

# **INDIGENOUS KNOWLEDGE AND RELEVANT RESEARCH**

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## CHAPTER 23



# WASTE GENERATION, COLLECTION AND MANAGEMENT PATTERN IN JOS CITY OF PLATEAU STATE, NIGERIA

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### ABSTRACT

Solid wastes generally constitute man's unwanted materials that need to be collected and properly managed. It consists of substances, materials and objects considered as worthless or defective and of no or less value for human economic productive activities at any point in time. Apart from constituting an eye sore to urban environment, it constitutes health hazards and threatens the health of man and animals in the city. This research attempts an assessment of Waste generation, collection and management pattern in Jos city of Plateau State, Nigeria. The study made use of primary data obtained from 335 questionnaires administered, out of which 280 were returned and analyzed using descriptive statistics. Results obtained show that 87.5% of landuse type responsible for waste generation is residential, 42% of the waste generated in the area is ashes. 76% of the waste generated in Jos is from domestic activity with 32.8% being disposed in open space. Majority of waste containers used were metals (33%). A focus

group discussion (FGD) gave more and detailed explanation on the prospects and limitations on solid waste generation, collection and management in Jos city of Plateau state. To this end, there is the need to overhaul both materials and methods of municipal solid waste collection and disposal in Jos city of Plateau State, Nigeria.

**Keywords:** Waste generation, management pattern, waste collection and landuse type

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## **INTRODUCTION**

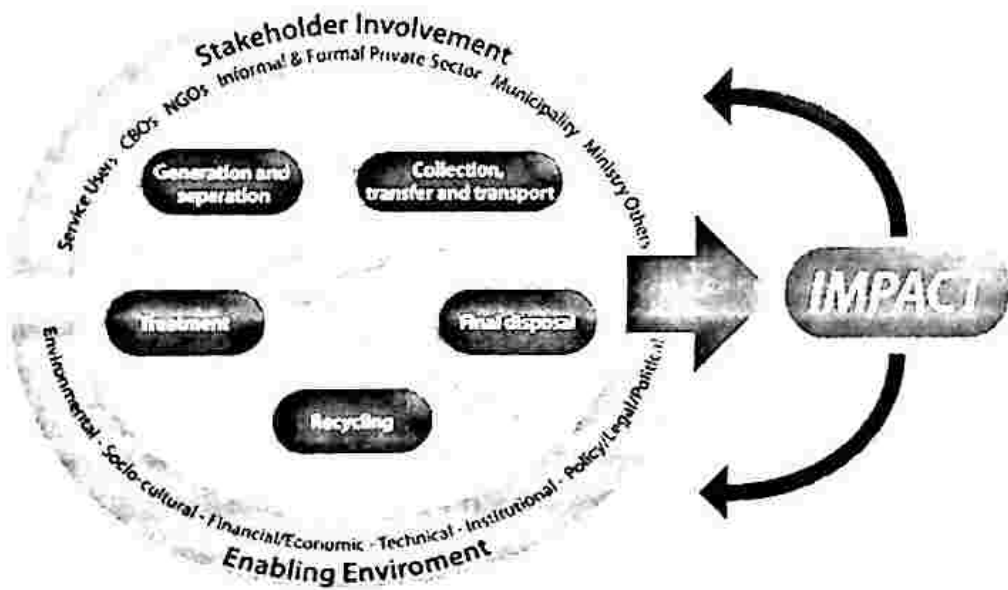
Solid waste management is a challenge for the cities' authorities in developing countries mainly due to the increasing generation of waste, the burden posed on the municipal budget as a result of the high costs associated to its management, the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system functioning (Liliana *et al.*, 2013). The management of municipal solid waste continues to be a major challenge in urban areas throughout the world but particularly in the rapidly growing cities of the developing world (Afroz *et al.*, 2007 and Fuo, 1997). A high rate of population growth and increasing per capital income have resulted in the generation of an enormous volume of solid waste, which poses a serious threat to environmental quality and human health (Afroz *et al.*, 2009 and Srigdha, 2003). To keep pace with the requirement of rapid economic development and continuing population growth, and because of the critical role of municipal solid waste management in protecting the environmental and public health, Plateau Environmental protection and sanitation Agency (PEPSA) must prioritize effective and efficient achievement of this task. It equally follows that the awareness of improper handling of municipal solid waste leads to contamination of water, soil and atmosphere and is a major impact on public health has caused developing nations to address this issue with increasing urgency (Al-Khatib *et al.*, 2010; Batoot, 2009, and sharholy *et al.*, 2008).

