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Research Article

Domestic Solid Waste Collection and Payment Policy with GIS Approach in Ajibode, Akinyele Local Government, Oyo - State, (Nigeria)

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Abstract

This study examined the profitability in investing in solid waste management at local government level by private investors. The study employed GIS and remote sensing to analyze the spatial entity and attributes of the 300 selected houses in Ajibode area of Ibadan metropolis. Questionnaire was administered to respondent house owners in the study area. The satellite imagery of the study area was downloaded through Google earth with a spatial resolution of 10 meters above the ground while the coordinates of the survey buildings were obtained through GPS. The study revealed that 39% of existing refuse payers and 35% of dwellers that do not have waste bin but are ready to acquire one in the study area, are ready to pay 1,500 naira conveniently. Also, 25% are willing to pay between 1,200 naira and 1,500 naira. Thus, with 1,000 buildings, the local government or private investors will realize 1.5 million naira per month base on the 1,500 naira payment framework. The study, therefore, suggested that government should make waste bin available for the residences and accept the amount they are willing to pay conveniently. In addition to the associated reduction in unemployment, this it will enhances clean environment by reducing the rate of open space refuse dumping, refuse burning and defecation as well as reducing greenhouse gases, drainage refuse dumping, road side dumping due to these practices. This study serves as a pilot study for both the local governments and private sector willing to invest in the system.

Keywords: GIS and Remote Sensing, Solid Waste Collection, Residential wastebin, pricing policy and revenue

Introduction

The defective strategies and arrangements adopted for solid waste management in Nigerian cities create the erroneous impression that urban waste management problems are intractable. This sterns from the fact that the rate of collection and evacuation perpetually lag behind the rate of generation which makes solid waste accumulation a major source of environmental nuisance in Nigerian cities. Solid waste management, therefore, concerns the interplay among generation, storage, collection, and final disposal [1].Solid waste management is increasingly becoming a concern particularly in highly populated areas. Improper solid waste management leads to both economic and environmental challenge. For instance, uncontrolled throwing of the waste and badly maintained waste results in the growth of diseases as well as increase the presence of unwanted species such as rats and mosquitoes, while bad odor created around the garbage area generates unaesthetic conditions which in turn decrease the market value of the area [2].Waste collection and transport constitutes a large fraction of the total municipal solid waste management costs worldwide. In Greece, currently this may account for 70-100% of the total MSW costs, most of it being spent on salaries and fuel[3]. Unfortunately, many people in African countries including Nigeria still regard the concern for effective strategies for managing urban solid waste as a less important issue which may distract attention from the most urgent and serious problem of achieving a fast rate of economic growth. This attitude stems in part from the belief that environmental degradation with urban solid waste generation is an inevitable price of development [4].

According to Tinmaz and Demir [5], waste has become a critical issue in development discussions, not because of the quantities of refuse being dumped, but due to inadequate management system. One of the major management issues in solid waste management is improving methods for interpretation of data. Vhora[6]noted that billions of dollars are spent in improving scientific methods for interpretation of data, but the steps involved in the said area are much demanding.

Manual methods used for analysis of factors related to solid waste management, which largely have a spatial component, are lengthy and tedious. Difficulty in the assessment of system functionality and efficiency has been largely associated with improper management of the data and records, which calls for the importance of data management in an integrated way so that the complexity of various systems could be reduced to solve various interrelated issues. The foregoing underscores the urgent need for the application of Geographic Information System (GIS) as it is robust to simultaneous analysis of several factors in planning waste management. Also, the method possesses layers property which minimizes chances of confusion and error and can coordinate between spatial and non-spatial data. In addition, information can be related spatially, exchanged, compared, evaluated, and processed with a high flexibility [2]. In fact, Upasna and Natwat [7] described GIS as a system designed to allow user to collect, manage, analyze, and retrieve large volume of spatially referenced data and associated attribute data collected from a variety of sources. Through different case studies, this paper discussed the application of GIS in solving problems related to waste storage, then demonstrating the usefulness of GIS in optimizing waste collection systems.

Despite waste management being considered as a necessity and integral to city live ability, urban and environmental policy makers, especially in most Nigeria States, have not been able to provide a workable, sustainable and permanent solution to the indiscriminate disposal of refuse within the urban areas. Channel of dumping of refuse is one improper method of solid waste disposal that has been in existence for a long period in the city of Ibadan. Ye-Obong and Uduak (2013) affirmed that the different categories of wastes in many Nigerian cities are most times disposed in an unsustainable manner in open dumps, streets, ravines and also drainages which then flow into streams that serve as a source of water to the people residing in such environment. They further stated that this act of lackadaisical means of disposing refuse has left the road stinking with odors from decayed sediments and waste materials which have been left for a long period of time.

