in urban areas.
2. To unravel the environmental pollution consequences of improper solid waste management in Calabar Municipality.
3. To investigate various systems of solid waste disposal and management in Calabar Municipality.
4. To determine the effect of poor solid waste management techniques on the quality of the environment possible in Calabar Municipality
5. To render viable recommendations for the purpose of reduction in the amount of solid waste generated and the need for proper management.

1.2. Statement of Hypothesis

- A hypothesis was generated and stated in null (H_0) and alternate (H_1) forms.
- $H_{o:}$ There is no statistical significance between solid waste management technique and the quality of environment that is possible in Calabar Municipality.
- H_1: There is a statistical significance between solid waste management technique and the quality of environment that is possible in Calabar Municipality

3. Materials and Methods

3.1. The Study Area

Calabar Municipality is one of the oldest local governments in Cross River State. It is densely populated with about 320,862 inhabitants as put forward by the 1991 population census of Nigeria.

Calabar Municipality has an area of 161.44sq km and is basically inhabited by three ethnic groups namely, the Quas, Efiks and Efuts. Also, two major languages are spoken and they are: Qua and Efik.

The area is a riverline settlement bounded to the North by Odukpani, to the South by Calabar South local government area, to the East by Akpabuyo local government and to the West by Calabar River.

Being a coastal town, Calabar Municipality is located between latitude 4.15^0 and 5.15^0 North and longitude 8.15^0 East. It falls within the rainforest belt and is basically characterized by a mangrove swamp.

Beside the fact that it is blessed with a very rich culture, the municipality is also blessed with abundant human and material resources. If the resources are fully harnessed, the economic viability of the area would be enhanced. Also an enabling environment would be created for the general development of Calabar, especially, due to the fact that the first free trade zone is situated in the shores of the municipality.

Above all, the people of the Calabar Municipality are peace loving, accommodating, God fearing – attributes which have gained them the accolade of a paradise city. Therefore, the acronym CALABAR meaning “Come and Live and be at Rest” is not a misnomer [16]. The municipality is a unique centre regarding its high degree of urbanism compared with the surrounding local governments like Akpabuyo, Odukpani and Calabar South. The area is also unique due to its housing types [4]. According to Sule[4] the greatest number of wattle wall, thatched roof houses are found in Calabar and this is not attributable to poverty but rather, a reflection of respect for cultural heritage.

The centre is characterized by a high concentration of rural-urban migrant population, dreaming for sophisticated consumption which is verily, the cause of solid waste generation and disposal problems.

5. Research Methodology

4.1. Data Sources

Data on the technique and volume of waste dump were collected primarily, and graded using the Penalty Point system. Personal interviews, computer-assisted telephone interviews (CATI) and administering of questionnaires to the target population being the ten districts selected from Calabar Municipality was also done.

Besides, among the group of primary data are those of qualitative data from ground based or terrestrial photography taken by the author of this work while carrying out his research. Finally, for opinion poll purposes, 200 household heads were selected (using purposive sampling technique) from all the districts. Twenty were selected from each district. The secondary data consist of already existing or established data, which were collected originally for a particular but related case study, now used as a basis for of inquiry. With regards to duration, the study was initiated between April and August 2007 but not published. However, between December 2019 and February 2020, appropriate ground truthing and another set of data were collected to validate an earlier collected data.

4.2. The Penalty Point System

The penalty point system is a scoring method of awarding penalties to defaulters. Before now, it was used by the law enforcement agencies such as the Federal Road Safety Commission (FRSC) for awarding penalties to defaulters of traffic offenses. Depending on the level and type of offense, penalties are awarded which are usually translated to fines to defaulter. In this research, it was used to award penalties to defaulting districts that have uncollected solid waste sites and solid waste dump in drainage systems.

Each point of default would be assigned a minus ten (-10) or ten (10) point penalty. The higher the penalty point, the greater the rate of filthiness or griminess the district is being translated into and thus, the poorer the waste management practices of solid waste that are being executed in the region or district. Therefore, the lower the penalty points, the cleaner the streets as compared to those with high penalty points. It may therefore be said that acceptable or moderate methods of waste managements are being practiced where total penalty point is lower.

4.3. Analytical Technique

For the purpose of easy and unhindered comparison of variables, data gathered through the survey was analyzed using a simple scoring method of Penalty Point System (PePS). The Chi-square test statistic was also used where appropriate, to test the hypothesis.

