Sustainable Solid Waste Management in Abuja Phase I: An Assessment of Current Practices and Roadmap for Improvement

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Abstract— Waste management is a critical issue in urban areas, and Abuja phase one is no exception. This study aims to assess the current waste management problems in Abuja phase one and propose viable solutions. The assessment reveals that the Abuja Protection Board collects approximately 52.6% of the waste generated in Abuja phase one. Indiscriminate dumping accounts for 12.6% of waste disposal practices, while 5.1% of waste is attributed to open dumping in burrow pits. Similarly, 3.2% of waste is disposed of in open spaces. One of the key challenges identified is the lack of public awareness regarding proper engineered land disposal techniques. The waste generated in Garki and Wuse, two prominent areas of phase one, is particularly high due to the presence of commercial and administrative activities. These findings emphasize the need for urgent action to address the inefficient waste management practices in the area. Abuja phase one generates a substantial amount of waste, with a monthly average of 290.163 tons and an annual estimate of 731,210.8 tons. The magnitude of waste generation necessitates the implementation of comprehensive and sustainable waste management strategies to ensure the preservation of the environment and public health. To overcome these challenges, it is imperative to implement a comprehensive waste management that encompasses efficient waste collection.

Keywords: waste management, disposal, generation.

I. INTRODUCTION

Solid waste management is a pressing issue in many urban areas, and Abuja, the capital city of Nigeria, is no exception. As the city experiences rapid population growth and urbanization, the generation of solid waste has become a significant concern. The improper handling and disposal of solid waste can lead to numerous environmental and health problems. Piles of waste are often found by roads, rivers, and many other open spaces in cities, and this is causing significant health and environmental problems. (A. Imam et al., 2008). While East Asia and the Pacific region currently produce most of the world's waste, Sub-Saharan Africa, South Asia, the Middle East, and North Africa have the largest growing rate of waste in the next three decades with economic growth and urbanization (Ajantha S K and Asankha P, 2020). A UN-Habitat report cited by (Maton, D.J., Kigun, P.A and Ogalla, M, 2016) observed that Africa is the fastest urbanizing continent having cities like Cairo, Lagos, Nairobi, Kinshasa amongst others, with growing fast rates that would make them triple their current sizes by the year 2050 (UN-Habitat, 2010).

Nigeria being a third-world country with so many emerging urban centers as a result of population increase has been battling with the issues of sustainable waste management, while waste dump sites have the capacity to pollute the underground water (Efe, 2014). According to a solid waste urban Report, the Nigerian population is increasing by about 2.8% per annum, the rate of urban growth is as high as 5.5% per annum (UDBN, 1998). The urban population is growing at an alarming rate and has implications on solid waste management among other social issues.

Therefore, it is vital to assess the current state of solid waste management in Abuja and formulate effective solutions to tackle this issue. This paper aims to explore the problems associated with solid waste in Abuja with emphases to phase 1(one), with a view to identify the underlying causes, and propose sustainable solutions to ensure a cleaner and healthier environment for the city's residents. By addressing these challenges head-on, we can pave the way for a more sustainable and greener future for Abuja.

II. BEST PRACTICES IN SOLID WASTE MANAGEMENT

Solid waste management could be referred to as, "The application of techniques that ensures the orderly execution of the functions of collecting, transfer, processing, treatment, and disposal of solid wastes (Onu, Price, Surendran and Ebie as cited in Mudiare, Folorunsho, Abdulkarim and Onaolapo, 2016)". According to (Mudiare, Folorunsho, Abdulkarim, and Onaolapo, 2016) some solid waste management strategies (open dumping, burning, and burying) adopted by a majority of households in Tunga, Minna, Niger State, Nigeria were found to be ineffective and unsustainable because the strategies are not in line with

