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# Solid Waste Management Problems, Solutions, Types and Its Effects; A Case Study of Okpoko Community

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

The aim of this study is to get to know the nature of solid waste management in Okpoko, identify the problems with the current management, and find a possible solution to them, thus creating a well-arranged environment where everyone can stay with no problem of solid waste. A field survey was conducted to get the opinion of the residents living in that particular area. After an analysis was done on the answers given to us by the residents with the help of the questionnaire that was shared, we finally learned the nature of the current solid waste management practiced there, which was mostly landfill, and the problems they were facing, such as air pollution caused by the open incineration (burning) of solid wastes. A possible solution was also found, which was the recycling and reuse of these solid wastes. The analysis method used for this study was Multiple Linear Regression (SPSS).

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## 1. INTRODUCTION

Waste could be identified in a number of ways and definitions. "Solid waste" is defined by RCRA (Resource Conservation and Recovery Act) as any trash or refuse, sludge from a wastewater treatment plant, water supply treatment plant, or air pollution control facility, as well as other discarded material resulting from commercial, industrial, mining, and agricultural operations, as well as from community activities [1-3]. Any material that has been thrown out or neglected could be it.

Solid waste management includes the collection, handling, and disposal of solid waste. Usually, this waste is thrown away because it is no longer needed or has outlived its usefulness [4-7]. Environmental contamination and epidemics of vector-borne diseases, which are diseases spread by rodents and insects, can result from unsanitary conditions brought on by inappropriate municipal solid waste disposal [8-11].

A steadily increasing generation of solid waste has become one of the biggest environmental problems that pose a threat to urban centers in Nigeria. Okpoko, an urban area of Anambra State, is not an exception to this state of affairs. The management of solid waste remains the main problem Nigeria is facing today [12-15]. This is an environmental problem that has been receiving less attention, but it continues to pose challenges to stakeholders and everyone at large. Solid waste, like other forms of waste (liquids and gases), presents the most difficulty in handling because it occupies a lot of urban space [16,17]. Because of rising urbanization, inadequate planning, and a lack of sufficient resources, solid waste management techniques are in very poor condition in the majority of developing countries [18-20]. Two things make the issue worse;

i. Okpoko's rapid socioeconomic development, which attracts migrants from all parts of Nigeria
ii. The city's expanding populace.

However, the Anambra state government has made a number of attempts to address the solid waste management issues in Okpoko. The private sector's involvement, the approval of numerous environmental sanitation and protection regulations, the implementation of the microenterprise program, the creation of solid waste disposal agency, and the monthly environmental sanitation program for the entire city are some of these initiatives. Despite the efforts, the city's solid waste collection and disposal system has not much improved.

The aim of this study is to examine how solid waste is produced spatially in Okpoko, stating the problems, solutions, types, and effects. This was achieved by:

i. Investigating the types, sources, and practices of Okpoko's solid waste management.
ii. Examining the solid waste collection methods and practices employed in order to regulate solid waste.
iii. Determining the causes and effects of inappropriate waste management techniques on the ecosystem.
iv. Inputting the best sustainable management of solid waste practice in the study area.

The study's findings will establish the waste management procedures used over time and how they contributed to the prevailing environmental and socio-economic issues in Okpoko, Anambra State, Nigeria. It may as well build a body of knowledge on the causes of environmental and socioeconomic problems in the area. This study will help unravel the numerous problems associated with waste management practices and propose environmentally sustainable measures.

### Types of Wastes

#### A. Solid municipal waste (MSW)

Municipal solid waste (MSW) is the bulk of the non-hazardous solid waste from a city, town, or village that requires regular collection and transfer to a processing or disposal facility. Other sources of MSW include commercial and residential properties, offices, educational institutions, and industrial sites.

However, MSW does not include industrial process wastes, debris from construction and demolition projects, sewage sludge, mining waste, or agricultural garbage. MSW is sometimes referred to as trash or rubbish. MSW and domestic waste are often used interchangeably.

