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DETERMINANT METHOD OF WASTE GENERATION IN NIGERIAN AIRFORCE BASE, KANO

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Abstract

Waste is generated universally and is a direct consequence of all human activities. The aim of the study is to examine the method of waste generation in Nigerian Air force base, Kano in order to propose a sustainable method of waste disposal. Data collection method involved the use of stratified random sampling techniques to determine the number of houses to be sampled. Sample frame was 270 houses in the three categories of housing units (low housing units was 36, medium was 84 and high density units was 150). Each stratum of population had proportionate sampling fraction of 25% to ensure that each category of housing units is well represented. Thus, 9, 21 and 38 houses were respectively sampled, totally 68 houses as the sample size. Wastes were collected and scaled once a week to get the weight of waste generated from different households. The wastes were then sorted into different components to identify the types of waste generated as well as the most common waste generated; these include paper/cartoon, clothes, leaves, perishable goods, bottle/glass. The results revealed that quantity of waste generated within the dwelling units varies according to income level of the household dwellers and perishable waste account for the highest waste generated. The high composition of non-biodegradable wastes requires alternative waste management like composting disposal method for environmental friendly systems. Composting is, therefore, recommended as the best method of disposal of solid waste generated in the air force base, and the non-biodegradable should be sorted out and recycled.

Keywords: Solid Waste, Compost, Disposal method, Housing unit, Kano

Introduction

Waste is generated universally and is a direct consequence of all human activities. Wastes are generally classified into gaseous, liquid, and solid waste (Bakare, 2016). Successful planning of a solid waste management system depends critically on the prediction accuracy of solid waste generation. However, the prediction condition of generation trends in many developing countries is quite different from those in developed countries.

Statement of Problem

Nigeria Air Force Base, Kano is becoming densely populated due to the various developmental activities which have resulted in a huge generation of solid waste, although there are transportation means put in place to collect the generated waste for disposal, it is nevertheless, not done routinely and ends up spilling from the waste bin before collection takes place. The absence of sampling and analysis in many developing countries due to insufficient budget and an unavailable management task force has resulted in a situation where the historical record of solid waste generation and composition can never be completed in the long term. Effective handling of these problems with the limited samples in order to fulfill the prediction analysis of solid waste generation requires development and application of a reasonable accuracy technique. This informs the popularity of solid waste management issues across the nation. This research on solid waste generation is important because of the number of gaps in knowledge on the topic. For instance, data and statistical information about the situation in Nigeria Air force Base Kano show that nothing has been gathered about the per capita generation of solid waste, the quality of waste generated from households, and the composition and types of solid waste generated. Therefore, in respect of this, the study is being carried out to ascertain the types of waste generated and make recommendations for the proper collection and disposal of waste.

Aim

The aim of the study is to examine the method of waste generation in Nigerian Air force base, Kano in order to ensure a proper treatment and disposal method of waste to avoid any harmful impact on the environment.

Study Area

Nigeria Air Force Base Kano (NAF) was established in August 1967, it began as a detachment, with three (3) types of housing units, the high, medium, and low

density housing unit which is allocated to military officers based on their ranks. The low density housing unit is referred to as the married officers' quarters, the high density housing unit is referred to as the corporal below quarters (CBQ) and the medium density housing unit is called the sergeant quarters. Nigeria Air Force base is located in the Fagge Local Government area in Kano as shown in Figure 1.