global solid waste management best practices. Participatory involvement in waste management in developing nations is likely to be helpful in bridging the gap created by local authorities' inability to deal with solid waste management challenges (Gunsilius and Chaturvedi, 2011) as cited in (Brotosusilo, Nabila, Negoro and Utari, 2020). Individuals and informal business enterprises gladly collect waste in order to create a [i]conducive environment (Brotosusilo, Nabila, Negoro and Utari, 2020). This implies that participatory approach to solid waste management can be an alternative tool in addressing solid waste management issues in the developing countries. It is usually practised in areas or regions where solid waste official threshold services have not been able to cover (Brotosusilo, Nabila, Negoro and Utari, 2020). In dealing with any waste management issue, attention should be given to key fundamental elements such as public awareness and participation, appropriate legislation, strong technical support, and adequate funding (Brotosusilo, Nabila, Negoro and Utari, 2020). In addition, encouraging private sector participation in solid waste management, public enlightenment about the significance of making our environment conducive on the means of

Minimizing waste generation at the source, recycling of waste materials and improved funding for solid waste management agencies are among the effective alternative best practices that may enhance solid waste management in developing countries (Mudiare, Folorunsho, Abdulkarim and Onaolapo, 2016). According to (Seow, Muhamad, Sulzakimin, Goh and Rozlin, 2017), policy promotion, staff capacity building and stakeholders' participation in decision-making process are some of the key indicators of good governance in solid waste management. They argued that staff training of personnel should be focused on their job description because such a sector specific approach to capacity building usually brings about more robust results. Furthermore, a research on Integrated Solid waste management in Abuja, by (Maton, D.J., Kigun, P.A and Ogalla, M, 2016) shows that effective solid waste management strategies largely depends on the perspective of waste generation, collection and disposal. The results show that; non-sorting and bagging at collection stage; poor machinery and lack of environmental regulations are some of the major challenges of effective solid waste management. The study recommends improved infrastructure, workers remuneration, change of schedule and punitive measures to the existing laws to protect the environment from defaulters who indiscriminately throw waste