In particular, the collection of municipal solid waste has been identified as a major problem in many areas; municipal authorities are either unable or unwilling to provide waste collection services to all residents in their

jurisdiction. On average, up to 50% of residents lack collection services in urban areas of low and middle income countries. There are limited opportunities for the development of a sustainable municipal solid waste system as government budgets are limited and more than often collection is overlooked, agencies are often understaffed, continuous usage of obsolete equipment in daily operations, cumbersome procedure employed and inflexible work schedule, coupled with inadequate supervision monthly forms the difficulties most agencies faced.

### **Conceptual Framework**

This work was based on the concept of integrated sustainable waste management model (ISWM) that allows studies of the complex and multi-dimensional systems in an integral way (Figure 1). The model acknowledges the importance of three dimensions when analyzing, developing or changing a waste management system. The dimensions are; the stakeholders, the elements or stages of the movement or flow of materials from the generation points towards treatment and final disposal and the aspects through which the system is analyzed (Scheinberge *et al.*, 2011).



**Figure 1: The integrated sustainable waste management model (WASTE, 2004; adapted from ISSOWAMA Consortium, 2009).**

### **Wastes generation and collection pattern**

At present, there exist no means of monitoring waste generation rate. There

are a number of factors such as population size, urbanization, standard of living of the inhabitants, and the aesthetic standards of the people among others that are concerned with measuring standard of waste generation rate for a given area (Sunday, 2013). Besides there are such factors as proximity to disposal sites, accessibility, transportation facilities, street layout, nature of waste and disposal methods affects the per capital rates of waste generation for a given municipality. In Egypt, a study carried out on waste generation estimated it to be about 10 million tons per year (Dorrah, *et al.*, 2004). This estimate was based upon a per capita generation rate of 0.3kg/day in rural areas and 0.8kg/day in urban areas. The study was based on the assumption that 60 percent of Egyptian population live in rural areas, while 40 percent live in urban areas.

The waste generated by a population is primarily a function of the people's consumption pattern and thus, of their socio-economic characteristics (Alabster, 1995). At the same time, waste generation is conditioned to an important degree by people's attitudes towards waste, their patterns of material use and waste handling, their interest in waste reduction and minimization, the degree to which they separate wastes and the extent to which they refrain from indiscriminate dumping and littering. He further stated that people's attitudes influence not only the characteristics of waste generation, but also the effective demand for waste collection services, in order words, their interest in and willingness to pay for collection services. Attitudes may be positively influenced through awareness-building campaigns and educational measures on the negative impacts of inadequate waste collection with regard to public health and environmental conditions, and the value of effective disposal. Such campaigns should also inform peoples of their responsibilities as waste generators and of their rights as citizens to waste management services.

While attitudes towards waste management may be positively influenced by public information and educational measures, improved wastes handling pattern, can hardly be maintained in the absence of practical waste disposal options. Awareness-building measures should therefore be ordinate with improvements in waste collection services, whether public or community-managed. Similarly, people's waste generation and disposal patterns are influenced by those of their neighbours. A collective logic is involved, because improved waste handling practices will only yield significant environmental impacts if most households in an area participate in the improvement. Thus besides general awareness, improved local waste

management depends upon the availability of practical options for waste collection and a consensus among neighbours that improvements are both important and possible.

Finally, industrial establishments present special problems regarding waste collection and disposal patterns due to the volume and the occasionally hazardous nature of the generated wastes. Regulation and control measures should be employed as far as possible. However, these measures are seldom very effective when as is often the case large numbers of small industrial establishments are scattered throughout residential and semi-residential areas. Problem awareness, reliable service options and consensus are crucial to improving waste generation and disposal patterns of industrial enterprises.