Omolawal and Shittu [8] identified a number of micro level arrangements introduced by state governments to complement institutional arrangements to enhance environmental sanitation which include Kerbside sweeping as a way of safeguarding public health and beautify the environment. This innovation came into existence in May 1999 as an attempt to make Ibadan city wear a good look in preparation for the World Youth Soccer tournament (Nigeria '99). In addition to street sweepers, approved waste depots and community waste depots were also used for people in localities to dump their wastes for eventual collection by the contractors. The idea is to bring the process close to the doorstep of the masses and enhance community participation in the process. Waste collectors are employed by the Ibadan Solid Waste Management Authority to collect refuse in drums in front of each house under their jurisdiction and dispose them off.

However, despite all these laudable structures and arrangements, the streets of Ibadan are still littered with piles of refuse which disfigure the environment and constitute serious health challenges. The habit of indiscriminate dumping of refuse on the streets, open places, drainages, and rivers is continues to be a menace. Thus, city corridors are now breeding places for rodents, insects, and diseases. Popoola et al, (2016) stated that inadequate distribution of refuse bin makes it impossible to establish the reason behind the indiscriminate disposal of refuse along the road divide.

Following the problem posed by solid waste collection in Ibadan urban areas. The pertinent questions are: (1) how can database be created for houses with waste bins in the city of Ibadan? (2) why are houses without waste bin, how do they dispose their refuse and how much are they willing to pay for refuse bin if provided? (3) How much can government or private sector generate with the affordable rate? The study therefore creates and designs the database for houses with existing waste bin in the study area. It also identifies houses with no waste bin and average amount they are willing to pay if provided with waste bin. Lastly, it determines how much government is likely to realize if they comply with the average amount citizens are willing to pay. This research work will be of huge significance to the Oyo State Government as it would inform the State's strategies towards raising the Internal Generated Revenue (IGR).

Study Area

Akinyele is a Local Government Area in Oyo State, Nigeria. With coordinates 7°33'41.47" N and 3°54'21.92" E. It is one of the eleven local governments that make up Ibadan metropolis. It was created in 1976, sharing boundaries with Afijio Local Government to the north, Lagelu Local Government to the east, Ido Local Government to the west and Ibadan North Local Government to the south. It occupies a land area of 464.892km^2 with a population of 211,811 on a density of 516 persons per km^2 which is subdivided into 12 wards. One of them is Ajibode, which is the main focus of this study. It is located in ward 5 at the periphery of Ibadan, sharing boundaries with villages like Apete, Oojo, Moniya, Balogun, Aponmade, Alade, amongst others. The city of Ibadan is known to be the third largest metropolitan area in Nigeria after Lagos and Kano. This is because it is one of the fastest urbanizing cities in Nigeria. The increase in urbanization is attributed to the provision of better economic opportunities due to setting up of factories and industries, which

has led to migration of population from rural regions to the city. As a result, people spread to the peripheral areas of the urban fringes. This spread is not properly planned; it looks haphazard thereby causing a lot of health and environmental disturbances to the community. The most versatile land use in Ajibode is purely residential. However, few pieces of land were found scattered around the area on which crops are cultivated as secondary means of livelihood for the residence

Literature Review

Domestic waste form about half of the solid wastes generated in third world cities Taiwo [9] and over the last ten years, both domestic and commercial sources of wastes have grown conspicuously in Nigeria [10,11]. For every good bought, a minimal addition of waste volume is added to the existing stockpile of waste at every point in time. This shows the relativity of waste generation to the population of the society.

Omuta [1]posit that what causes waste problem is not volume produced but the degree of effectiveness of solid waste management. However,Rosenbaum [12]argued that solid waste is an unofficial measure of prosperity since wealthy nations produce more wastes than poor. Waste storage at the source has also been described has the second functional element of the solid waste management. Usually, waste is stored in waste bins located in both sides of streets next to buildings and other sources of waste generation. Meanwhile, more attention is given to residential waste storage due to its direct impact on the public health and attitude, as these storage points are commonly placed in close proximity to houses. Due to microbiological decomposition of the waste, studies have argued against storing waste for long time. According to Ammar [2], Uncollected garbage causes serious threat to public health as it is a breeding ground for insects, flies, and bacteria which this could spread disease.

