

*Full Length Research Paper*

# **Appraisal of solid waste collection systems in Bauchi metropolis**

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**This research is mainly aimed at identifying the techniques used and the problems encountered in solid waste collection as a basis for suggesting more effective technique. Questionnaire, interview guide and observation methods were used to gather information from the sample population of the study area. Major findings revealed that though the area has up to 50% of the respondents educated to secondary level but their income level is generally low and the household size is high with teenagers dominating. About 30% of the respondents do not have storage facilities and those with storage facilities dispose of their refuse immediately it is gathered. Over 70.00% travel more than 100 m to the nearest collection centre. Also Bauchi State Environmental Protection agency is the only agency that evacuates solid waste generated in Bauchi metropolis and the collection centres are few which lead to emergence of unauthorized collection centres and large accumulation of uncollected solid waste. The research recommends that among other things, all households should possess storage facilities. A house-to-house collection method should be introduced in Government Residential Area (GRA), and Bauchi Local Government should resume evacuation of solid waste. Community effort should be integrated in the solid waste evacuation process and more collection centre should be provided.**

**Key words:** Community, appraisal, solid waste, collection, environment.

## **INTRODUCTION**

Solid wastes are unwanted or discarded materials that result from activities of man. The prompt evacuation of these waste from the dwelling units/compounds to collection centres and from the collection centres to final disposal sites is necessary for a health living environment and requires the joint effort of household members, community associations, government agencies, non-governmental organizations (NGO's) and private organizations (Oseni, 2003; Zeschmar-Lahl, 2002). UWEP (1998) observed that the management of solid waste is one of the earliest man's branches of knowledge and probably in some ways it is also one of the latest (Medina, 2005; Streese and Stegmann, 2005). From the earliest civilization removal of waste from place of residence to the countryside has always been comparatively necessary and specified by Moses as a required practice for Israel (Deuteronomy 23:12-13).

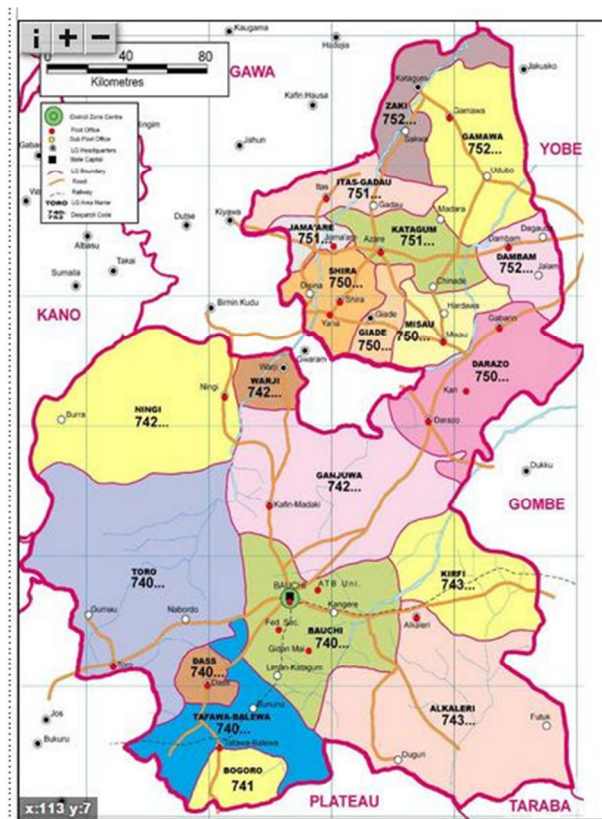
It has been and is still common practice to collect refuse by means of expedient method (Mantell, 1975),

but with an increasing population and urbanization our total quantity and the composition of our solid waste has changed and collection problems become difficult with increasing population density and changes in consumption habits because both factors increase the rate of generation (Dias, 2010; Chattopadhyay et al., 2009). The growth of cities gave birth to the development of complex land uses which subsequently lead to solid waste generation and variety, the concomitant resulting problems manifest in the form of environmental degradation which is hazardous to human health, hence the need for its effective collection (Bernstein, 2004). It should be understood that the volume of solid waste generated per se does not invariably measure the degree to which the environment will be polluted (Dong et al., 2010). Thus if the waste can be collected and disposed of, satisfactorily, and as fast it is generated there would be no accumulation and hence, no insult abuse or pollution of the environment

**Table 1.** Solid waste generation and collection by regions of the world.

Region	Average waste generation kg / Person / Day	Collection rates (%)
Africa	0.54	60.20
Arab States	0.63	64.90
Asia	0.69	67.00
Latin America	1.21	84.80
Industrialised Nations	2.10	99.40
Transitional Nations	1.30	89.50
All Cities	0.95	68.70

Source; World Bank, 2001.