Chi-square is a term used for geographical pattern of association and distribution. It is used in social science for test of significance. It is also applied to problems in which two nominal values are cross-classified.

The Chi-square formula is given as below:

$$X^2 = \sum \frac{(O - E)^2}{E}$$

Where:

- X^2 = Chi – square.
- O = The observed frequency or distribution.
- E = The expected frequency or distribution.
- Σ = The summation sign.

In application, when the calculated Chi – Square is greater than the statistical table value, the null hypothesis is rejected while the alternate is accepted.

That is $X^2_c > X^2_t$, rejected H_o and accept H_1.

Alternatively and rarely, if the calculated Chi – Square is less than the table value, the null hypothesis is therefore accepted while the alternate is rejected. That is $X^2_c < X^2_t$, accept H_o and reject H_1.

5 Analysis

Table 1. Frequency Distribution and Penalty points for Uncollected Solid Wastes on Waste Sites and Dump in Drainage Systems/Gutters for 10 selected districts

Districts	Uncollected Waste Sites	Dump in Gutters	Defaults (Total)	Penalty Points	Percentage %
Akim	2	10	12	120	20
Big Qua	6	6	12	120	20
Ediba	0	2	2	20	3.3
Ekong Etta	3	1	4	40	6.7
Etta Agbor	7	2	9	90	15
Housing Estate	1	0	1	10	1.7
Marian	8	1	9	90	15
Mekenge	4	2	6	60	10
Okoro Agbor	2	2	4	40	6.7
Parliamentary Village	1	0	1	10	1.7
TOTAL				**600**	**100**

Source: Field Survey by the Author (2020).

Table 1 above depicts the nature and distribution of environmental nuisance of solid waste as occasioned by its improper management in ten selected districts from the study area.

Unfortunately, Akim and Big Qua earned the highest penalty points of 120 each amounting to forty percent of the study area. This attribute clearly qualifies both districts as the poorest with regard to urban environmental sanitation. They are therefore the filthiest and dirtiest among the ten districts visited. Etta Agbor and Marian are (from the study) the second dirtiest districts among all.

Regarding cleanliness, proper sanitation and hence proper solid waste management, Housing Estate and the Parliamentary village are the cleanest. They obtained a total penalty point of ten points each. Considering filthiness, both districts amounted to only 3.4 percent (3.4%) of the entire area at 1.7 percent each. This is almost insignificant.

The Fig. 2 below is a summary to table 1 above..

Fig. 2. Solid Waste Distribution Chart for Uncollected Waste Sites and Dump in Gutters

Source: Analysis by the Author (2020).

Table 2. Periodic Collection Process Adopted by Waste Management Agency in Calabar Municipality.

Waste Collection Periods	Respondent Households	Percentage %
Daily	1	0.5
Weekly	61	30.5
Monthly	65	32.5
At Random	73	36.5
TOTAL	**200**	**100**

Source: Field Survey by the Author (2020).

As reflected on the Table 2 above, views of the respondents on waste evacuation schedule is not encouraging. As shown above, 73 households representing 36.5% asserts that collection is done at random.

In contrast to this, only one household indicated that waste is collected daily. This is however less than one percent.

Finally, 61 households constituting 30.5% asserts that wastes are collected weekly, while 65 households comprising 32.5% and the second largest value are convinced that wastes are collected monthly as represented by Fig. 3