Uwadiegwu and Chukwu [13] assessed solid waste management in Enugu cities to develop urban solid waste management strategies aiming to effectively address the problems emanating from solid waste management. The authors adopted Principal Components Analysis (PCA) version of Factor Analysis to analyze the responses of respondents. The PCA was used to reduce the 27 considered management options into 7 composite strategies to be adopted for effective urban solid waste management. Their found that citizen mobilization and environmental education, strengthening of public agencies, responsible government, logistics and infrastructural improvement, legislation, appropriate technologies, monitoring, and surveillance are effective strategies to checkmate uncontrolled wasted dumping. Gana and Ngoro [14] posited that the waste management problem in Nigeria is relatively enormous, and many attempts made at getting rid of it from human settlement have not been very successful. In developed countries like Europe, there are effective systems for the removal of waste from different settlements, although ultimate and final disposal usually pose problem in the environment due to lack Basic facilities. In an attempt to proffer solution to uncontrolled dumping of solid waste along the major roads, Gana and Ngoro [14] suggested provision of waste bin and provision of health education for the residents. Adeniran [15] evaluated the challenges posed by disposal of solid waste on the built environment in general and specifically on property values by exploring its impact on the inhabitants and the building structures. The framework of healthy city concept is used as a standard for quality while closed and open-ended questions were administered on randomly sampled 87 residents of Old Bodija, Ibadan and analysed using simple descriptive analysis. Results revealed that values of buildings, as well as the physiological welfare of residents, cannot be isolated from the building and the environment in which they live vis-à-vis their waste disposal methods[16].

The foregoing indicates that much research have been carried out to checkmate incessant dumping of refuse along the streets of Nigerian urban, open space, and drainages with so many statistical approaches. Surprisingly, little work has yet been done to address the key issue of effective strategies for the collection of urban solid waste with Geographical Information Systems and Remote sensing approach and how this solid waste collection can encourage private sector or local government to invest into the system and drastically reduced unemployment in Nigeria cities. This study is therefore designed to close the identified research gap in literature.

Methodology and Data Acquisition

A GIS involves the acquisition of both spatial and attribute data. As shown in Table 1, the attribute data used for this study came from mainly primary sources. The primary data (questionnaires) such as information about buildings concerning sanitation practices were collected from 300 sample survey buildings and then transferred to ArcMap 10.3 (ArcGIS 10.3) software; the layers were projected into WGS 1984 UTM Zone 31N. each copy of the questionnaire was administered to one household per building. To get high spatial resolution of the study area, the satellite imagery of the study area was downloaded part by part and later mosaics them to a whole Figures1&2. Essential features including roads, buildings and schools digitized in ArcMap. Handheld GPS (Garmin 76) was also used to obtain the coordinates of each of the building under the sample survey.

Table 1: Data sources (primary and secondary sources).

	Data	Source
Primary Data	Locational data of houses with waste bin.	Handheld GPS (Garmin 76) and ground truthing
	Attribute data	Ground truthing and questionnaires(300)
Secondary Data	Georeferenced satellite Imagery of the location	Ikonos Image (10-meter Resolution)