#### B. Dangerous Wastes

Wastes classified as hazardous are those that put the environment and people at risk. It can

come from businesses that produce chemicals, oil refineries, paper mills, smelters, and other types of businesses. Each year, thousands of chemicals are utilized in the plastics industry. They can create health risks if handled improperly or in an inappropriate way. Hazardous wastes are sub divided into;

i. **Toxic wastes:** Wastes that are hazardous in minute or trace concentrations are considered toxic. On humans or animals, some may have a severe or immediate effect. biological alterations in the offspring of animals and humans who have been exposed to carcinogenic or mutagenic substances. For instance, heavy metals and insecticides.
ii. **Reactive wastes:** Wastes that create poisonous gases, explode under normal management conditions, or are unstable to shock or heat are considered reactive wastes. With air or water, they also frequently react violently. N2G and gunpowder are two examples.
iii. **Ignitable wastes:** are those that spontaneously ignite during storage, transportation, or disposal at relatively low temperatures (60ºC). Examples include alcohol, paint thinners, and gasoline.
iv. **Corrosive wastes:** are individuals who use chemical reactions to degrade goods and living tissues. For instance, bases and acids.
v. **Infectious wastes:** hospital garbage that contained hypodermic needles, discarded bandages, and human tissue from surgeries.

### C. Industrial Wastes

These have a higher toxin content and need specific handling. This may come from the food processing industry, metallurgical chemical and pharmaceutical units, breweries, sugar mills, paper and pulp businesses, fertilizer and pesticide firms, which are significant sources of toxic wastes discharged during processing, scrap materials, tailings, acids, etc.

### D. Agricultural Wastes

Crop and livestock waste are included in the waste produced by agriculture. Since the majority of this waste is utilized, such as dung for manure and straw for feed, it doesn't pose a big issue in developing nations. Some agro-based industries, such as those that produce tea, tobacco, or mill rice, produce trash. Rice husks, degasses, pulverized nuts, cobs of corn, and other agricultural wastes are examples.

### E. Wastes from Biomedicine

Any waste produced while diagnosing, treating, or immunizing people or animals, during associated research, during the creation or testing of biologicals, is referred to as bio-medical waste.

## 2. STUDY AREA

Nigeria's Anambra State includes the town of Okpoko. Just north of the larger city of Onitsha, it is located on the Niger River's east bank (Wikipedia). Okpoko has been recorded as being one of the most populated areas in Onitsha, which has been badly affected by waste. The

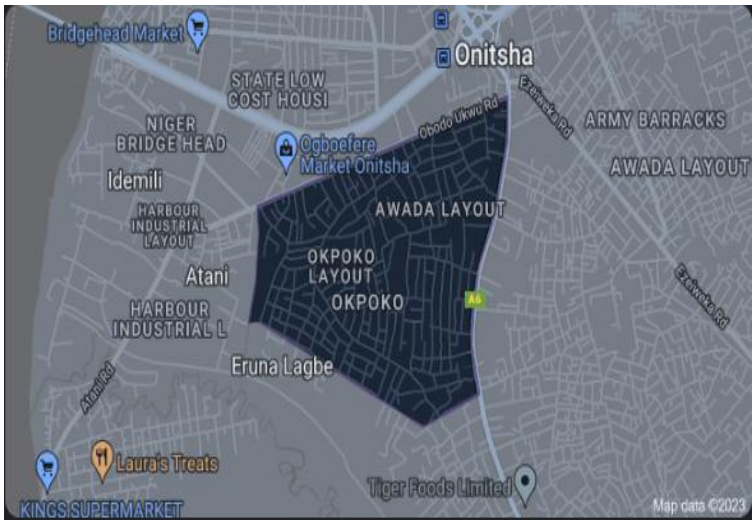


**Fig. 1. Map of the Okpoko Region**
*(Source: Google)*

population is rapidly growing, and the burden on the government to evacuate them is becoming increasingly unbearable. Even where they operate, the method of disposal is grossly inefficient, unhygienic, and environmentally unsustainable. Environmental and health implications of these practices are enormous and include the spread of this waste material when constant rainfall occurs in the area, psychological impacts, pollution from leachates, disease spread by rodents and birds, as well as land contamination.