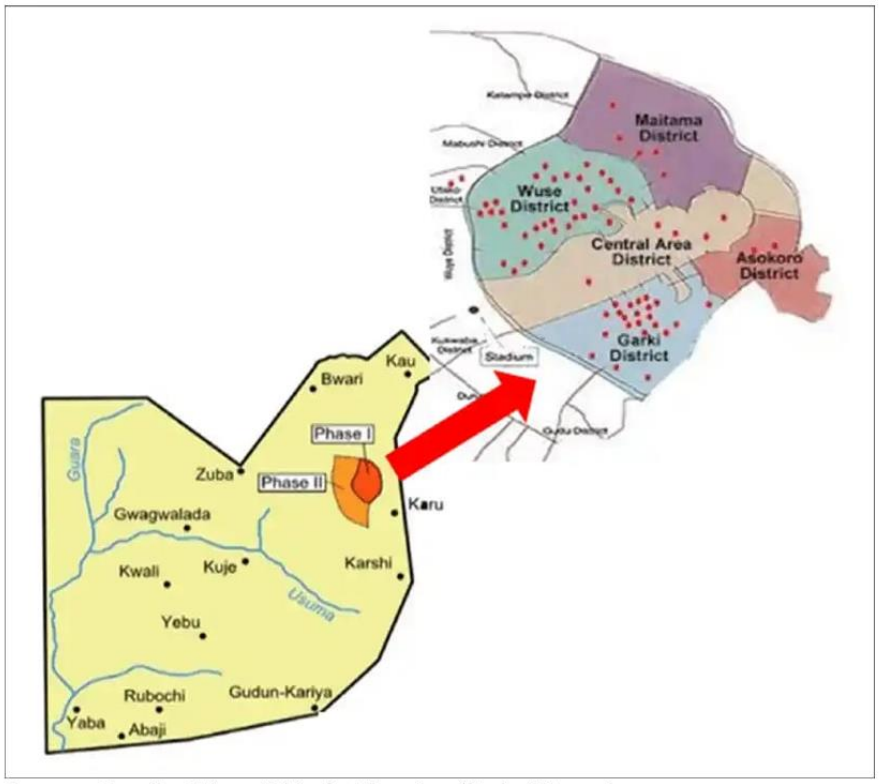
III. REVIEWS OF SIMILAR LITERATURE

S/NO	TOPIC	AUTHORS	GAP	FINDINGS
1.	Solid waste management challenges for cities in developing countries.	Lilliana Abarca Guerrero, Ger Maas and W. Hogland	The study identifies stakeholders' actions/behavior that play a part in the waste management process in over thirty urban locations across 22 developing nations on four continents.	The study recommends a comprehensive analysis on stakeholder's involvement in waste management
2.	Household waste disposal mechanisms in Sri Lanka: Nation-wide survey evidence for their trends and determinants	A.S. Kumara and A. Pallegedara	The study provides empirical evidence from Sri Lanka on trends and factors of trash disposal strategies at the household level during the last decade from 2007 to 2016.	The study reveals that burning and dumping waste within the premises are preferred by households.
3.	Integrated Solid Waste Management: A Palliative to Existing Waste Management Challenges in Jabi-District, Abuja	Maton et., al	The report provides a qualitative assessment of solid waste management practices in Abuja's Jabi district.	(1) Poor/inadequate infrastructure and machinery (2) Non-sorting and bagging

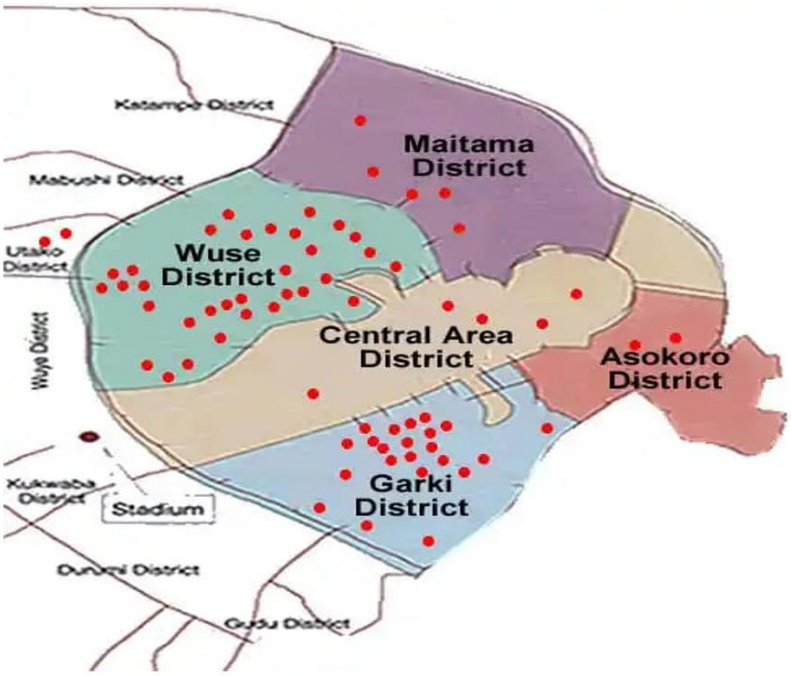
				(3) Lack of environmental regulations
4.	sustainable waste management strategies in emerging urban centers: a case study of Warri urban area, delta state Nigeria	Ekokobe Emmanuel Efe	The goal of the study is to propose a solution to the waste management problem in Warri Delta State.	It was discovered that improper dump sites, burning, and indiscriminate dumping the rule of the day, with severe negative health and environmental consequences for residents.

IV. THE STUDY AREA

Abuja, the capital of Nigeria, is in the middle of the country. The city's skyline is dominated by Aso Rock, a gigantic monolith that was mostly constructed in the 1980s. It ascends behind the presidential residence and offices of Nigeria, which are situated in the Three Arms Zone on the eastern outskirts of the city, in the Presidential Complex. Close by are the National Assembly and the Nigerian Supreme Court. Abuja, the capital of Nigeria, is the location of almost all federal ministries, parastatals, and organizations. Abuja has a land area of 1,769 km2 and is 360 meters above sea level. There were 403,000 residents there as of a 1999 estimate. Abuja is divided into three sections: phases 1 and 2, and phase 3. The research area, which is phase 1, is covered by five areas, which include the Central Area, Garki, Wuse, Maitama, and Asokoro.