**Figure 1.** Map of Bauchi showing its longitude and latitude.

(African Development Bank, 2002; American Public Works Association, 2005). It is when the collection perpetually lay behind the rate of generation that solid waste becomes an environmental nuisance (IPCC, 2003). Industrialised nations generates as high as 2.0 kg per person per day while Africa generates less than 1.0 kg per person per day (UNEP/GPA-UNESCO/IHE, 2004; United Nations, 1997), yet because the industrialised nations evacuate more than 90% of their solid waste, their cities are cleaner than African cities as shown in Table 1.

Abel (2009) and FMHand E (1983) reported that between 25-40% of the solid waste generated in Nigerian urban centres are often not collected. It is this deplorable condition in our environment that must have led Mabogunje (2001) to conclude that “Nigerian cities are reputed to be among some of the dirtiest, the most insanitary, the least aesthetically pleasing, least safe and secure and the most poorly governed cities of the world”. This gloomy picture of our cities should concern planners because it seems to be pointing at accusing fingers at environmentalists’ and planners’ failure to

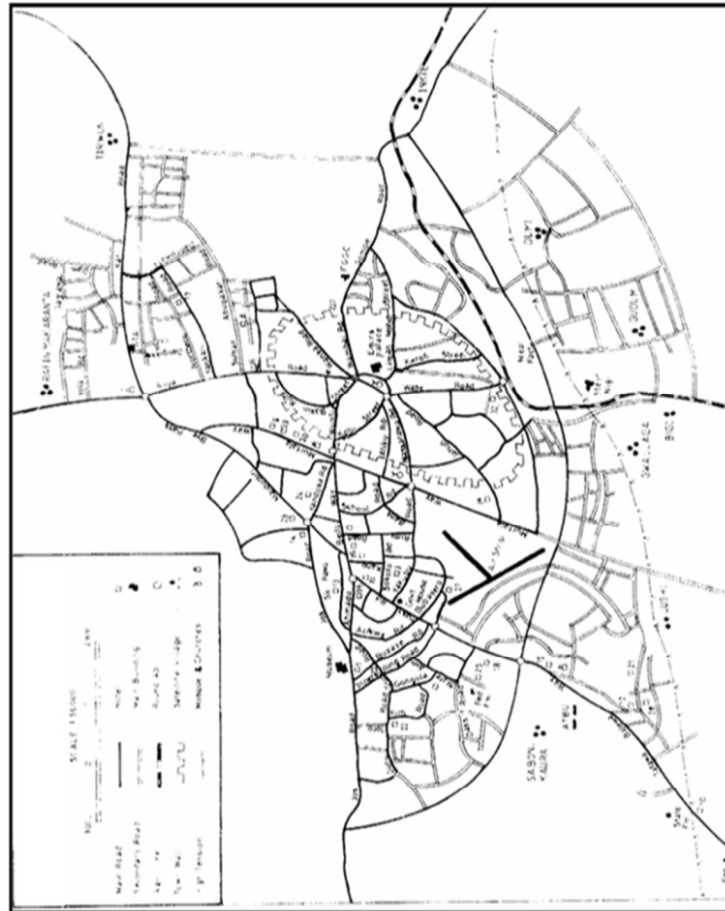


Figure 2. Map of Bauchi metropolis.

deliver functionally aesthetic and livable cities. An efficient and dynamic solid waste collection system for attaining sustainable healthy urban environment is necessary (Samson, 2009; Stegmann, 2005). It is critically expedient for promoting a safe, clean and healthy living environment where the lives of the urban dwellers would be prolonged (Falade, 2001). Its other benefit includes promotion of environmental quality, aesthetics and the enhancement of economic productivity of the people through employment and income generation. Few attempts have been made in Nigeria by public sector towards effective and appropriate collection of solid wastes since in the early 1920's to current time (Ogwueleka, 2003). All the attempts have been faulted with one form of problem or the other. Private sector has tried to fill this void, but all to no avail. Large quantity of solid waste has persistently accumulated in Bauchi metropolis which the agency responsible has failed to effectively evaluate. The collection of solid waste in Bauchi metropolis is far from been satisfactory (Bogoro, 2001). The problem is acute despite its (small) size compared to other major cities in Nigeria like Ibadan, Kano, Lagos, etc. In an attempt to tackle the problem of solid waste collection, the state

like other states of the federation is pursuing several sanitation programmes, such as Operation Keep Bauchi Clean by Bauchi State Environmental Protection Agency (Bauchi State Edict No. 3, 1977). The adoption of the national environmental policy as well as the specific urban programmes for solid waste collection is to proffer an efficient and sustainable solid waste evacuation strategy for Bauchi metropolis that would be practically viable and feasible (Bogoro, 2010).