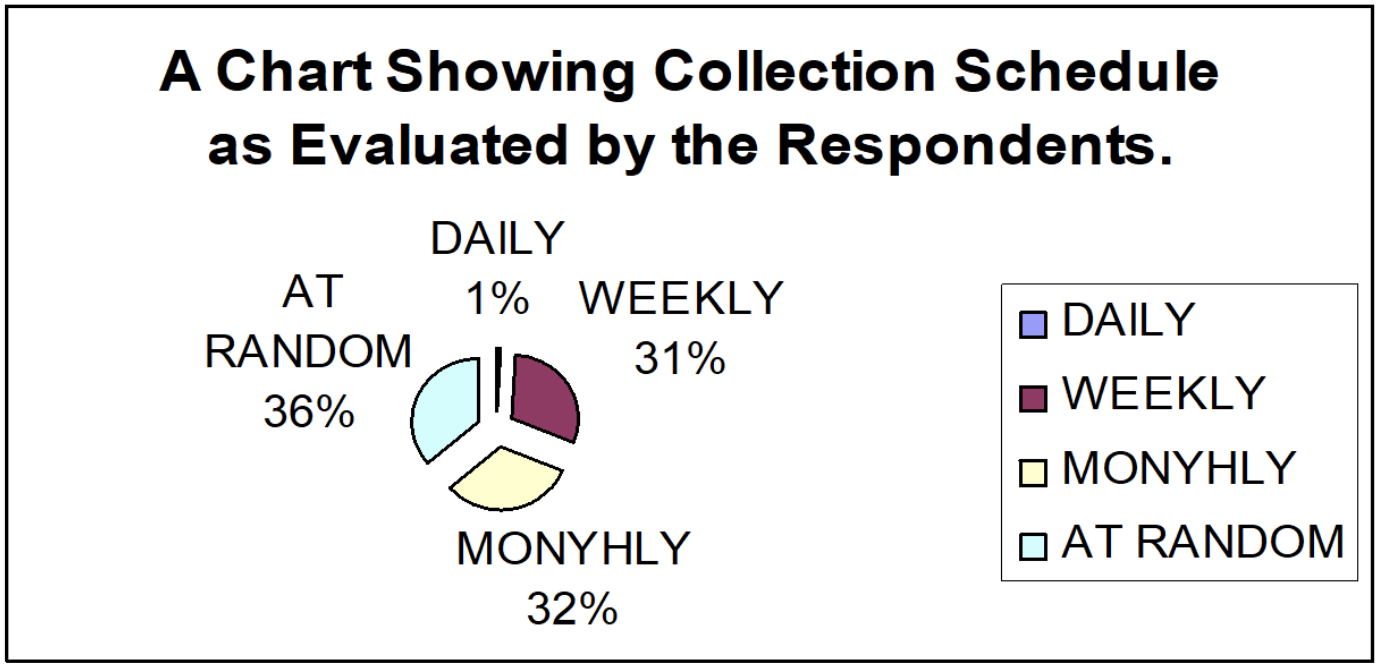

Fig. 3. Periodic Collection Process Adopted by Waste Management Agency in Calabar Municipality.

Source: Analysis by the Author (2020).

Table 3. Waste Disposal Sites Operated by Sampled Household Units.

Sites Used	No. of Households	Percentage %
Gutters/Drainage Systems	46	23
Rivers and Streams	26	13
Waste Depots	62	31
On the Streets	26	13
Open Space within reach	40	20

Source: Field Survey by the Author (2020).

Table 3 above shows the result as given by respondents regarding where they dispose waste. The observed score of 46 (23%) shows that more of the households empty wastes in gutters or drainage systems. Besides, 26 households representing 13% make use of rivers and streams. Again, the highest number of 62 households representing 31% makes use of waste depots.

Finally, 26 households litter the streets while 40 households dump on open spaces within reach or compound. They represent 13% and 20% respectively.

Source: Analysis by the Author (2020).

5.1. Test of Hypothesis

Using Table 1, the hypothesis was tested using Chi-Square test statistics to determine whether there is or is not any significant effect of poor solid waste management technique and the quality of environment possible in Calabar Municipality. Table 4 presents row by colums contingency table. It shows number of streets with the frequency of uncollected waste sites as well as dump in drainage systems/gutters.

Table 4. Row by Column Contingency Table.

Street Name	Uncollected Waste Sites	Dump in Gutters	Sum of Row
Akim	2	10	12
Big Qua	6	6	12
Ediba	0	2	2
Ekong Etta	3	1	4
Etta Agbor	7	2	9
Housing Estate	1	0	1
Marian	8	1	9
Mekenge	4	2	6
Okoro Agbor	2	2	4
Parliamentary	1	0	1
TOTAL (Column)	**34**	**26**	**60**

Source: Analysis by the Author (2020).

Table 5. Calculated Chi – Square Value for Solid Waste Dumps in all Districts.

Street Name	Uncollected Waste Sites (Chi-Square Value)	Dump in Gutters (Chi-Square Value)	Total (Row)
Akim	3.39	4.43	7.82
Big Qua	0.09	0.12	0.21
Ediba	1.13	1.47	2.6
Ekong Etta	0.23	0.31	0.54
Etta Agbor	0.71	0.93	1.64
Housing Estate	0.32	0.43	0.75
Marian	1.65	2.16	3.81
Mekenge	0.10	0.14	0.24
Okoro Agbor	0.03	0.14	0.17
Parliamentary	0.32	0.43	0.75
TOTAL (Column)	**7.97**	**10.56**	**18.53**

Source: Analysis by the Author (2020).