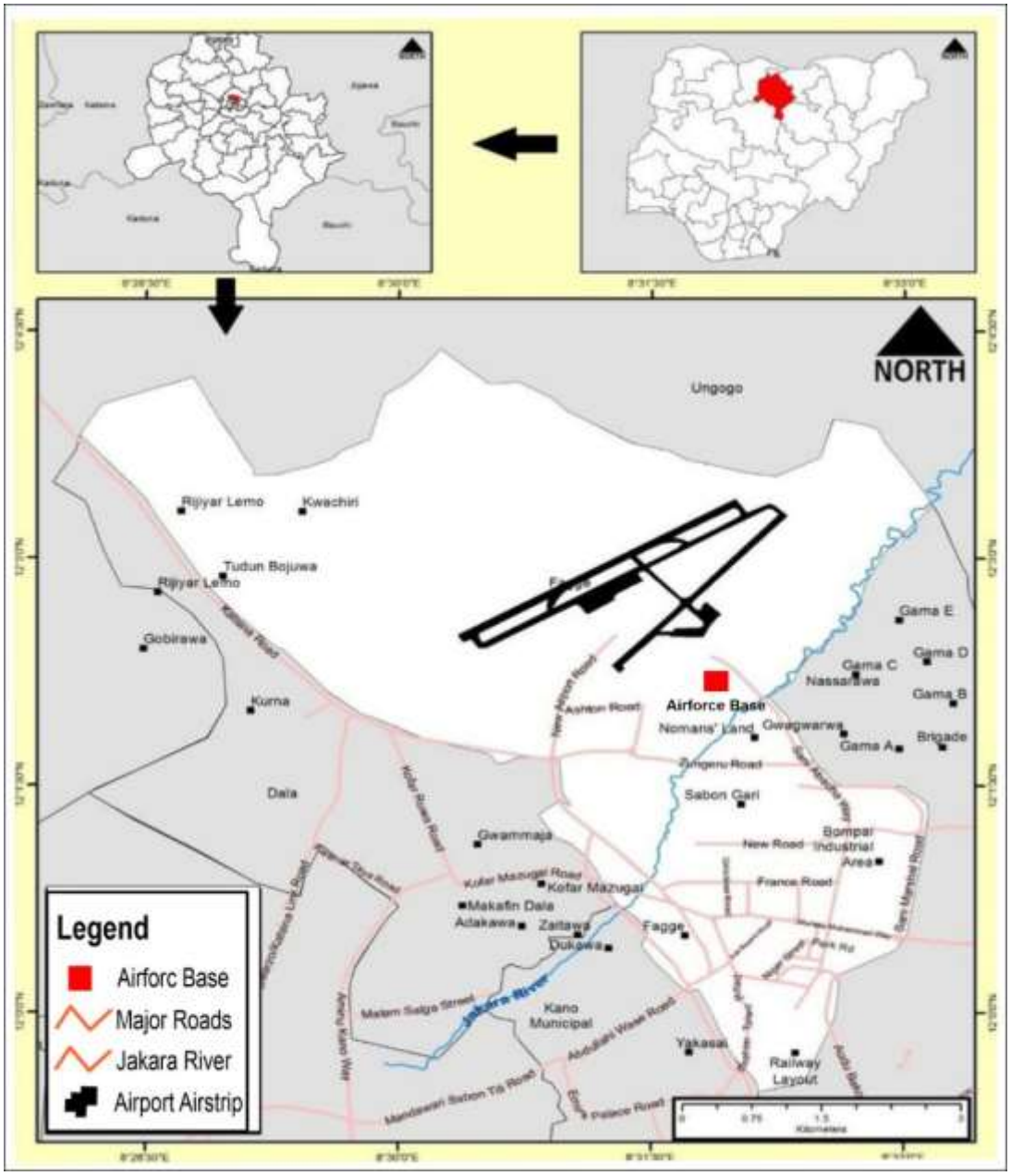

Fig 1. Map showing the Nigeria Air Force Base, Kano
Source: Ministry of Lands, Kano State. 2022

Scope and Limitation

This study is limited to only the type of waste generation and composition of the waste in the Air Force Base quarters, Kano. The composition of waste was limited to physical components and therefore the chemical and calorific content were not investigated.

Significance of the Study

The urge for waste recovery in waste management in Nigeria can only be well articulated if the composition and rate of waste generation are known. Most often, research on such issues as waste composition has hitherto been considered and lumped together in different housing units and types for easier representation and assessment. This has, to large extent reveal rates that could be thought of as distorting the real picture of organized areas such as the NAF Base quarters. This study, therefore, has significant contributions to make especially, to the organized waste management sectors that are willing to invest in waste recovery mechanisms.