Source: Google: Map of Abuja Showing Abuja Phase 1



Source: Google: MAP OF ABUJA PHASE 1

THE ABUJA ENVIRONMENTAL PROTECTION BOARD (AEPB) IS IN CHARGE OF SOLID WASTE MANAGEMENT IN THE CITY. IT IS RESPONSIBLE FOR:

- Domestic, commercial, and industrial garbage should be removed, transported, and disposed of.
- Clear and maintain public drainage infrastructure, as well as clean streets and remove abandoned automobiles.
- Register non-public waste collection businesses.
- Prepare and keep the city's master trash collection and disposal strategy up to date.
- Approve and monitor all disposal systems in the city.
- Examine recycling as a waste management alternative for companies and governmental bodies.
- Establish and recommend the basic standard requirements for solid, liquid, gaseous, or toxic waste management, as long as they do not conflict with, but rather complement, the FEPA criteria.
- Establish and recommend appropriate safe collection and disposal techniques for hazardous and toxic waste materials in the FCT.
- Educate the general population about the many acceptable disposal methods for household and industrial waste materials.
- Introduce environmental legislation and keep existing legislation up to date with the newest discoveries and observations on the subject.

- Organize and mobilize the public to actively participate in regular clean-up exercises and beautifying of their surroundings.

V. METHODOLOGY

The study employed a mixed method approach combining qualitative research and gathered secondary and primary data from existing literature as well as individuals. The survey was limited to the following: Site visits and observation, questionnaire administration as well as focus group discussion with residents of the community and the relevant Authorities; For questionnaire administration, the areas were further divided into districts within the Abuja phase one (1). These districts include Wuse, Asokoro, Central Area, Garki, and Maitama; A systematic random and stratified sampling technique was applied in the selection of residents (respondents) for questionnaire administration; A total of 280 questionnaires were administered randomly to each of the 5 districts making a total of 1400 questionnaires. 201 questionnaires were retrieved from Wuse while 198 questionnaires were retrieved from Garki. Asokoro 182 and 192 questionnaires from Central Area and 171 from Maitama, making the total number of retrieved questionnaires to be 944. The questionnaires for this study was primarily designed to obtain information from relevant Agencies responsible for waste management in the various Districts; obtaining information from households in the area on methods of solid waste disposal and the challenges faced; obtaining information from community heads or their representatives and other stakeholders on their level of satisfaction with waste management practices in the community; descriptive and analytical methods were employed in analyzing the data obtained from the presentation of the survey work by the group members.

V.I. DATA ANALYSIS AND RESULTS

This chapter deals with the analysis of data. The data collection tool administered by the researcher is a set of questionnaires. The data is collected from Abuja Phase one (1) covering

Asokoro, Maitama, Wuse, Garki, and Central Area with a total of 380 respondents included in the overall data collected.

V.II. SOCIO-DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

Table 1: sex of respondents

Table 1 reveals that 58.47% of the respondents are female whereas the male constitutes 41.52%. This implies that female mostly engage in domestic waste management when compared with their male counterparts. The reason for this is the cultural belief in most African societies that females are responsible for most domestic activities.

Table 1

SEX	**FREQUENCY**	**PERCENTAGE**
Male	392	41.52
Female	552	58.47
Total	**944**	**100**

Source: Authors Field Work

Table 2: duration of respondents' resident in the area

Table 2 reveals that 20.9 % of the respondents spent less than one year in the area due to rural urban migration, 18.9 % spent 1 – 2 years, 5.1% spent 3 – 4 years, 19.9% spent 5 – 9 years, 20.2% spent 10 – 19 years and 14.7% spent 20 years and above. This shows that majority of the respondents spent more than five (5) years in the study area.

AGE	**FREQUENCY**	**PERCENTAGE** %
less than one year	198	20.9
1 – 2 years	179	18.9
3 – 4 years	49	5.1
5 – 9 years	188	19.9

10 – 19 years	191	20.2
20 years and above	139	14.7
Total	**994**	**100**

Source: Authors Field Work

Table 3: Educational Status of Respondents in the Study Area

Table 3 shows the educational status of respondents in the study area, it is expected that the more educated a person is, the more responsive and hygienic he/she will be thereby disposing of waste in a better way. The table shows that 34.6% of the respondents are educated up to the tertiary level, 31.8% post-secondary level, 24.1% secondary level and 9.3% primary level.