The paper is aimed at identifying and reviewing the different techniques used in solid waste collection in Bauchi metropolis and the problems encountered as a basis for suggesting more effective techniques with a view to improving the environmental quality of the metropolis

## MATERIALS AND METHODS

Bauchi metropolis, the headquarters of Bauchi metropolis, is located between latitudes 9° 00' and 9° 30' North of the Equator and longitudes 10° 25' and 11° 20' East of the Greenwich Meridian. It occupies a total land area of 3,604.0 ha as shown in Figures 1 and 2. It had a

**Table 2.** Distribution of samples.

Ward	Population	Hh Size	No. Hh	% Sample	Frequency	Density	Income
Old G R A	15560	7.1	2192	5	79	Low	High
New G R A	8974	7.5	1197	3	48	Low	High
Fadaman Mada	20194	7.0	2885	7	111	Low	High
Yelwa	50533	7.7	6563	17	270	Medium	Medium
Dan Iya	28956	7.6	3810	10	159	Medium	Medium
Makama	12134	8.0	1517	4	64	Medium	Medium
Ibrahim Bako	17100	7.6	2250	6	95	Medium	Medium
Nassarawa	35444	8.5	4170	11	175	High	Low
Dan Kade	31763	8.5	3737	9	143	High	Low
Dawaki	42156	8.8	4790	12	190	High	Low
Dan Amar	39488	8.2	4816	12	190	High	Low
Hardo	15736	9.0	1748	4	64	High	Low
<b>Total</b>	<b>318038</b>	<b>8.0</b>	<b>39755</b>	<b>100%</b>	<b>1587</b>		

Sources: Field Survey, June 2010; Census, 2006

**Table 3.** Age-sex distribution of the population of Bauchi City.

Age	Male		Female		Total	
	No	%	No	%	No	%
Less than 14	43,450	16.4	42,391	16.0	85,841	32.4
15-24	24,905	9.4	25,964	9.8	50,869	19.2
25-34	21,195	8.0	21,195	8.0	42,391	16.0
35-44	19,074	7.2	18,811	7.1	37,887	14.3
45-54	16,161	6.1	15,897	6.0	15,897	12.1
55 and above	6,094	2.3	9,802	3.7	15,896	6.0
<b>Total</b>	<b>138,881</b>	<b>49.4</b>	<b>134,060</b>	<b>50.6</b>	<b>264,941</b>	<b>100.0</b>

Source: National Population Commission 1991 Census.

total population of 318,038 people as at June 2010, population census (NPC, 2006). Furthermore, based on the average household size of 8 persons per household as revealed by the 2006 census, there are 39,675 households in the metropolis.

The study area was divided into twelve wards (Gunduma) which form the sample frame. From each ward, a proportionate unit of household was selected for the purpose of administering questionnaire and interview. Four (4) percent of 39,755 households were taken as the sample size, which are 1,587 households; considering the heterogeneous environment like Bauchi metropolis, where population density, income level and occupation (which to a great extent determine solid waste generation and characteristics), are quite varied. Stratified sampling technique was applied to group the wards into three densities and their corresponding income levels. There after systematic random sampling techniques was adopted for the selection of the samples as shown in Table 2.

The instruments used in data collection include:

structured Questionnaire, oral Interview, direct measurement of solid waste on site, Observation, Photograph and Discussion. After the field survey, information obtained from questionnaires, interview guide and observation guide were collated and coded in a summary sheet. The data were further presented in tabular form in frequency distribution tables and percentages. Pie chart and bar charts were used for graphical description, comparison and assessment of the existing condition of refuse evacuation in the area.

## RESULTS AND DISCUSSION

Projected from 1991 census, the population of Bauchi metropolis stood at 264,941 in 2001 using the National growth rate for urban centres, which is 4.5%. The survey revealed that female dominated with 50.6% (134,060) of the total population (Table 3). The table indicates that there are more female than male. Bauchi is a Hausa community and by Hausa tradition, it is the responsibility

**Table 4.** Occupation of respondents.

Household size	Number	Percentage
Civil servants	873	55.00
Farming	200	12.60
Business	287	18.10
Schooling	121	7.60
Unemployment	73	4.60
Others	33	2.10
<b>Total</b>	<b>1587</b>	<b>100.00</b>

Source: Field Survey 2001

**Table 5.** Income level of respondents.

Level	Income monthly	Number	Percentage (%)
Low	Below ₦10, 000.00	938	59.10
Medium	₦10,000.00 - ₦30,000.00	481	30.30
High	30,000.00 and above	168	10.60
<b>Total</b>		<b>1587</b>	<b>100.00</b>

Source: Field survey 2001

of the woman to sweep the surrounding while the unmarried girls carry the stored waste to the collection centres. The high number of female between 14-15 years could be a potential for regular conveying of refuse to collection centres.

The household size directly influenced the amount of solid wastes generated as the higher the household size, the greater the amount of solid wastes generation to a certain extent. It could be seen that 45.90% of the households surveyed have 6-10 persons per household, and 13.70% have 11-15 persons per household. The average household size is 8 persons per household. This high household size is a typical characteristic of Hausa settlement.