LITERATURE REVIEW

Solid Waste Generation and Management

Solid waste arises from unusable residuals of raw materials left over, rejects and scraps from processing operations, used or scrapped package material and even the sellable produce themselves when they are finally discarded (Michael-Agwuoke, M. U, 2012). The urban population in most economies and specifically in developing countries is increasing. This leads to generating an enormous amount of municipal waste in the areas, making its management more complicated which eventually poses an environmental nuisance that threatens public health (Chris. Z. and Roland, S., 1998) A few decades ago, waste was defined as useless, unwanted, unused, or discarded materials resulting from normal community activities (United Nations of Statistics Division, 2008), but now, the above definition is no longer completely correct because of development in recycling and resource recovery (technological).Waste management involves the effective generation, collection (storage), transportation, treatment (processing & sorting), and disposal (for municipal waste), however, if it is clinical waste, it is treated before transportation). In developed countries, the process of waste management is: waste generation, collection, processing, sorting, treatment, and disposal, on the other hand, for developing countries such as Nigeria, the process involves the generation,

collection, transportation, and disposal. Before planning, the first thing to know is how the waste is been generated, the waste programme, and the quantity generated (Sha'ato, 2003). This is very vital for planning purposes because the issue of global warming can also be traced to untreated waste. The composition of generated waste varies as a result of seasonal variation, lifestyle, demographic, geographic, and local legislation impacted (AbdAlqaderHamad, 2012).

Solid Waste Characteristics

The different components that form solid waste are the physical characteristics of solid waste of a particular community which varies according to the following variables.

- Standard of living sampling: this means the level of income of the individual
- Variation in the customs of people: solid waste characteristics will vary because the food habits of people vary. The waste from the southern part of Nigeria (Yoruba) constitutes leaves while in the Northern part (Hausa land) it constitutes mainly nylon etc.
- Climatic conditions: this can be explained in terms of weather and climate and;
- The quantity and quality of solid waste vary with the days of the week; the quantity is often more at weekends than on other days because more people go for shopping at weekends.

This relatively high rate of waste generation is also attributed to high consumption of seasonal vegetables, for example, a variety of plantain consumption is 2kg/capita/day, and 50% of it is wasted. Generally, density values from municipal social waste vary widely. Waste tends to have a lower density in industrialized countries than in developing countries due to the predominance of non-putrescible components such as paper, plastic, and other packaging materials. Typical waste densities in Northern America or Europe are between 100 and 150kg/m^3, while in Southeast Asia, the typical density at the point of collection varies between 250 and 500k/m^3, and densities tend to be higher at commercial points due to self-compaction. In 1978, private consultants in Kano undertook a study on waste management where they found 180kg/capita/year to be the estimate of the refuse generation in the state. Taking refuse density of 0.20 tonnes (t/m^3) cubic meter (0. 20t/m^3), the volumetric rate of 0.9m^3/capital/year was proposed and they gave the estimated quantities of

refuse up to 1995. This was found that in 1993 and 1995 an estimate of 1,300,000m^3/year and 143,000m^3/year will be generated respectively. Yet another team of researchers made a slightly different finding from the assumed 200kg/m^3 density of 260,000 metric tonnes/year and 283,000/year found for 1993 and 1995 respectively. (The Energy Team, BUK 1995). This shows an increase in the weight of solid waste and also an increase in the weight and quantity of refuse in Kano. The rate of daily generation determined the number as well as the frequency of daily tipper workloads to maintain a clean and healthy environment. This has to be considered in formulating an effective waste management policy.

The daily rate of refuse generation can exceed the utilization capacity of workloads. Thus, in 1981, with the average tipper load of 3.5 tonnes (i.e. about 5% capacity utilization) the total annual collection of refuse is 57,375 tonnes which account for only about 20% of the generation capacity of residents, this means there would be a gradual accumulation of refuse due to the generation in excess of haulage capacity of the types of equipment (PAI Association FMH, 1981). PAI Associates (1981) undertook a study on urban solid waste generation and found out the rate of solid waste generation for Kano; old tonnes were 25 kilograms per household per day, while the new tonnes it was 3.4 kilograms per household per day while in other areas, it was 2.1 kilograms per hours per day. This shows that the quantity, composition, and rate of solid waste generated varies within a region in terms of population densities and the per capital income of the people living in an area. Since the beginning, human being has been generating waste, like the bone from animals they slaughter for their food and also from wood cut to make their carts. With the progression in civilization, waste generation become more complex in nature. At the end of the 19th century, the industrial revolution saw the rise of the world of consumers, and the air get more polluted with the generation of non-biodegradable solid waste. The increase in population and urbanization was also largely responsible for the increase in solid waste generation (US Environmental protection Agency, 2006). One may wonder whether waste has got importance, it is significant to note that some people depend on waste as their source of income. Waste is, therefore, important among others for the reclamation of land, source of nature, and animal feed; it is also recycled for usage. (Mabogunje, 1991).