Educational Status	**Frequency**	**Percentage**
Primary	88	9.3
Secondary	228	24.1
Post-Secondary	301	31.8
Tertiary	327	34.6
Total	**944**	**100**

Source: Authors Field Work

Table 4: Occupation of Respondents in the Study Area

The Table below shows the occupation of respondents in the study area, the table shows that 15.5% of the respondents are unemployed, 23.8% are self-employed, 29.02% are into trading and 31.5% are civil servants.

Occupation	**Frequency**	**Percentage**
Civil servant	298	31.5
Trader	274	29.02
Self employed	225	23.8
Unemployed	147	15.5
Total	**994**	**100**

Source: Authors Field Work

Table 5: Orientation on Waste Management Status of Respondents in the Study Area

Table 5 shows whether respondents have ever been educated on proper waste management disposal or not. 41.4% were opportune to be educated while 58.5% were not as such calls for proper awareness on waste management.

educated on proper waste management disposal	**Frequency**	**Percentage**
Yes	391	41.4
No	553	58.5
Total	**944**	**100**

Source: Authors Field Work

Table 6: Waste Type Generated after Sorting

Table 6 shows the disposal methods of generated wastes in the study area. It was seen that illegal disposal is common in the study area. Piles of solid wastes are often found along roads, underneath bridges, in culverts and drainage channels and in other

open spaces. From Table 7, it can be clearly seen that 0.634% waste consist of paper and carton, 6.405% are plastic, 71.9% are food waste and 7.199% are glasses

Waste Type	Approximate Volume (Kg)	Percentage of Total Waste after sorting
Paper and Carton	8768	0.634
Plastics (Bags and Bottles)	87966	6.405
Food waste	987456	71.9
Tins and Cans	8757	0.638
Fibre bags	85867	6.252
Glasses	98874	7.199
Others	95679	6.967
Total	**1,373,367**	**100**

Source: Authors Field Work

Table 7: Disposal Methods

The result from Table 7 reveals a multi-faceted but organized system of waste disposal in the study area. It shows that 5.1% of the respondent's dispose of their waste through burrowed pits/ backyard this is mostly experienced in places where there is high residential and commercial activities like Garki, 10.4% through burning, 12.6% through indiscriminate dumping, the presence of waste management is evident in most of the areas at 34.5% and 16.10% takes it to designated points. Scavengers have 22.1%

Disposal Method	Frequency by Number	Percentage%
Burrowed pit/ backyard	49	5.1
Burning	99	10.4
Indiscriminate Dumping	119	12.6
Collected by waste manager	316	34.5
Taken to designated points	152	16.10
Collected by scavengers	209	22.1
Total	**944**	**100**

Source: Authors Field Work

Table 8: Frequency of Waste disposal by respondents

Table 8 reveals that majority of respondent dispose of waste either daily (20.9%), weekly (20.3%), or every two to three days (19.2% and 18.1% respectively). Less frequent disposal occurs among 16.1% (Every two weeks) and 5.1% (other/less frequent) of respondents

Frequency	Frequency by Number	Percentage
Daily	198	20.9
Once in two days	182	19.2
Once in Three days	171	18.1
Once a week	192	20.3

Once in two weeks	152	16.1
Others	49	5.1
Total	**944**	**100**

Table 9: Showing Waste Generated by Location

Table 9 shows that Garki and Wuse generate the most waste due to the presence of commercial and administrative activities in the areas around working hours, followed by Maitama., Asokoro and Central area, which is a mix of administrative, commercial, and residential activities.

LOCATION	NO OF TRIPS	TRUCK VOLUME	VOLUME	TONNES
ASOKORO	4	56	156	35.571
MAITAMA	8	56	208	48.672
WUSE	7	116	348	89.856
GARKI	10	107	400	93.6
CENTRAL AREA	2	48	96	22.464
TOTAL	**31**	**383**	**1208**	**290.163**

Source: Authors Field Work

Table 10: Showing the Estimated amount of waste generated (Tonnes)

Table 10 shows the amount of waste generated per district. The result shows that Wuse and Garki generate the highest amount of waste due to the presence of commercial and administrative activities. Abuja phase one (1) generates an estimated amount of 60934.23 monthly and 731,210.76 tonnes of waste annually.