**Table 1: Estimated and projected volumes of solid waste generated in some Nigerian cities in tone per year**

Urban Area	1982	1985	1990	2000
Lagos	625,395	681,394	786,071	988,081
Ibadan	305,823	322,224	440,956	559,882
Kano	319,935	348,580	402,133	535,186
Onitsha	242,240	263,929	204,477	386,593
Port-Harcourt	210,934	229,821	265,129	352,853
Jos	99,871	11,905	135,272	197,990
Warri	67,477	75,602	91,396	133,531
Gusau	44,488	48,471	57,24	79,835
Potiskum	15,434	16,816	19,399	20,923
Suleija	9,383	10,514	13,311	21,336

*Source: Federal Ministry of Housing and Environment: the state of Environment in Nigeria Monograph series no. 2 Lagos.*

From Table 1 above, it can be seen that as the urbanization and modern standard of living increases, the rate at which waste are generated also increases, thereby constituting a much greater burdens. Solid waste collection may be in street alleys from building with or without return of storage containers or carriage from the building in separate containers. In general, those methods requiring the least labour by the collection crew will be least expensive. However there are communities with existing collection system such as compactor trucks, self-loading trucks for use with mobile containers, among others. Open trucks are not recommended for routine

collection of waste, they are for use primarily in the collection of bulky items which will not fit into ordinary compactor truck (Parker and Steve, 1997). The refuse trucks only need to go round the district roads collecting all wastes disposal in collection points. According to Oyalayo (2000) about 80% of the total cost of managing wastes goes into the collection alone, much funds is spent on programmes aimed at collection and by the time the waste gets to the dump site, there is bound to be duplicated expenditure. Proper wastes collection is important for the provision of public health and safety and environmental quality. It is labour intensive activities accounting for approximately three-quarters of the total cost of refuse collection involved. Public employees are given the task, but sometimes it is more economical for private companies to do the work under contract to the municipality or for private collection to be paid by individual households' owners.

According to the national development plan (1975-80), refuse disposal as environmental component is one of the most important factors affecting human health and environmental quality of human settlement. However, the methods of collecting and disposing of human waste and households refuse are grossly inadequate and inefficient. This constitutes grave health dangers for the inhabitants. If waste generation is gathered quickly there would be no accumulation hence no abuse and pollution of the environment. It is against this background that (Heeranum, 1995), suggested that, for the collection of solid waste containing garbage, the maximum period should not exceed the following: the normal time for the accumulation of the amount that can be placed in containers or dust bins of reasonable size; the length of fly-breeding cycle which during hot periods is less than seven (7) days; the time it takes for garbage to putrefy and emit offensive odour under normal storage conditions.

### **Treatment and disposal system of waste**

Waste disposal is the final treatment given to waste in order to make it stable and environmentally friendly (American Society of Civil Engineering, 2000). The term waste disposal also means the collection, storage, transportation and final disposal of waste. Waste disposal services are highly expensive and as a result are not always provided, especially in most developing countries. The several methods by which waste could be disposed include: open dumping, land filling, incineration, swine feeding, on the site, pyrolysis and composting. These are as explained thus: Open dumping is done in areas located on the outskirts of a town where solid wastes are dumped and allowed to remain exposed to the atmosphere, rodents and rats (Joseph *et al.*, 1998).



Open dumps is not an acceptable method of waste disposal because of its environmental problems though it is the most prevalent method of waste disposal especially in rural areas of developing countries because of its cheap nature. The probability of ground water contamination is especially high at these sites (Henstock, 1993).

Land filling has been defined as a method of disposing of solid waste on land without creating nuisance or hazards to public health (Jones and Wild, 1992). Land filling also involves depositing of solid waste in layers about two meters thick, compacting it and covering it immediately with such stable materials as laterite, sand, ashes and cinder (American Society of Civil Engineering, 2002). Land filling is sometimes called waste burial method and has been described as one of the best method of solid waste disposal and has been described as one of the best method of solid waste disposal (Macalla *et al.*, 1999). By applying the principle of engineering, the waste can be confined to the smallest practical volume and covered with a layer of earth at the end of each day's operation or as such frequent intervals as may be necessary. Land filling consists of four operations namely:

- a. The wastes are dumped in a controlled manner in a prepared portion of the site.
- b. The wastes are covered daily with the layer of earth.
- c. The wastes are spread and compacted in thin layers.
- d. The covered materials are compacted daily.