In terms of solid waste evacuation, large household size though generated more wastes, but can also be an advantage where the family members carry the solid waste storage containers to the collection centre themselves. The large household size can provide free and cheap labour for solid wastes evacuation to collection centres and it also encourage community effort toward evacuation of refuse from collection centres to disposal sites.

From the research, it is discovered that civil servants constituted up to 55.00%. This confirms the saying that Bauchi metropolis is not a commercial or industrial town. Business population forms only 18.10%; this includes traders, carpenters, masons and cobblers as shown in Table 4. The type of occupation influenced the type and amount of solid wastes generation. For instance, in areas where farmers dominated, most of their storage

containers were filled with farm wastes. Since 87.8% are employed, they should be able to afford to buy solid wastes storage facilities or/and hire labourers to collect the solid waste.

Income level plays a vital role in solid waste generation *vis-a-vis* its evacuation. 87.8% of the respondents are employed. In Nigeria, civil servants on GLO1- 05 are referred to as low income earners, whose monthly earnings ranges between ₦5000.00 to 10,000.00, 59.10% of the respondents fall within this category. Only 10.60% fit into the high-income group with monthly income of ₦30, 000.00 and above (Table 5). In a situation where one has very low income, he prefers to spend his little income on basic needs like food and health rather than buying solid wastes storage facilities or hiring labourers to evacuate solid wastes. From Tables 4 and 5, the income level which does not exceed one hundred and fifty naira to three hundred naira is to be a problem.

Quantitatively, Keziah (2009) reported that, residential area in Bauchi metropolis; generate an average volume of 0.003 m<sup>3</sup>/person/day for high density areas, 0.004 m<sup>3</sup>/person/day for medium density areas and 0.005 m<sup>3</sup>/person/day for low density areas. Eight years later, Maikano (2001) reported that high-density residential areas of Bauchi metropolis generated an average volume of 0.006 m<sup>3</sup>/person/day, medium-density areas generated 0.007 m<sup>3</sup>/person/day while low-density areas 0.009 m<sup>3</sup>/person/day. In the two studies, no account of weight of solid wastes generated was considered and the second researcher, Maikano (2001), claimed that

**Table 6.** Solid waste generation in Bauchi in 2011 (m<sup>3</sup>/capita/day).

Ward	Density	Garbage	Rubbish	Trash	Ash	Polythene	Total	Average
Old G R A	Low	0.0111	0.0057	0.0048	0.0010	0.0053	<b>0.0297</b>	<b>0.0047</b>
New G R A	Low	0.0092	0.0061	0.0052	0.0008	0.0047	<b>0.0260</b>	<b>0.0043</b>
F/Mada	Low	0.0100	0.0067	0.0060	0.0012	0.0060	<b>0.0299</b>	<b>0.0050</b>
Yelwa	Medium	0.0100	0.0060	0.0041	0.0041	0.0040	<b>0.0282</b>	<b>0.0047</b>
Dan Iya	Medium	0.0072	0.0059	0.0052	0.0034	0.0054	<b>0.0271</b>	<b>0.0045</b>
Makama	Medium	0.0052	0.0062	0.0048	0.0037	0.0049	<b>0.0248</b>	<b>0.0041</b>
I/ Bako	Medium	0.0070	0.0049	0.0050	0.0024	0.0046	<b>0.0239</b>	<b>0.0040</b>
Nassarawa	High	0.0039	0.0047	0.0051	0.0043	0.0035	<b>0.0215</b>	<b>0.0036</b>
Dan Kade	High	0.0033	0.0050	0.0045	0.0051	0.0038	<b>0.0217</b>	<b>0.0036</b>
Dawaki	High	0.0041	0.0032	0.0047	0.0038	0.0028	<b>0.0186</b>	<b>0.0031</b>
Dan Amar	High	0.0037	0.0028	0.0037	0.0051	0.0026	<b>0.0179</b>	<b>0.0030</b>
Hardo	High	0.004	0.0037	0.0044	0.0041	0.0038	<b>0.0200</b>	<b>0.0033</b>
Total (M <sup>3</sup> )		<b>0.0787</b>	<b>0.0609</b>	<b>0.0575</b>	<b>0.0390</b>	<b>0.0514</b>	<b>0.2875</b>	
Average M <sup>3</sup> )		<b>0.0066</b>	<b>0.0051</b>	<b>0.0048</b>	<b>0.0033</b>	<b>0.0049</b>		

Source: Field Survey June 2011

residential density was not a strong factor in determining the quantities of solid wastes generation as asserted by the first researcher.

This study discovered that the average solid waste generation for low income earners is 0.007 m<sup>3</sup>/capita/day, 0.008m<sup>3</sup>/capita/day for medium income earners while 0.010 m<sup>3</sup>/capita/day for high income areas. The overall average stood at 0.008 m<sup>3</sup>/capita/day (Table 6).