Determination of Solid Waste Characteristics

Solid waste can be determined in two ways; physical and chemical ways. The physical determination is, however, used for this research.

Physical determination: To determine the physical characteristics of waste, the following procedure is followed: Take a known sample of waste; sort and

separate them into various components e.g. paper, glass, and metal, then weigh the individual components. When added, the total weight must tally with the original quantity taken; it is then converted to a percentage. To sort the waste into different categories, the materials used include hand gloves, cellophane or nylon bags, a face mask, and a weighing scale.

Classification of Solid Waste

Nkanga (2001) in Saulawa (2010) classified waste into solid, liquid, and gaseous forms and further classified solid waste into degradable (organic) and non-degradable (inorganic).

Degradable solid wastes are generated from domestic activities which include vegetables, fruits, meat, food ruminants, papers, etc. While non-degradable include plastics, metal scarps, used cans, packs, polythene bags, glasses, etc.

Types of Waste Generation

In developing countries like Nepal, Ethiopia, and Nigeria, there are six general sources of solid waste generation, these are domestic, industrial, agricultural institutional, and natural. House dwellers are the producers of domestic solid waste, domestic waste includes kitchen waste, paper, and cotton plastics, cellophane bags, bone, glass, and metals. The sources of commercial waste generation are stores, tea shops, business premises, restaurants, markets, fruit vendors, hotels, and motor repair shops.

METHODOLOGY

The method of data collection involves the selection of houses to be sampled, sorting the waste into different components to identify the types of waste generated; a scale was used to estimate the percentage of waste generated from different households as well as the most common waste generated. The waste components include paper/cartoon, leaves, perishable goods, bottle/glass etc.

Stratified random sampling techniques were used to determine the number of houses to be sampled, each stratum of population had proportionate sampling fraction of 25% to ensure that each category of population under study is well represented. There were 270 houses in the three categories of housing units (low, medium, and high density), this represent the sample frame. A 25% sample ratio of the sample frame which is 68 was used as the sample size for the research work; to determine the sampling interval, the formula: sampling interval =

sampling frame/ sample size was used i.e. Sampling interval = 270/68 = 3.971≈ 4.

Thus, a random start of housing unit 2 was taken and subsequently, every 4th house was sampled i.e., 2+4=6th, 6+4 = 10, etc. This is to have a fair and accurate housing unit to interview and to administer questionnaire to. The low housing unit consists of thirty-six houses (36) and only nine(9) were sampled, medium housing consisted of Eighty-four (84) houses and Twenty-one (21) were sampled while high housing units consist of One hundred and fifty (150) and only thirty-eight (38) houses were sampled. A total of sixty-eight (68) houses were sampled due to financial and time constraints. The wastes were collected once a week to get the weight of the components. This is because the collectors come once a week. Lastly, interview was granted to the occupants of the house to know the average number of people per household and also the income earning per month.