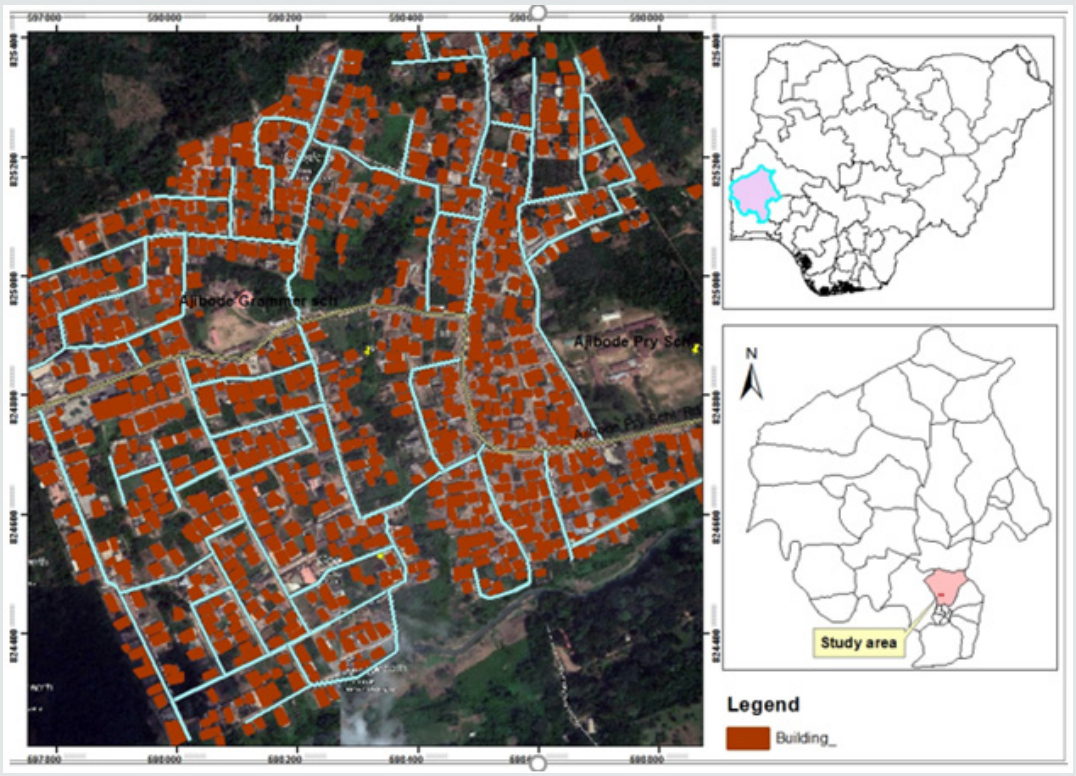

Figure 1: Cadastral map of the study area.

Figure 2: Satellite imagery of the study area in which the spatial resolution was downloaded.

Georeferenced satellite imagery of the study area was digitized on-screen using ARCGIS 10.3 version. Following the design phase, the database was created and populated in ARCGIS 10.3 environment. Polygon, Line and Point layers were created, respectively. These form individual relations which were then populated with their attribute values.

Analysis and Discussion of Results

Spatial search was used to test the database created by looking for certain attributes within the neighborhood, which must be logically and systematically defined. This gave rise to querying the database towards answering questions related to the application. Some of the information obtained includes the number of houses with and without waste bin, uncompleted buildings, and amount government is expected if complying with the average amount Ajibode dwellers are willing to pay.

Double and Multiple Queries

a) Selection of all the buildings with existing waste bins; pays for refuse collection and amount they pay. Query expression(from all buildings WHERE "pay refuse" = Yes And "Amount" = 2,000).As shown in Figures 3&4, out of 300 sample survey buildings, 139 buildings have refused bin and also pay for waste collection. And it can be deduced that 161 buildings do not have waste bin. Analysis of the Figure shows minimum payment of 2,000 naira and maximum payment of 2,000 naira, which means that the fix regulated amount is 2,000 naira. Due to dwindling economy and so many alternative ways of refuse disposal in the study area and insatiable nature of human being, these existing refuse payers may decide to opt out because of the 2,000-naira payment. Thus, further analysis of houses that are not satisfied with the existing 2,000-naira payment is conducted and how much they are willing to pay.