The volume of solid wastes general in Bauchi metropolis is relatively small but absence of segregation practice at the household level and ineffective evacuation were possibly the major factors responsible for the continued accumulation of solid wastes on the metropolis.

Still quantitatively, World Bank sponsored project (World Bank, 2001) adopted weight as the standard measure for determining amount of solid wastes quantities. For instance, data for thirty countries compiled by the World Bank showed that per capita wastes generation ranged between 0.6 and 1.5 kg/capita/day for low income countries and 0.8 and 2.0 kg/capita/day for industrialized countries. For Nigeria, the average per capita waste generation stood at 1.02 kg/person/day. The maximum figure was 1.2 kg/capita/day and recorded in Port Harcourt while the lowest figure was 1.2 kg/capita/day recorded in Minna. Bauchi metropolis is not one of the high waste generators among Nigerian urban centres.

The rate of solid waste generated in Bauchi metropolis is 0.16 kg lower than the national average per capita which is 1.02 kg/capita/day. The average solid waste generated in high density residential areas at 0.79 kg/capita/day; 0.89 kg/capita/day for medium density residential areas and 1.03 kg/capita/day for low-density

residential areas. The general average per capital solid waste generated was 0.86 kg/capita/day as shown in Figure 3.

From the table, it can be deduced that income and quantity of solid waste generation are directly and proportionately related as high income areas like GRAs generally generate more waste.

### Solid waste collection

The collection of solid wastes is discussed in two stages. The first stage looked at the conveyance of solid wastes from individual house to the collection centres, while the second stage discussed the further evacuation from the collection centres to the final disposal sites.

In the first stage, every household is supposed to have a container for temporary storage of the solid waste generated in the house. But from the survey, it was discovered that 31.50% of the respondents sampled did not have solid waste storage facilities. Different reasons were given for their lack of storage facilities; for instance, 30.60% said because they were very close to the collection centres, they did not need storage facilities; 26.60% claimed that they burned their wastes as soon as it is gathered as shown in Figure 4.

The need for individual on-site solid waste storage facilities in every household cannot be over emphasized. The high number of households without solid waste storage facilities was a serious problem, as it leads to indiscriminate disposal of waste. Out of the aforementioned reason, more is strong enough to justify the lack of the storage facility. For instance, there were many reported cases of fire outbreaks caused by refuse burning within/near the compounds. It is never the

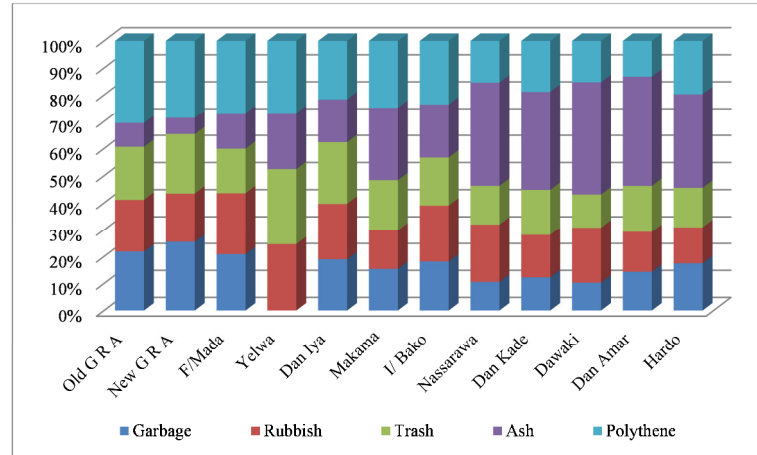


Figure 3. Solid waste generation in Bauchi in Metropolis (kg/capita/day).

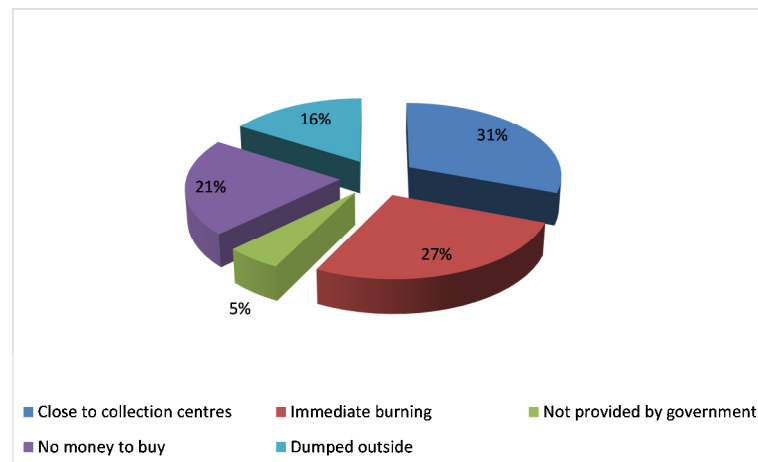


Figure 4. Reasons for lack of storage facilities.

responsibility of the government to provide individual households with storage facilities and more so, storage facilities such as plastic baskets, polythene leathers are not expensive, since none exceed three hundred naira so every household should be able to buy storage facilities. The time taken to fill storage facilities varies from one household to the other depending on household size, consumption habit, income level, number and size of the containers used. 45.40% of the respondents filled their storage containers daily; 24.50% filled theirs twice a week and not more than 1.80% took up to a month to fill theirs as shown in Figure 5.