Table 1: Housing Unit Sample Frame/Size

Housing Unit	Sample Frame	Sample Size
Low Density	36	9
Medium Density	84	21
High Density	150	38
TOTAL	**270**	**68**

Source: Authors' Fieldwork, 2022

Determination of Waste Generation

There are two ways of measuring waste generation, these are:

1. Estimation Analysis: In developed countries such as Europe and North America, the amount of solid waste generated is estimated to be 2kg per person per day while in developing countries; it varies between 0.3kg to 1kg per person per day. In Nigeria, it is 0.4kg per person per day (Cairn cross 1993). Estimates can be based on the number of people residing in a house multiplied by the amount of solid waste generated.
2. Weight Volume Analysis: The density of each load is determined by the following process;
   i. Weigh different containers separately e.g. plastic containers and buckets.
   ii. Weigh the container and the waste.
   iii. The actual weight of the waste is the weight of the container minus the container and waste

Data Analysis

The data generated were analyzed using descriptive statistics, cross-tabulation, and correlation analysis. **To determine the waste generation per capita, simply divide the total waste generated by the total population.**

DATA PRESENTATION, ANALYSIS, AND DISCUSSION

The total households sampled were sixty-eight (68) households. The total population in the 68 households was 243; there exists variation in the distribution of the population according to the dwelling unit. For instance, the high dwelling unit accounted for a total population of 112, medium accounted for 70; while the low dwelling unit accounted for 61, In addition, the variation equally affected the distribution according to the number of persons per household.

Monthly Income

It is important to note that all the household heads are military officers and hence the researchers are of the opinion that the contribution of housewives could further influence the waste generated. The income status of each of the household density dwellers reflects in the volume of their waste generation. The low-density dwellers for example, incidentally are the superior officers and they generate more waste. Table 2 shows the variation in the monthly income within the dwelling units.

Table 2: Monthly Income of the different dwelling units

Monthly Income (₦)	Types of Dwelling Units			
	Low Density	**Medium Density**	**High Density**	**Total**
60000	0.0%	0.0%	17.6%	17.6%
80000	0.0%	0.0%	23.5%	23.5%
100000	0.0%	4.4%	0.0%	4.4%
120000	0.0%	4.4%	14.7%	19.1%
150000	0.0%	13.2%	0.0%	13.2%
180000	0.0%	8.9%	0.0%	8.9%
250000	1.5%	0.0%	0.0%	1.5%
300000	1.5%	0.0%	0.0%	1.5%
400000	4.4%	0.0%	0.0%	4.4%
450000	5.9%	0.0%	0.0%	5.9%

Total	13.3%	30.9%	55.8%	100%

Source: Authors' Field Work (2022)

Table 2 shows the variation in the monthly income of the respondents and this is translated that about 13.0% of the respondents living in low-density houses earn N250, 000.00 and above monthly while medium and high dwelling units earn between N60, 000 to N120, 000 respectively. The results revealed that high-income earners generate more waste than low-income earners.

To easily get the percentage of income scale of each housing unit, table 2 is translated into table 3, where the income range for high density housing dwellers is between ₦60000 -₦80000 and this represents 55.8% of the total respondents, medium density housing dwellers receives between ₦100000 and ₦180000 with 30.9% and the low density housing unit dwellers income range is between ₦250000 and ₦450000 representing 13.3% of the total sampled population.

Table 3: Monthly Income of the different dwelling units

	Types of Dwelling Units			
Monthly Income (₦)	**Low Density**	**Medium Density**	**High Density**	**Total**
60000 -80000	0.0%	0.0%	55.8%	55.8%
100000-180000	0.0%	30.9%	0.0%	30.9%
250000 - 450000	13.3%	0.0%	0.0%	13.3%
Total	13.3%	30.9%	55.8%	100%

Source: Authors' Field Work (2022)

There is variation in total waste generated, perishable goods account for the highest generated waste. It can be noted that there is not much variation in per capita daily solid waste generated. The generated waste per person in a house within the low density housing unit is 0.29 kg per person /day, 0.28 kg/person/day in the medium, and 0.28 kg per/day in the high density units. There is a relationship between income and waste generated this is because waste generated depends on income. Table 4 clearly shows that the low-housing units generate more waste due to their high-income earnings.

Table 4: A comparison between Monthly Income and Total Waste Generation

Monthly Income (₦)	Total Weight of Waste Generated (kg)
60000	1.8817
80000	2.8700
100000	3.3233
120000	3.4815
150000	2.4789
180000	3.1400
250000	4.3900
300000	5.3900
400000	3.9233
450000	4.7150
Total	3.0190

Source: Field Work, 2022

The mean income and mean waste generation is trying to show the differences between the dwelling units in terms of waste generated and their income level. The low housing unit accounts for the highest waste generation because of their high-income level.