This necessitated the need for this work, which will fill the gap concerning the management of waste generated (picking, sorting, and recycling) so as to reduce the effects of environmental decay in Okpoko.

## 3. RESEARCH METHODS

This section covers the research design and additional techniques the researcher used to complete the project. It also covers population, sample, and sampling methodologies, as well as the creation of instruments and their use in various types of information analysis.

This research is an experimental survey aimed at getting the people's opinion on "solid waste management" in Okpoko, Anambra State. The research will be used to obtain relevant information by using a dictionary and other published works that could help expand our understanding of this project or experiment. The data collected will be appropriately analyzed, and interpretations of the findings will be made.

### A.) Types of Data Required

1. Okpoko's current solid waste management practices
2. The techniques and procedures used in the management of solid waste for solid waste collection
3. Determining the causes and effects of improper waste management practices on the environment.
4. Including the study area's top sustainable solid waste management technique.

### B.) Source of Data

#### i. Primary source

To gather information from Okpoko in Onitsha, a standardized questionnaire, informally conducted interviews, and observations were used. These are anticipated to provide an understanding of how to manage solid waste, the issues, and potential solutions to the environment's current situation. To find connections and similarities in the material gathered, an interactive method of data synthesis was used. In just two days, the questionnaire-sharing fieldwork was completed.

#### ii. Secondary source

The theoretical conception of the work was enhanced by the addition of information from the body of literature that was already available. The accessible literature consists of relevant books, journals, texts—both published and unpublished—documents, magazines, conference papers, ministries of the environment, and organizations with a similar focus. In addition, there are publications from the United Nations, the World Bank, the National Bureau of Statistics, and websites that are related.

### C.) Sample and Sampling Techniques

Interviews were conducted with a total of 100 respondents, which was deemed to be an appropriate sample size. To achieve the primary goal of finding a potential solution to the current issues with solid waste management in Okpoko, information from the questionnaire was analyzed and presented using tables, percentages, and charts specifically for the objectives. Multiple Linear Regression analysis was also used. Multiple linear regression analysis of the data was carried out using the Statistical Package for Social Science (SPSS).

## 4. RESULTS AND DISCUSSION

### A. Characteristics of Respondents in Terms of Socioeconomic and Democratic Life

**Table 1. Respondents**

| Gender | Age | Education | Occupation | Marital status | Problems faced | Possible solution |
|---|---|---|---|---|---|---|
| 1000 | 1000 | 1000 | 1000 | 1000 | 1000 | 1000 |

This is table above shows the total number of respondents that filled the available questionnaire.

**Table 2. Gender**

| Gender | Frequency | Percent |
|---|---|---|
| Female | 45 | 45.0% |
| Male | 55 | 55.0% |
| **Total** | **100** | **100%** |

This table above shows that 45% of females and 55% of males out of the 100 respondents filled out the questionnaire.

**Table 3. Age**

| Age | Frequency | Percent |
|---|---|---|
| 19 - 29 | 51 | 51.0% |
| 30 - 39 | 25 | 25.0% |
| 40 - 49 | 15 | 15.0% |
| 50+ | 9 | 9.0% |
| **Total** | **100** | **100%** |

This table shows the percentage of various age intervals that were used in the question, with the age interval of 19–29 having the highest percentage of 51%. This shows that the majority of respondents to of the questionnaire are of age interval of 19 – 29.

**Table 4. Educational level**

| Educational level | Frequency | Percent |
|---|---|---|
| Educated | 58 | 58.0% |
| Not educated | 42 | 42.0% |
| **Total** | **100** | **100%** |

This table shows the percentage and number of respondents' educational levels, of which respondents that are educated have the highest percentage of 58%.