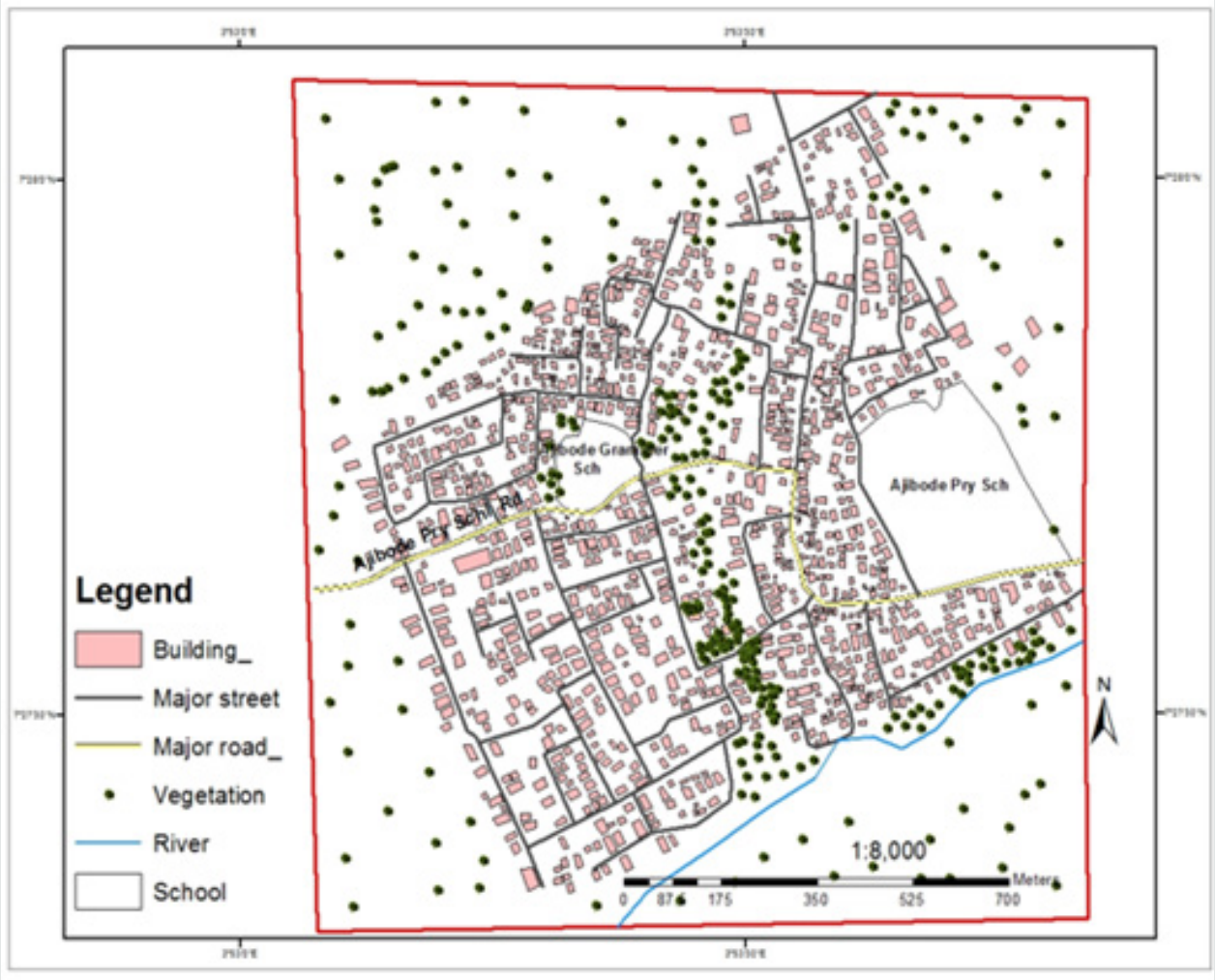

Figure 3: Digitized map of the study area.