Land filling has been found to have a number of advantages over open dumping. Though, it is quite costly and hardly practiced commonly among the people in urban areas.

Incineration is a high temperature pre-treatment process that helps to reduce the original volume of solid waste effectively by 80% (Oruambo, 1990), if the waste has high organic and low moisture content. A high temperature of about 76% is required to prevent smoke and odour, which result from incomplete combustion. Efficient incineration process requires that air quality and air pollution control devices be put in place (Parish and Brooks, 1995). The advantages of incineration are: a small land is required, the possibility of locating the incineration centrally, thus halving transport cost, volume reduction and production of stable residues. Its disadvantages include the high operating cost, the need for continuous maintenance, the difficulty of keeping collected refuse dry in wet weather, the need for further disposal of the residues normally by land filling since its volume and weight is

greatly reduced and most plant nutrients in the refuse are lost, the residues are of negligible agricultural volume. Its major disadvantage is the contamination of the atmosphere with obnoxious products that the process produces during combustion.

Swine feeding is a process whereby swine are fed with garbage. Various studies have shown that the method is the profitable one. The consequences of the method is however the possibility of the outbreak of vascular exanthema among farm animals which may result in substantial economic loss. But if the need arises, the garbage may be cooked before feeding the swine as practiced in United States of America (Fife, 1993). On the site is a kind of household disposal method aimed at reducing the cost of solid wastes collection by reducing the volume that must be handled at central disposal sites. Home incinerators and garbage are the mostly widely used methods. Gas fired or electricity heated combustion chambers are the most common home incinerators used in burning solid waste under controlled condition within building. Garbage portion of the waste can be processed by grinding in machinery called flushing plant for the disposal. Mostly domestic grinders are permanently installed in the drains of the kitchen sinks (Fife, 1993). Household and communities which have installed grinders can reduce the frequency of waste collection because all easily spoiled refuse is ground and flushed away.

Pyrolysis is another high temperature solid waste pre-treatment method that involves the heating of refuse under relatively low temperature in the absence of air. Pyrolysis is also known as destructive. Pyrolysis process initiates what nature does over a thousand years to produce petroleum, asphalt, wax, lubricant, tar, and other organic compounds (Ogwuru, 1995). Pyrolysis is yet to prove itself and is receiving much attention at present. Resource recovery involves obtaining some economic benefits from materials that someone has regarded as waste. It includes recycling of waste materials or conversion of waste materials to make something different. Example includes the production of pads from clothes and sleeping bags from waste foam, and production of compost from food waste. (Ogwuru, 1995).

Compositing is the conversion of the organic content of waste into manure. A soil conditioner improves the fertility and structure of agricultural soil (WHO, 1990). Composting is a biological process in which the organic content in waste is converted to usable stable materials by the action of micro-organisms present in the waste. These organisms break up the waste and convert it to compost (American society of Engineers, 2002). Composting is a

typical solid recycling process and a popular waste management alternative as communities look for ways of directing organic wastes away from rapidly filling landfills (FEPA, 1992). Compositing could be classified based on the approach by the end product could be achieved, which is on the basis of whether it is carried out in the presence or absence of air.