LOCATION	EXISTING	ESTIMATED WASTE GENERATED IN A WEEK	ESTIMATED WASTE GENERATED IN A MONTH	ESTIMATED WASTE GENERATED IN A YEARLY
ASOKORO	35.571	248.997	7469.91	89638.92
MAITAMA	48.672	340.704	10221.12	122653.44
WUSE	89.856	628.992	18869.76	226437.12
GARKI	93.6	655.2	19.656	235.872
CENTRAL AREA	22.464	157.248	4717.44	56609.28
TOTAL	**290.163**	**2031.141**	**60934.23**	**731,210.76**

V.III. PROBLEMS OF SOLID WASTE IN ABUJA PHASE ONE (1)

The city of Abuja is facing numerous issues when it comes to solid waste management. These problems include Indiscriminate Disposal (21.3%): One major challenge is the improper and random disposal of solid waste. Many residents do not follow proper waste disposal practices, leading to the accumulation of waste in unauthorized areas. Encroachment of Central Refuse Collection Point (9.9%): Another issue is the encroachment of the designated central refuse collection points. These areas are meant for organized waste collection, but unauthorized structures or activities often hinder their proper functioning. Frequency of parking (12.6%): The frequency of waste collection and disposal is a concern. Inefficient waste collection schedules lead to overflowing bins and unattended waste, causing health hazards and deterioration of the overall environment. Deviation from Approval Site (11.7%): Sometimes, waste is disposed of in locations that are different from the approved sites. This leads to a lack of

coordination in waste management efforts and creates difficulties for waste management authorities to maintain an efficient waste disposal system. Poor Infrastructure (8.9%): Insufficient infrastructure for waste management, such as inadequate waste transfer stations, landfill sites, and recycling facilities, contributes to the solid waste problem in Abuja. Without proper infrastructure, effective waste management becomes challenging. Lack of Sorting (8.7%): The absence of proper waste sorting facilities and practices results in mixed waste being disposed of together. This makes recycling and resource recovery difficult and reduces the overall effectiveness of waste management efforts. Proximity from Waste Disposal Point (10.8%): The distance between residential areas and waste disposal points can present a challenge. If these points are located far away, it often leads to illegal dumping or inefficient waste transportation, increasing the burden on the existing waste management systems. Lack of Orientation (15.9%): Many residents may not have sufficient knowledge or awareness about proper waste management practices. This lack of orientation can contribute to the mismanagement of waste, further exacerbating the solid waste problem in Abuja. Addressing these issues requires a comprehensive approach that involves raising public awareness, improving waste collection and transportation systems, investing in infrastructure development, implementing proper waste sorting practices, and ensuring strict enforcement of waste management regulations. Collaboration between the government, waste management authorities, and the community is crucial to effectively tackle the solid waste problem in Abuja.

S/NO	PROBLEMS OF SOLID WASTE	NUMBER OF RESPONDENT	PERCENTAGE
1	Indiscriminate disposal	201	21.3%
2	Encroachment of central refuse collection point	94	9.9%
3	Frequency of Parking	119	12.6%
4	Deviation from waste Approval site	111	11.7%
5	Poor/inadequate infrastructure	84	8.9%
6	Lack of sorting	82	8.7%
7	Proximity to waste disposal point	102	10.8%
8	Lack of orientation	151	15.9%
	TOTAL	**380**	**100%**

VI. CONCLUSION

1. The study finds that trash management collection is present in all areas of Abuja Phase One, with the Abuja Environmental Board serving as the primary custodians of waste management in Abuja Phase One (1)
2. According to the results, the Abuja Environmental Protection Board collects 52.6% of the waste. However, indiscriminate garbage dumping accounts for 24.5% of total waste, while unlawful disposal methods such as burning and dumping in burrow pits account for 15.5% and 3.2%, respectively.
3. Waste is currently conveyed to a single poorly engineered land disposal technique due to a widespread lack of public understanding or care about waste issues.
4. According to the study, Garki and Wuse generate the most waste due to the presence of commercial and administrative activities in the areas around working hours, followed by Maitama Asokoro and Central area, which is a mix of administrative, commercial, and residential activities.
5. Abuja phase one (1) generates 290.163 tons of waste daily, 60934.23 tons of waste monthly, and 731210.8 tons of waste annually.