**Table 5. Occupation**

| Occupation | Frequency | Percent |
|---|---|---|
| Employed | 41 | 41.0% |
| Student | 32 | 32.0% |
| Unemploy | 27 | 27.0% |
| **Total** | **100** | **100%** |

This table shows if the respondent has an occupation, the percentage employed people where much (41%). This indicates that most people are employed.

**Table 6. Marital status**

| Marital status | Frequency | Percent |
|---|---|---|
| Divorced | 2 | 2.0% |
| Married | 38 | 38.0% |
| Single | 60 | 60.0% |
| **Total** | **100** | **100%** |

This table shows that marital status of respondents and the respondents that choose being single in the questionnaire are 60% which us the highest and this signifies that most respondents are single.

**Table 7. Nature of the solid waste management**

| Nature of the solid waste management | Frequency | Percent |
|---|---|---|
| Through Compositing | 10 | 10.0 |
| Through Incineration | 32 | 32.0% |
| Through Recycling and Reuse | 6 | 6.0% |
| Through Landfill | 52 | 52.0% |
| **Total** | **100** | **100%** |

This table shows the nature of solid disposal which the mostly used solid disposal is through landfill (52%) followed by incineration (burning) 32%.

**Table 8. Problems faced**

| Problems faced | Frequency | Percent |
|---|---|---|
| Air pollution | 48 | 48.0% |
| erosion | 7 | 7.0% |
| Land sewage sickness | 25 | 25.0% |
| Untreated land | 20 | 20.0% |
| **Total** | **100** | **100%** |

This table shows the problems faced by wrong means of solid disposal and air pollution has the highest percentage (48%) an air pollution that comes from burning of solid disposals in open places.

**Table 9. Possible solutions**

| Possible solutions | Frequency | Percent |
|---|---|---|
| Arranged composting | 7 | 7.0% |
| Closed incinerat | 9 | 9.0% |
| Recycling and reuse | 66 | 66.0% |
| Source reduction | 6 | 6.0% |
| Treated lanfill | 12 | 12.0% |
| **Total** | **100** | **100%** |

This table shows the possible solution of wrong solid disposals and with the information gathered the respondents that choose recycling and reuse has the highest percentage of 66%, using pie chart to show more about the result.

## B. Further Analysis Using Multiple Regression to Analysis the Results of Possible Solution.

### a) Multiple Linear Regression Model

The selected model for the investigation is multiple linear regression. It is a regression model with multiple independent variables and has the following format:

$$Y_0 + {}_1X_1 + {}_2X_2 + + {}_KX_K + e_t \quad (1)$$

In this study, we'll focus on the scenario where there are just two independent variables in the model.

$$Y_{i0} + {}_1X_{1i} + {}_2X_{2i} + e_t \quad (2)$$

where

Y = the dependent variable
$X_1$ and $X_2$ = the explanatory variables (or repressor's)
$e_t$ = The error term
$\beta_0$, $\beta_1$ and $\beta_2$ = the parameters

The observation will be indicated by the subscript t if the data are a time series. Since our data is a time series data, the equation (2.2) will now be written as

$$Y_t=\beta_0 + \beta_1X_{1t} + \beta_2X_{2t} + e_t \quad (3)$$

Where

Y, $X_1$, $X_2$are in deviation forms, then (2.3) becomes

$$Y_t=\beta_0 + \beta_1x_{1t} + \beta_2x_{2t} + e_t \quad (4)$$

Hence, the error sum of squares is given by;

$$\sum (Y_t - {}_1x_{it} + {}_2x_{2t})^2$$

The estimate of the parameters when OLS is been applied;

$$\therefore \quad \hat{\beta}_1 = \frac{\Sigma x_1 y \Sigma x_2^2 - \Sigma x_1 x_2 \Sigma x_2 y}{\Sigma x_1^2 \Sigma x_2^2 - (\Sigma x_1 x_2)^2} \quad ---$$