Limited quality of special wastes may be sealed in strong containers and carried far into the ocean where they are deposited at the bottom. But in coastal cities, the shores are always littered with refuse, which leads to flies' infestation. The pollution consequences are usually obvious. The methods should not therefore be encouraged. Sorting and pulverization are pre-treatment methods employed before composting, incineration or land filling is carried out. Sorting is simply the separation of solid waste into various homogenous components. Such separates are said to have been reclaimed if returned to their original use. Otherwise they may be modified and put to the former use or used differently. Sorting could be carried out at any point in the course of solid waste management (American Publication Work Association, 2003). By pulverization, domestic refuse is pressed into high density bales thus allowing a neat, building block pattern of land filling disposal method. In Nigeria, one of the most pressing problems facing our cities at present is the disposal of huge quantities of solid waste, which accumulates in our urban areas a by-product of modernization. Until very recently, Nigeria was not much concerned with solid waste disposal. Our concern is just the physical removal of waste from streets. It has been and is still common practice in the country to dispose solid waste by the cheapest method such as open dumping and/or uncontrolled burning. But with an increasing population and a rapid urbanization, our solid waste is piling up faster than we can find satisfactory places to put them. Besides the changes in total quantity, the composition of our solid waste has changed, both which have compacted the problem of satisfactory disposal. What come readily to mind in relation to the complication are the thrown away containers which are difficult to handle in the traditional disposal processes. The indiscriminate dumping of vehicle scraps and disused machinery on our streets and high ways is another major source of environmental degradation (Federal Ministry of Environment, 2000).

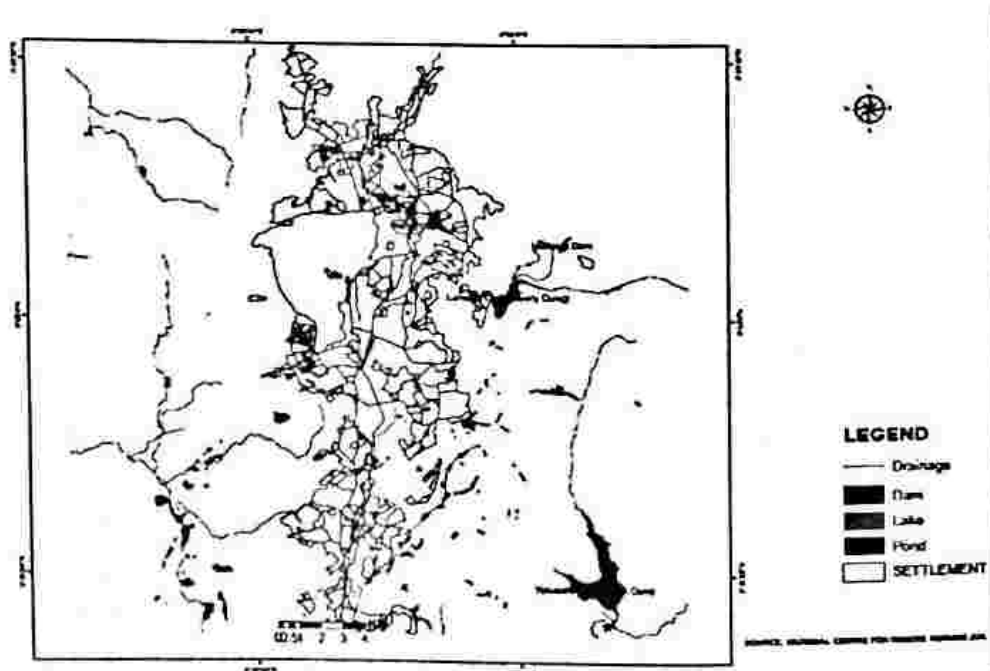
Nigerian government has initiated several environmental protection practices and programmes which include the institution of the environmental sanitation days, the promotion of waste to wealth and pursuit of specified urban action programmes for waste management as well as the passing into law of the national environmental policy. Refuse generation and

its likely effects on the health, quality of environment and the human landscape have become burning national issues in Nigeria today. All stakeholders concerned with the safety and beautification of our environment have come to realize that the negative consequences of uncleared solid human wastes found in residential neighborhoods, markets, schools, and central business districts in our cities. These solid wastes have become recurring features in our urban environment. It is no longer in doubt that our cities are inundated with the challenges of un-cleared solid wastes. As a result, urban residents are often confronted with the hazardous impacts to their collective health and safety.