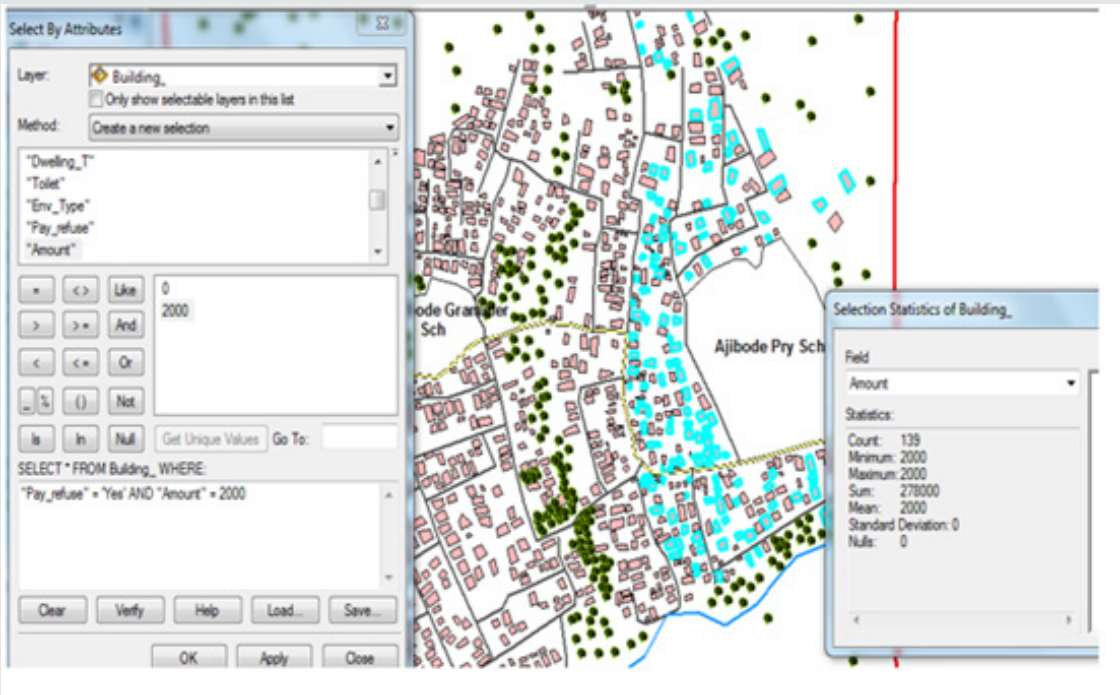

Figure 4: Query and result of buildings with existing refuse bin and amount paid.

b) Selections of all the building that pays for refuse collection but not satisfy with the 2,000-naira amount paying. Query expression (from all buildings WHERE "pay refuse" = Yes And "Payment_satisfy" = No and "satisfy_amt_willing">= 500).

The analysis in Figure 5 indicates that 96 buildings out of 139 buildings that are paying for refuse collection are not satisfied with the existing 2,000-naira payment and only 43 buildings are satisfy with the payment. The analysis also revealed that the maximum amount willing is 1,500 naira which is accounted for 35% of the buildings. Also, 28% are willing to pay 1,000 naira, 20% are willing to pay 1,200 naira while the rest are willing to pay less than 1,000 naira.

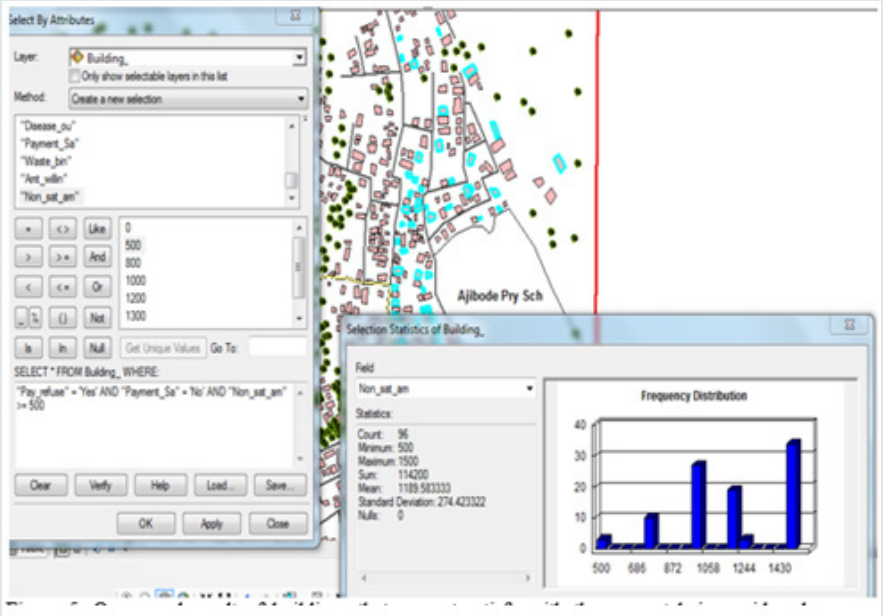

Figure 5: Query and result of buildings that are not satisfy with the amount being paid and amount they are willing to pay.

However, for 161 buildings in the sample survey that does not have refuse bin, larger percentage of them burn their refuse within their compound. The analysis in Figure 6 indicates that 125 buildings out of 161 buildings that do not have refuse bin are willing to have and pay for refuse collection. Results also show that maximum amount they are willing to pay is 1,500 naira. While 39% are willing to pay 1,500, 25% are willing to pay 1,200 and 30% are willing to pay 1,000 naira. It can be deduced that the percentage of those that can afford between 1,200 naira and 1,500 naira is 64%. Therefore, in other to persuade these dwellers to make use of refuse bin, it is suggested that government of Oyo State should fix the refuse collection price at 1,500 naira.