(5)

$$\hat{\beta}_2 = \frac{\Sigma x_1^2 \Sigma x_2 y - \Sigma x_1 x_2 \Sigma x_1 y}{\Sigma x_1^2 \Sigma x_2^2 - (\Sigma x_1 x_2)^2} \quad ---$$

(6)

$$\text{and} \quad \hat{\beta}_0 = \overline{Y} - \hat{\beta}_1 \overline{X}_1 - \hat{\beta}_2 \overline{X}_2 \quad ---$$

(7)

### b) Variance of OLS Estimator

If $x_1$, $x_2$ are in deviation forms, then

$$\text{Var}(\hat{\beta}_1) = \frac{\Sigma x_2^2}{\Sigma x_1^2 \Sigma x_2^2 - (\Sigma x_1 x_2)} \cdot \delta^2 \quad ---$$

(8)

$$\text{Var}(\hat{\beta}_2) = \frac{\Sigma x_1^2}{\Sigma x_1^2 \Sigma x_2^2 - (\Sigma x_1 x_2)^2} \cdot \delta^2 \quad ---$$

(9)

$$\text{Cov}(\hat{\beta}_1, \hat{\beta}_2) = \frac{-\Sigma x_1 x_2}{\Sigma x_1^2 \Sigma x_2^2 - (\Sigma x_1 x_2)} \cdot \delta^2 \quad ---$$

(10)

The standard error SE ($\beta_k$) is obtained by taking the square root of the corresponding variances.

### c) Coefficient of Determination

A number, frequently just a line or curve, that quantifies how well data fit a statistical model is denoted R2 or r2, and it is pronounced R squared. It is a statistical model whose primary objective is either the forecasting of future results or the testing of the hypothesis based on other pertinent data.

The formula for the multiple coefficients of determination is

$$R^2 = \frac{\hat{\beta}_1 \Sigma x_1 y + \hat{\beta}_2 \Sigma x_2 y}{\Sigma y^2} \quad ---$$

(11)

Where $x_1$, $x_2$, y is said to be in deviation form, The adjusted $R^2$ written as $\bar{R}^2$ written is defined by

$$\bar{R}^2 = 1-(1-R^2) \quad (12)$$

### d) Test of Hypothesis

Our model Y = ${}_1x_1$ + ${}_2x_2$ + U involves two variables that are explanatory. Therefore, we can conclude that it is possible to run both individual and joint tests on the model's parameters.

**e) Individual Test**

When an explanatory variable is tested individually, it is to see if it has any impact on the dependent variable even when the other explanatory factor is held constant.

The following could be used to express the null and alternative hypothesis:

$H_0$: $\beta_i = 0$, i = 1 or 2 (i.e., Xi and Y do not have a linear relationship, with X holding constant).

$H_1$: $\beta_i 0$ (i.e., There is a connection between xi and y.).

The test statistic will be obtained by under the assumption that each Ui is N (0, 2).

Rejecting H0 at the level of significance is the decision rule if tcal>ttab (indicating that it is possible to draw the inference that y and xi are related) and to accept H0 in all other cases.

**f) Joint Test**

Testing if x1 and x2 are mutually related to y is involved in this. this is equivalent to determining if

$\beta_2 = 0$

Consequently, the null and alternate theories are;

$H_0$: $\beta_1 = \beta_2 = 0$ (i.e., $x_1$ and $x_2$ are jointly related to y)
$H_1$: β0 for at least one (i.e., $x_1$ and $x_2$ are jointly related to y).

As a result, a joint test can also be carried out using the following methods for analysis of variance:

RSS = $\sum = {}_1\sum x_1 y + {}_2\sum x_2 y$

ESS = TSS –RSS

The decision rule is to approve H1 if H0 is rejected (Fcal F2n - 3).