## **MATERIALS AND METHODS**

### **Study Area**

The Jos city is located in Nigeria's middle belt region, with an area of about 26,899 square kilometers; it has a population of about 850,000 people based on the result of 2006 Nigerian census figures. It is located between latitude 8° and 10°N, Longitude 7° and 11°E. It shares boundary with Barkin-Ladi in the southeast, Jos South and Riyom in the southwest and Bassa in the north (Plateau State Ministry for lands, survey and town planning). The State is named after the picturesque Jos Plateau, a mountainous area in the north of the state with captivating rock formations. The area has bare rocks that are scattered across the grasslands, which cover the plateau. The altitude ranges from around 1,200 meters to peak of 1,829 metres above sea level. Years of mining have also left the area strewn with deep gorges and tales (Blench *et al.*, 2003).



**Figure 2: Map of Jos metropolis**

### **Data Collection**

The primary data for this study were obtained directly from the field through observation, field surveys and use of questionnaire. The questionnaire was designed to collect information on various aspect of the study. Section 'A' contains bio-data of the respondents; section 'B' contains information on the general assessment of PEPSA. The population of the study is the aggregate of the total number of the people in each of the four selected wards. Hence, a total of 3,344 people formed the sample population of the study (National Population Commission, 2011). The sample size selected is a percentage of the total number of people in Naraguta B, Jenta Adamu, Jenta Apata and Tudun-Wada Kabong Wards. Hence, 10% of the people were selected each from Naraguta B, Jenta Adamu, Jenta Apata and Tudun-Wada Kabong Wards using a simple Random Sampling to get the sample size of the study. A total of three hundred and thirty-five (335) questionnaires were administered, out of which two hundred and eighty (280) were returned.

### **Statistical Analysis**

Data obtained was analyzed using descriptive statistics.

## **RESULTS AND DISCUSSION**

**Table 2: Waste Generation Information**

SN	VARIABLE	CLASS	SCORE	PERCENTAGE (%)
1	Type of landuse	Residential	245	87.5
		Cominercial	33	11.8
		Industrial	0	0
		Others	3	0.7
2	Living Duration	1 - 5 years	157	56
		6 - 10 years	60	21
		11 - 15 years	47	16
		16 and above	16	6
3	Types of waste generated	Ashes	117	42
		Garbage	87	31
		Rubbish	31	11
		Others	45	16

**Table 3: Sources of wastes and nature of disposal**

S/N	VARIABLE	CLASS	SCORE	PERCENTAGE (%)
1	Source of waste generation	Farm products	23	8
		Domestic Activity	213	76
		Others	44	16
2	Refuse disposal	Open space	92	32.8
		Backyards	79	28.2
		Drainage	38	13.6
		Others	71	25.4

Source: Field Work, 2012

Analysis in Table 2 showed that most of the areas where this study was carried out were mostly residential houses constituting about 87.5% of the respondents while 11.8% for commercial purposes. Further analysis also shows that 56% of the respondents confirmed that they have lived there for about 5 years. Others 6–10 years (21%), 11–15 years 27% while 16 years and above are 6%.

On the type of waste generated, investigations carried out showed that most of the waste generated were ashes (42%). This could be attributed to the fact that most wastes were burnt. Next is garbage (31%), followed by others (16%) and the least was rubbish (11%). Table 2 also shows that most of the respondents are using plastic containers representing about 23.2%. Metal containers were also found in some areas representing about (33%). This could also be attributed to the fact that the activities of PEPSA is more pronounced in Jenta Apata where some of their metal waste bins are found as shown in the ward by ward analysis.

Table 3 further showed that most wastes generated were from domestic activities with (76%). This high percentage further agreed with the findings that most areas were for residential purposes. This was followed by other activities with 16%, and only 8% were farm products. This can also be seen in Jenta and Tudun-Wada Kabong in the ward by ward analysis.

Finally, Table 3 showed that most wastes were disposed openly constituting (32.8%) of the respondents while those who disposed at the backyards (28.2), drainage (13.6%) and others (25.4%). The indiscriminate dumping of this refuse seems to buttress the research position that enough waste bins are not provided at specific points/ locations by the authorities in Jos city.

awareness campaigns, public lectures to ensure a better way to live. Any sanitation or beautification exercise should ensure the removal of refuse heaps and reduction of their offensive odour emanating from un-cleared solid wastes. Invoking the Clean Air and Health Acts of 1964-68 are crucial in terms of making waste reduction a daily routine in our societies.