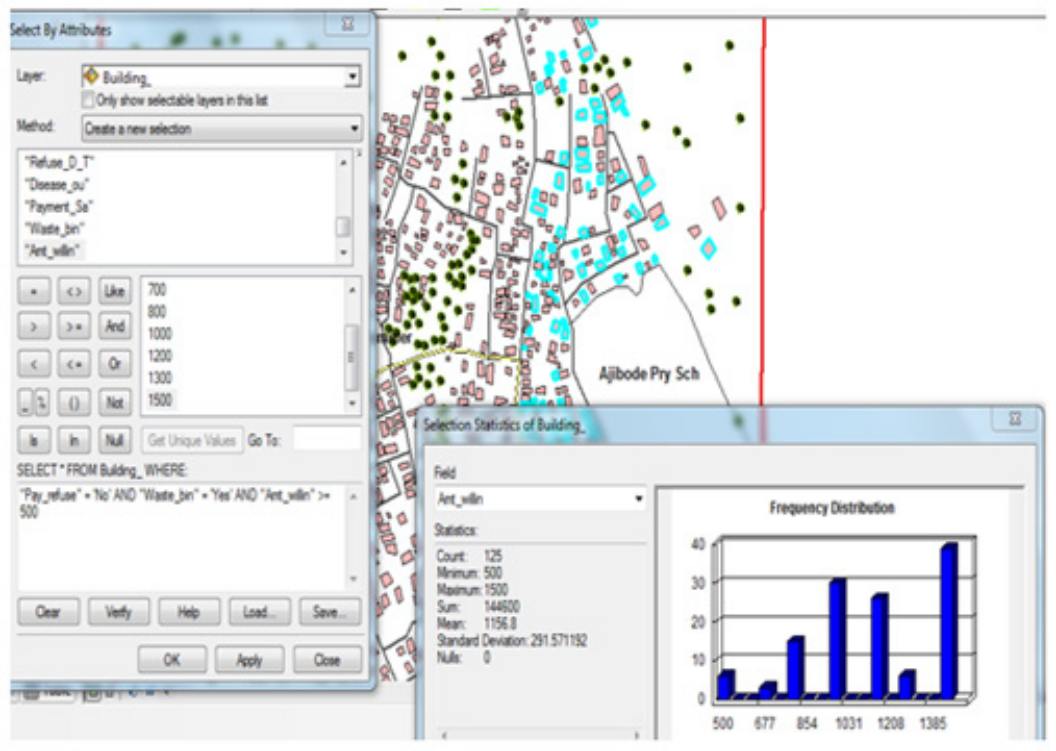

Figure 6: Query and result of building with refuse bin and willing to have refuse bin if provided.

c) Selections of all the building that do not have refuse bin neither pays for refuse collection but are willing to have refuse bin if given to them and amount they would want to pay for refuse collection. Query expression (from all buildings WHERE "pay refuse" = No And "Waste bin" = Yes And "Amt_willing">= 500).From the Figure 6 above, 125 household per building are ready to acquire refuse bin and 39% of them are willing to pay 1500 naira.

As observed from Table 2, 41.5% of the dwellers burn their refuse within their compound, 6.8% of the dwellers drop their refuse in an open space, 4.2% drop their refuse in stream and river channel and 19.1% drop their refuse at the road side to be taken by government agent. Also, only 17.1% of the population has waste bin in their house while 4.3% of the dwellers refuse to give detail of how they dispose their refuse. Furthermore, in terms of frequency of payment for refuse collection, 74.7% choose a monthly payment, 2.3% choose daily plan, 13.8% weekly bases, 2.8%fortnight while less than 1% agreed to a yearly payment.The solid waste collection practice in the study area is well moderated. Door-to-door waste collection, initiated by private organization and supported by state government, was observed. But in some areas, the practice was not so maintained recurrently resulting to jumbled waste disposal. Most of the buildings in the study area have no containers for dumping of solid wastes.

Table 2: System and frequency of refuse disposal in the study area

	Items	No	%share
How did the household dispose their waste	Drop refuse at the road for collection by govt.'s agent	49	19.1
	Drop refuse at open space	18	6.8

	Drop refuse at govt's waste bin	47	17.7
	Drop refuse in stream/river's channel	12	4.2
	Drop refuse in drainage	17	6.4
	Burn refuse within compound	111	41.5
	Others	14	4.3
Total		268	100
	Items	No	%share
	Daily	5	2.3
How often the household want to be paying if provided with waste bin	Weekly	30	13.8
	Fortnightly	14	6.5
	Monthly	162	74.7
	Yearly	6	2.8
	Total	217	100

In a sample survey of 300 buildings, this study indicates that 139 buildings have refuse bins of which they pay 2,000 naira as collection fee. Out of these, only 43 buildings (31%) are satisfied with the payment, the rest, which accounted for 96 buildings (69%), are not satisfied with the 2,000 naira payment. it is found that the highest amount the dwellers are willing to pay is 1,500 naira. While 161 (54%) of the participating buildings do not have refuse bin, 41.5% of them burn their refuse within their compound, 6.8% drop their refuse at open space, 6.4% in a drainage and 4.2% in river channels. Moreover, 19.1% dumps their refuse along the major roads. Among the 161 buildings who do not have refuse bin, 125 building (75%) are willing and ready to have refuse bin if given to them and 40% of these buildings are willing to pay 1,500 naira for the refuse collection.