**g) Assumptions of the Model**

1. Test for multicollinearity
2. Test for homoscedasticity
3. Test for autocorrelation

**C. Results And Interpretations from SPSS**

**Joint Test**

Hypothesis

$H_0$: The responds are all helpful and good
$H_1$: There is some responds that are better than the others

$F_{cal} = 76.661$

The decision rule is rejected ($F_{cal}$ Ftab).

Where

$F_{tab} = F_{5, 94, 0.05} = 2.29 > Fcal = 76.661$, hence we accept $H_1$ and reject $H_0$. Now more than ever, an individual test must be conducted.

INTERPRETATION:

T-calculated for ${}_1 = -0.029$ ,${}_2 = -0.025$, ${}_3 = -0.013$, ${}_4 = -0.321$ and, ${}_5 = -0.722$

SE (${}_1$) =14.271, SE (${}_2$) = 12.061, SE (${}_3$) = 16.182, SE (${}_4$) =7.837and SE (${}_5$) =2.893

(not all are helpful and good to the environment and mankind).

0 (all are helpful and good for the environment and mankind).

The decision rule is to reject $H_0$ if $t_{cal}$ $t_{tb}$ where

$T_{tab} = t_{a/2, v} = t_{0.025,94} = 1.960$

**Table 10. ANOVA[b]**

| Model | Sum of Squares | DF | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 66915.000 | 5 | 13383.000 | 76.661 | .000[a] |
| Residual | 16410.000 | 94 | 174.574 | | |
| **Total** | **83325.000** | **99** | **174.574** | | |

*a. Predictors: (Constant), Recycling and reuse, source reduction, treated landfill, closed incineration, arranged compositing*
*b. Dependent Variables: Respondents*

**Table 11. ANOVA[c]**

| Model | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|
| | B | Std. Error | Beta | | |
| Constant | 83.500 | 2.266 | | 36.850 | .000 |
| Source reduction | -3.500 | 14.271 | -.029 | -.245 | .807 |
| Closed incineration | -2.500 | 12.061 | -.025 | -.207 | .836 |
| Arranged compositing | -1.500 | 16.182 | -.013 | -.093 | .926 |
| Treated landfill | -28.500 | 7.837 | -.321 | -3.636 | .000 |
| Recycling and reuse | -44.000 | 2.893 | -.722 | -15.211 | .000 |

*a. Dependent Variable: Respondents*

Since t-cal of all betas is less than t-tab =1.960, this means that all ways of solid disposal are good but the most significant among the t-cal is that of recycling and reuse which is = -15.211.

With this analysis, we can conclude and say that recycling and reuse are the best solid waste disposal systems that are most advantageous to mankind.

## 5. CONCLUSION AND RECOMMENDATIONS

The aim of this study was to identify the solid waste management problems in Okpoko, Anambra state and find the possible solution. The solid waste management problems faced in Okpoko included that of Air pollution caused by open incineration of solid waste, Erosion, Untreated landfill, Land sewage sickness and according to the respondents, Air pollution had the highest complaint with 48% out of the 100% while Erosion, Untreated landfill and Land sewage sickness have 7%, 20%, and 25%, respectively. Then the possible solutions were listed out in the Questionnaire which is Source reduction, closed incineration, Arranged composting, treated landfills and recycling and reuse of solid waste. At the end of the field survey work and analysis, recycle & reuse had 66% and proved to the best solution to the current solid waste management problem in Okpoko.

The following are recommended;

1. Solid waste collectors should be consistent with their routine weekly or daily activities.
2. Scavengers should be employed to daily pick up scrap materials at untreated landfills.
2. Individuals should be lectured on the importance of recycling and reusing. Hence, people should stop throwing or dumping waste on side roads.
3. Governments should build a recycling company at Onitsha to help reduce the cost of transportation of taking these wastes to other states for recycling.
4. Waste management agencies such as Anambra State Waste Management Agencies (ANSEPA) should work with the government to provide more dumpsters to these neighborhoods and streets in Okpoko.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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