The filling of the storage containers within a day demands an untiring and intensified effort by the family to regularly empty the containers to the collection centres. It also calls for the evacuation agencies to provide more collection centres to reduce long distance travelled daily to dump refuse and ensure constant

evacuation of refuse from collection centres to avoid large accumulation of refuse in the open.

The survey conducted revealed that over 50.0% of the household sampled carried the filled storage facilities to collection centres themselves and 22.30% used hired labourers (Figure 6). From Figure 6, it is clear that no government agency collects refuse from individual houses. The high participation of family members in the first stage collection is an indication of their readiness to co-operate in general waste management and the high number of female teenagers would be a great potential for cheap labour. The use of labours, on the other hand, in the collection of refuse to some extent serves as sources of employment. 66.10% of the 36 sampled respondents whose storage containers were carried by hired labourers did not complain about the amount charged by the labourers because they do not pay more than ₦100.00 weekly as shown in Table 7.



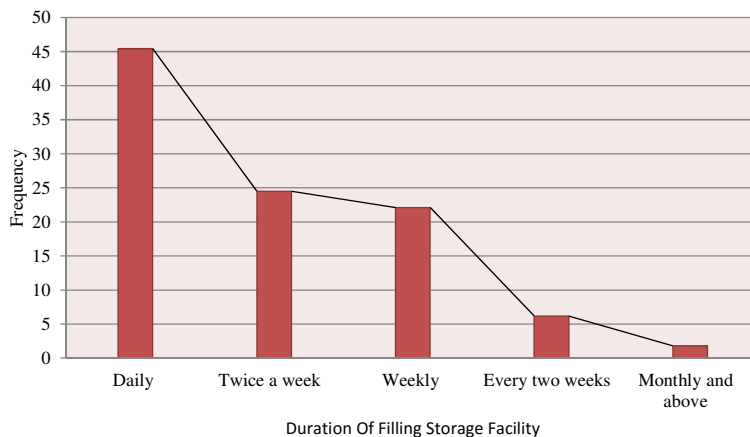


Figure 5. Frequency of filling storage facilities.

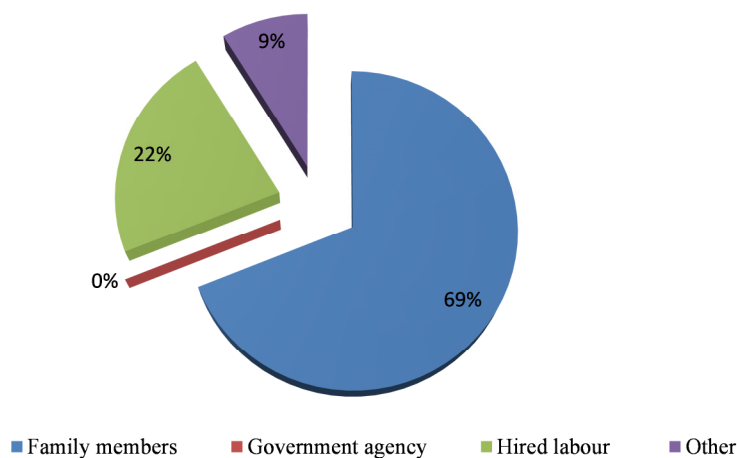


Figure 6. Conveying refuse containers to collection centres.

Table 7. Cost of carrying filled containers to collection centres.

Cost	Number	Percentage (%)
Less than ₦50.00	419	26.40
₦51.00- ₦100.00	630	39.70
₦101.00 and above	538	33.90
<b>Total</b>		<b>100.00</b>

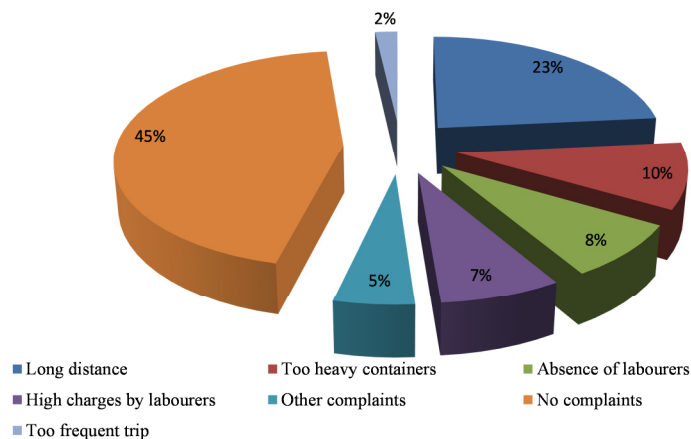
Source: Field Survey 2001.