Thus, of the 139 existing refuse payers, about 90% are willing to pay for refuse collection., If government could fix the refuse collection fee at 1,500 naira, the amount realize per refuse collection in a month is 396,000 naira(139existing refuse bin payers +125 ready to pay for refuse bin =263*1500new price = 396,000). With 1,000 buildings, government will realize 1.5million naira per months.

Conclusion and Recommendation

It is therefore recommended that the government and private sectors should invest in waste collection system by providing the urban dwellers refuse bin while considering the maximum amount they are willing to pay. This will held to avoid street and open space dumping in Ibadan urban areas, as well as reduce unemployment rate in Oyo State and increase the internal revenue and drastically reduce unemployment in the state. With this amount, the rate of environmental and atmospheric pollution through refuse burning and open space refuse dumping will reduce. With the longstanding challenges of urban solid waste management in the Nigeria, there is the need for the introduction of Waste Management Advisers to the State governors and creation of sanitation committees in the State Houses of Assembly.

References

1. Omuta GED (1987) Urban Solid Waste Generation and Management; Towards an Environmental Sanitation Policy. Habitat International 11(2): 77-87.
2. Ammar HT (2007) GIS application in solid waste management. An unpublished term paper submitted for Introduction to Geographic Information System (GIS) course work.
3. Chalkias C, and Lasaridi K (2009) A GIS based model for the optimization of municipal solid waste collection: The case study of Nikea, Athens, Greece. WSEAS Transactions on Environment and Development 5(10).
4. Salau AT (1992) "Global Environmental Change: A Research Agenda for Africa. CODESRIA Working Paper 2: 49.
5. Tinmaz E, Demir I (2006) Research on solid waste management systems: To improve existing situation in Corlu Town of Turkey. Science Direct 26(3): 307-314.
6. Vohra (2006) notes for the course CE 647 Municipal Solid Waste Management.
7. Upasana S, Natwat MS (2003) Selection of potential waste disposing sites around Ranchi Urban Complex using Remote Sensing and GIS techniques. Map India 2003.
8. Omolawal SA, Shittu SO (2016) Challenges of solid waste management and environmental sanitation in Ibadan North Local Government, Oyo State, Nigeria. 19(1).
9. Taiwo A (2009) Waste management towards sustainable development in Nigeria: A case study of Lagos state. International NGO Journal 4(4): 173-179.
10. Babayemi JO, Dauda KT (2009) Evaluation of solid waste generation, categories and disposal options in developing countries: a case study of Nigeria. Journal of Applied Sciences and Environmental Management 13(3): 83-88.
11. Oyedepo SO (2012) Energy and sustainable development in Nigeria: the way forward. Energy Sustainability and Society 2: 15.

12. Rosenbaum WA (1974) The Politics of Environmental Concern. New York, Praeger (pub).

13. Uwadiegwu, Chukwu KE (2003) strategies for effective urban solid waste management in Nigeria. European Scientific Journal 9 (8).

14. Gana AJ, Ngoro D (2014) An Investigation into Waste Management Practices in Nigeria (A Case Study of Lagos Environmental protection Board and Abuja Environmental protection Board). West African Journal of Industrial and Academic Research 12 (1).

15. Adeniran AA, Elegbede OT, Ogundiran AA (2018) Solid Waste Management and Property Values: Issues and Challenges in Old Bodija, Ibadan, Nigeria. International Journal of Social Science and Humanities Research 6(1): 185-194.

16. Udoakah Y and Akpan U (2013) A Sustainable Approach to Municipal Solid Waste Management in Southern Nigeria. A paper presented at the Institute of Electrical Electronics Engineers (IEEE) Global Humanitarian Technology Conference (GHTC) October 20-23, Silicon Valley - San Jose, California, USA.

DOI: 10.32474/OAJESS.2020.05.000221