RECOMMENDATIONS

The following recommendations are proposed for sustainable Solid Waste Management.

1. The involvement of people and the private sector through NGOs could improve the efficiency of SWM.
2. Public awareness should be created especially at primary school.
3. Littering of Solid waste should be prohibited in cities, towns, and urban areas.
4. More so, house-to-house collection of Solid Waste should be organized
5. The collection bins must have a large enough capacity to accommodate 20 more than the expected waste generation in the area.
6. Municipal authorities should maintain storage facilities to avoid unhygienic and unsanitary conditions. Proper segregation would lead to better options and opportunities for scientific disposal of waste.
7. An open dump or an uncontrolled waste disposal area should be rehabilitated. It is advisable to move from open dumping to sanitary landfilling in a phased manner. Landfilling should be restricted to non-biodegradable, inert waste and other waste that are not suitable either for recycling or for biological processing

Image showing overflowing waste bin at Asokoro, Abuja

Central Refuse Collection point

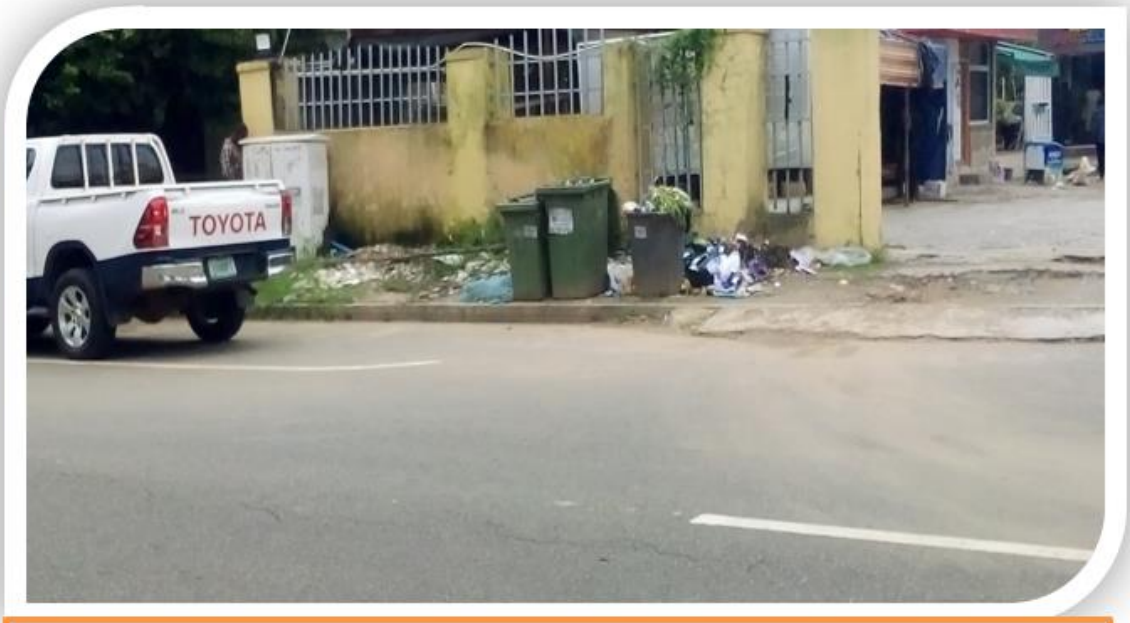


Image Showing Indiscriminate Dumping of Waste at Maitama, Abuja.

Image Showing Indiscriminate Dumping of Waste at Garki, Abuja.

Image Showing Scavenger Collecting Waste at Garki, Abuja.

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