## **RECOMMENDATIONS**

- i. The efforts of the government agencies like Plateau Environmental Protection and Sanitation Agency (PEPSA), Ministry of Environment, and all those in charge of waste management should focus on how to improve the prevailing conditions and sharing decision making process, with individuals, neighborhood group and organizations at the grass roots level in Jos city.
- ii. Greater participation of individuals, families and the populace should be achieved through mobilization and education. They should be involved in all deliberation and activities connected with all aspects of solid waste management within their environments.
- iii. Privatization and/or combination of both privatization and commercialization must be embarked upon. Also levies must be imposed on all residential polluters towards meeting the cost of wastes generated, collected, transferred and disposed. The actual collection, processing and management should be handled by licensed private firms rather than by only quasi-public agencies.
- iv. The attitudes of individuals and the general public needs to be changed to accept the fact that good waste management practices and clean environment guarantee the quality of life for all towards ensuring sustainable development including the quality of the environment than sticking to the belief that government can provide everything even when the resources are not available.
- v. Plateau Environmental Protection and Sanitation Agency (PEPSA) should be as a matter of urgency encourage individual, public and private partnership in solid waste collection, transfer and disposal in Jos city. Also roads should be constructed and rehabilitated particularly in high populated areas.
- vi. The promotion of formalized recycling or use of solid waste materials by such modern devices as composting and generation of methane through anaerobic decomposition should be encouraged. Incinerators should be built or constructed at every collection point to minimize

**Table 4: Waste management pattern in Jos**

Waste Disposal	No. of respondents	Percentage (%)
Open dumping	70	25
Land filling	50	17.9
Incineration	40	14.3
Swine Feeding	10	3.6
On the site	25	8.8
Pyrolysis	5	1.8
Composting	10	3.6
Recycling	5	1.8
Dumping in water	55	19.6
Sorting/pulverization	10	3.6
Total	280	100

Source: Field work, 2012

From Table 4 twenty-five percent (25%) of the respondents said they dump their wastes indiscriminately in any available open space as their own management method while over 19% dump theirs in a water system, thereby polluting the soil and water and posing very grave risk to man, plant and animal life. Over 17% resorts to usage of wastes in filling eroded land and about 14% use incineration method as means of managing the wastes they generated within the households and 3.6% resort to composting and outright burning which is equally detrimental to human health and the ozone layer. Over 32% on the other hand are said to be using a more appropriate and environmentally friendly methods of land filling, swine feeding, on the site, pyrolysis recycling and sorting and pulverization within the Jos city leaving the majority with the options of polluting the environment, defacing the ambiance of the city and creating heaps of waste mountains here and there.

## CONCLUSION

The analysis of the survey carried out in the study areas have shown that most areas of the Jos Metropolitan environment is dirty due to open dumping and burning of refuse which makes it possible for many potential vector breeding places, eye-sore to public, odour in the immediate environment and environmental degradation. The issue of reduction of solid wastes from our cities has remained a major challenge to urban beautification and safety of the entire urban landscape. There must be put in place a concerted approach to waste avoidance, minimization and reduction through modern methods of waste management and disposal using the right mix of strategies to enhance sustainability of a clean environment, better living conditions through



open dumping and burning of solid wastes. In addition, promotion of segregation of waste materials at the source and streamlining the operations of the waste pickers (scavengers) through proper training, upgrading of techniques and the requisites health protection should be embarked upon.

- vii. In addition, effective penalties must be invoked and culprits punished, so that the enforcement of proper practices are not left to area wide waste management authorities alone. An effective chain in the cycle of timely clearance to designated landfills, dump sites, for incineration, compacting and composting should be integrated into energy and the land reclamation schemes envisioned in the future.
- vii. Finally, it is recommended that further research should be conducted covering areas that were not covered during the survey due to time and security reasons in order to validate this very study. There is the need to explore in more detail and widely too, methods and techniques to improve the solid waste management situation in Jos and in Nigerian cities as a whole. This has the promise of tackling the increasing scale of solid waste management in Jos city and in Nigeria as a country.

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