In addition to job opportunity for the labourers, the low charges tend to encourage the public to engage the labourers in getting rid of solid wastes from their carrying of the filled containers to collection centres. As for the reason for not carrying containers to collection, out of the 55.80% that made different complaints, 23.30% felt the collection centres are too far from them; 7.40% complained of high charges by hired labourers as shown

in Figure 7.

It is indeed hard work to carry full storage containers over a long distance, if not well packed; the refuse may be blown away on the way and litters the environment. The long distance may also be a source of discouragement and certainly increases the amount of charges by the hired labourers. Community collection centre system is the method of collection system used in





**Figure 7.** Reason for not carrying containers to collection.

**Table 8.** Distance to collection centres.

Distance (m)	Number	Percentage (%)
Less than 100	467	29.40
101-500	614	38.70
501 and above	506	31.90
<b>Total</b>	<b>1587</b>	<b>100.00</b>

Source: Field Survey 2001.

**Table 9.** Willingness to pay collection charges.

Cost	Number	Percentage (%)
Willing	1195	75.30
Not willing	268	16.90
Undecided	124	7.80
<b>Total</b>	<b>1587</b>	<b>100.00</b>

Source: Field Survey 2001.

Bauchi metropolis. Distance of collection centres to the households is vital in encouraging the effective usage of the collection centres. 38.70% travelled with their refuse between 100 to 500 m to the nearest collection centre and 31.9% had to go as far as over 0.5 km to dump their refuse as shown in Table 8.

The collection centres are not fairly distributed, collection centres are community facilities, so they should be in close and assessable locations. Long distance and inaccessibility may lead to emergence of illegal dump site or convention of drainage channels, road sides and uncompleted buildings to dump site. It was found that 75.30% of the respondents were willing to pay some charges to improve refuse collection and 7.80% remained undecided as to whether they would pay service charges or not (Table 9). Their willingness to

pay service charges indicated their readiness to eradicate the menace caused by solid waste and keep clean environment.

In the second stage, the evacuation of the accumulated solid waste from collection centres to disposal sites is discussed at this stage. It is considered here as the responsibility of communities and government agencies such as Bauchi State Urban Development Board (BSUDB), Bauchi Local Government and Bauchi State Environment Protection Agency (BASEPA).

Bauchi local government was created in 1976 by the local government reform Decree No. 1 of 1976. Refuse management was a statutory function assigned to it by the 1979 and 1989 constitution of the Federal Republic of Nigeria (Decree NO. 12 of 1989). But it stopped

**Table 10.** Frequency of waste collection.

Frequency	Number	Percentage (%)
Weekly	670	42.20
Every two weeks	455	28.70
Three weeks and above	462	29.10
<b>Total</b>	<b>1587</b>	<b>100,00</b>

Source: Field Survey 2001

collection of the refuse for two obvious reasons: Financial constraints and lack of refuse collection equipment.

Bauchi State Urban Development Board (BSUDB) was established in 1977 after the creation of Bauchi State in 1976. Refuse handling was among the activities of this department, but with the introduction of national monthly sanitation (every last Saturday of the month) in the country, a task force on environmental sanitation in the state was established in 1986 by edict No. 5 of 1986 as amended in edict No. 7 of 1986 (Bauchi State Government Edict 5 and 7, 1986). The Task Force was established to take over from the department of environmental planning and sanitation with refuse collection and to enforce all sanitary laws for effective and continued general cleaning of the metropolis. The Task Force existed for ten years and was later dissolved in 1990 during the democratisation process. Bauchi State Environmental Protection Agency was established by Edict No. 3 of 1997 and came into force on 10<sup>th</sup> June 1997 to replace and take over the activities of the defunct task force on Environmental Sanitation which was abrogated in 1996.

As earlier highlighted, the quantity of waste generated in Bauchi metropolis would not have been a problem if effective collection systems were put in place. At the time of the survey, Bauchi State Environmental Protection Agency was the only authority carrying out solid waste collection and disposal. BASEPA used the community depot system for collection and disposal of the waste generated. Regular collection of solid waste from dump sites is necessary to maintain a clean living environment. The survey found that 42.20% collection centres were collected weekly, the rest accumulated for over two weeks before collection (Table 10). Solid waste should be collected weekly from collection centres to have a Solid environment. The performance of BASEPA in terms of solid waste collection is below expectation, everyday, on average, BASEPA collects 35 trips of solid waste from residential areas and the capacity of their vehicles is 5.5 m<sup>3</sup> each. Therefore, the total amount of solid waste collected daily is  $35 \times 5.5 = 195 \text{ m}^3$ .