From the Table 5 above, the calculated Chi – Square is 18.53 whereas, the table Chi – Square is 16.919 ($X^2_c > X^2_t$), the null hypothesis (H_o) is therefore rejected since the table Chi – Square is less than the calculated value while the alternate hypothesis (H_1) is accepted.

The alternate hypothesis (H_1) states that there is statistical significance between solid waste management technique and the quality of environment that is possible in Calabar Municipality. The level of confidence that the right decision has been made is 95%.

5.2. Results and Discussion

Akim and Big Qua earned the highest penalty points of 120 each, amounting to 40 percent of the study area. This attribute clearly qualifies both districts as the poorest with regards to urban environmental sanitation. Further analysis was done using the Chi-square statistics. From the results the calculated Chi – Square is 18.53 whereas, the table Chi – Square is 16.919 ($X^2_c > X^2_t$), the null hypothesis (H_o) is therefore rejected since the table Chi – Square is less than the calculated value while the alternate hypothesis (H_1) is accepted.

The alternate hypothesis (H_1) states that there is statistical significance between solid waste management technique and the quality of environment that is possible in Calabar Municipality. The level of confidence that the right decision has been made is 95%. Solid waste management system has a great effect on the quality of environment that is possible in urban areas. The neglect and deprivation of most districts in Calabar Municipality in relation to basic sanitation facilities is now

being reflected in poor environmental conditions and its related health consequences. This has been attributed to laxity on the part of the government.

Besides, from observation, the available method of collection and transportation of waste are crude in nature. This posse a menace to the city traffic as solid waste spill over road networks due to use of open vehicles in most cases for collection and transportation. Workers are subject to health and injury risks as they have no protective wears and other facilities that will minimize exposure to dangerous objects.

Concerning placement of depots, most depots or containers for waste collection are wrongly placed, not considering accident risks to motorists. Most - if not all are placed along roadsides. At night, they become death traps and in the day, they are like abandoned coffins. People detest passing by them except the person has a business with it.

Sadly, through the course of writing this research work, it was observed that some poor people as well as those that are mentally degraded feed on trash found in most waste depots. This type of encounter is an eye-sore both to visitors and citizens. The incidence is dehumanizing and can be very shameful. To avoid this, wastes should be emptied regularly.

The literacy level of people also impacted on the aesthetics and health of their environment. Educated heads of households sampled know the consequences of poor environment. But for the uninformed or illiterates, “anything goes”. The influence of poverty in encouraging poor environmental sanitation is found more among the uneducated than the “educated poor”.

Finally, improper solid waste management in Calabar Municipality is as a result of several, varying attributes. This ranges from laxity on the part of the government, lack of commitment on the part of workers of waste collection agencies, negative and lackadaisical attitude of the inhabitants, poor policy and the grave problems of poverty and illiteracy.

6. Conclusion

The main source of the problem of poor environmental condition is lack of proper management of solid waste in Calabar Municipality.

There is a strong relationship between solid waste management and environmental quality. The policy approach adopted should be sufficiently scientific to reflect the dynamic nature of the Calabar Municipality.

Finally, it is only through this medium of scientific policy approach that an effective and operational solid waste disposal technology can evolve with its resultant emergence of habitable, sanitary and pollution–free Calabar Municipality.

7. Recommendations

This document is a step towards improving environmental health and safety through proper management of solid waste. It provides a broad view of the issues enough to make it clear that the environmental health and safety risks are

compellingly significant. We, therefore, recommend as follows:

- As a long-term measure, the government should enforce, support and sustain environmental education which is needed to promote manufacturing technologies that would enhance the production of consumer goods using low-waste generating practices. Again, when people are aware of their environment, they would take better care of it and minimize pollution and hazards.
- The government should provide access roads that are free from surface damage. It should be navigable to waste disposal vehicles.
- The government should also adopt and practice modern methods of municipal solid waste management, some of which are incineration, sanitary landfill and source reduction.
- The government should ensure that an adequate number of standard waste bins is owned by every district and that the collection schedule is adhered to strictly.
- There is also a need for the computerized schedule to be designed to avoid the issue of forgetfulness. This schedule for waste collection will enhance consistency in waste evacuation.

Conflict of Interest

The authors declare no conflict of interest.

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