Quantity of Waste Generation

The quantity of waste generated in table 5 shows that perishable goods account for the highest quantity generated. If there is no efficiency in the routine collection of the waste, domestic animals in the area will litter the waste resulting into a nuisance in the environment.

Table 5: Quantity of Waste Generated in NAF Base

Types of Waste	Minimum	Maximum	Mean
Pampers/Pad (kg)	0.00	1.99	0.69
Polythene bag (kg)	0.09	0.99	0.54
Perishable goods (kg)	0.00	2.49	1.15
Glass/bottles (kg)	0.00	2.00	0.05
Metal (kg)	0.00	0.00	0.00
Paper/cartoon (kg)	0.19	0.99	0.54
Leaves (kg)	0.00	0.00	0.01

Source: Authors' Field Work, (2022)

Household Waste Management Strategies

The management strategies engaged in by many households in the air force base for disposal of their generated waste is shown in table 6. This implies that instead of dumping their waste in the provided bins, the households dispose their waste through the various methods shown in table 6.

Table 6: Household Waste Management Strategies used in the base by Houses

Method of Disposal	Clothes	Leaves	Total
Burning	1.5%	15.1%	16.6%
Exchange for other materials	53.8%	0	53.8%
Gift	7.4%	0	7.4%
Donation to Motherless Homes	7.4.%	0	7.4%
Nothing	1.5%	4.1%	5.9%
Selling	9.2%	0	9.2%
Total	80.8%	19.2%	100.0%

Source: Authors' Field Work (2022)

The waste management strategies employed by household dwellers in NAF is sustainable, judging from the percentages of disposal methods represented in table 6. Exchange of clothes for other materials has the highest percentage of 53.8%, followed by selling of the clothes which is 9.2%, gift and donation to motherless homes has 7.4% each while 1.5% of the households burn the clothes. 15.1% of the respondents also burn leaves litter. This shows that it is sustainable because the greater percentage (53.8%) of the waste serves as a means of income generation for the household dwellers. This move also protects the environment from different forms of pollution. Table 7 shows that only 10.3% of used bottles and glasses are sold out to buyers.

Table 7: Household Waste Management Strategy for Glass and bottles (Kg)

Household waste management	Bottles	Glass	Total
Nothing	82.4%	7.3%	89.7%
Selling	10.3%	0.0%	10.3%
Total	92.7%	7.3%	100%

Source: Authors' Field Work (2022)

The greater percentage (89.7%) is not used and so there is need to research into why this is the case.

Discussion

The quantity of waste generated shows that perishable goods account for the highest quantity of waste generated. If there is no efficiency in routine waste collection, thus, domestic animals in the area litter the waste which results in a nuisance. The quantity of waste generated within the dwelling units varies according to the income level of the household dwellers. The results revealed that high income earners generate more waste than low income earners. The high composition of non-biodegradable wastes bears the implication of the requirement for alternative waste management solutions for sustainable and environmental friendly waste management systems such as composting method of disposal.The relationship between income level and waste generated shows that as the income of a person increases the waste generated will also increase.

The management strategies employed by many households for the disposal of bottles and glass in the study area is a non-strategy method while exchanging and selling of the clothes material amount to the highest income generation and sustainable strategies.

Conclusion

It can be concluded that income level has a strong relationship with waste generated, that is, the more your income, and the more the waste generated. In addition, the composition of such waste could constitute a high proportion of non-biodegradable material.

Recommendations

It is therefore, recommended that:

- The Nigeria Air Force Base Kano should work hand in hand with the waste collectors, in order to enhance efficiency of routine waste collection after the generation of solid waste. This will minimize littering by domestic animals, especially dogs.
- Composting is the best method of disposal of solid waste generated in the air force base because perishable goods account for the highest waste composition.
- That the issue of solid waste management should be emphasized in the air force base, Kano in order to harness sustainable alternative ways of disposing leaves, glass, and worn-out clothes in the area instead of burning.
- The non-biodegradable should be sorted out and recycled.

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