The agency evacuates 68.70% (192.5 m<sup>3</sup>) of the 280.20 m<sup>3</sup> of the solid waste generated daily. Certainly, because 31.30% is not collected, heaps of solid waste

would continue to accumulate. There are opportunities that could be harnessed to improve solid waste evacuation likewise problems that could militate against effective evacuation of solid waste in Bauchi metropolis. The strong legal backing which the agency enjoys give her the power to carry her activities; more so, the political will of the government to support the desire for a clean living environment further strengthen their aspirations to operate effectively. Bauchi metropolis especially the medium and high residential density areas have very good road network that offer adequate accessibility to household, for this can be a good opportunity for house-to-house collection system. However, this cannot work in the high density areas.

The readiness and willingness of the community to cooperate with the agency for effective evacuation of solid waste and pay service charges would not only supplement the agency's effort but open up another source of income. However, a major problem militating against the efficiency of the agency is inadequate funding and lack of income base which is responsible for improper maintenance of the vehicles. The entire metropolis is too large for the agency to cover with the number of staff and equipment at their disposal, unless Bauchi Local Government council and the community participate in the solid waste handling.

## Conclusion

It is certain that there is generation of solid waste in Bauchi metropolis but the collection exercise has been ineffective because the task is too much for BASEPA only. Bauchi Local Government has failed to carry out its statutory function of refuse collection and disposal and the communities do not organized labour to assist BASEPA in the solid waste evacuation. Recommendations are made towards achieving maximum community participation in waste evacuation, introducing appropriate collection method and expend the economic base of the agency. However, this research was limited to collection of solid waste in residential areas only. It would be very important if further studies is carried on the disposal and expended to other land users.

## Recommendations

Now that many collection centres are overflowing, and unauthorised dumping sites have emerged, an immediate joint action should be adopted to evacuate the wastes accumulated in order to restore environmental sanity in the metropolis. This can be achieved by establishing a strong team comprising of staff of the agency, representative of the communities and private organisation. For immediate collection, BASEPA should contract the evacuation of outside walled-city to private contractors to be completed within one month, meanwhile the agency would mobilised all its resources (equipment/vehicles and staff) and concentrate on the walled city. The community should assist the agency with labour force, which will clear filled drainages and load refuses into the trucks. A one-month sanitation exercise should be declared in the metropolis to be observed during work free days. 'Stop' notices should be placed on all unauthorised dumping sites and a monitoring team comprising staff of the agency and representative of the communities should supervise the collection and disposal of waste. Bauchi local government should source fund from National Ecological Fund to procure refuse handling equipment in order to resume its statutory function of solid waste collection. The local government should limit its service within the walled city; the agency covers the outside walled city. However the agency would constantly offer technical assistant and professional advice to the local government when the need arises. A high level of awareness and education on sanitation, environmental health matters and benefits of segregation at household level should be created to the entire public so that they can appreciate need for a clean living environment and actively participate in the segregation exercise. Bauchi Radio Corporation, Bauchi Television Authority and the FM Station should transmit programmes organised by the agency on environmental health, highlighting on the roles of individual and at community level. Posters and handbills should also be printed to create more awareness. In the low-residential density areas such as GRA and Kari Housing Estate, each household should be encouraged to provide a bin of regulation size and weight with a lid that can be easily lifted and emptied by the refuse collectors, the bin should be kept outside by the roadside where the collection crew will put it back after emptying the waste into collection vehicle. The good road network in the areas is an opportunity for accessibility to each house. Service charges should be introduced to these areas to generate income for the agency and alleviate the financial constraints. In order to achieve a full collection system, it is suggested that more collection centres should be established on convenience with road access, some 250 to 300 m apart. This allows a maximum walking distance of any tip of some 125 m, and it is estimated that these would

mean about 220 such sites being set aside in addition to the existing 25 located in the residential areas. These 245 collection centres should distribute in the high and medium residential densities where communal collection centres would be practiced. On average, the 245 Bin (collection centres) can serve 50 households, which would generate 11.5 m<sup>3</sup> (0.32x50x7) weekly, therefore the evacuation should arrive with an empty bin, and deposit it besides the full in, the full bin can then be toyed to be disposal site. To achieve the weekly evacuation schedule, 35 collection centres must evacuate daily, 7 tractors would be required to make 5 trips daily. Each of the 12 wards in the metropolis should form a visitation team comprising of community representative, staff of the two authorities and security member. The activities of the team should involve house-to-house health and sanitary inspection to ensure the provision of storage facilities in each household. The team shall enjoy the legal powers of the environmental and sanitation law to fine defaulters. The agency in conjunction with the local government council should occasionally organise workshop and seminars on environmental sanitation for community heads, community based organisations to be fully integrated in the refuse evacuation activities. A yearly award for the cleanest ward should also be organised to entice the community and encourage them maintain a high standard of environmental cleanliness.

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