

Solid Wastes Management In Urban Areas: The Case of Khartoum State, Sudan

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Accepted 13 April, 2015

ABSTRACT

As one of the most effective reasons causing ecological deterioration in Khartoum State is the absence or improper treatment of daily produced solid wastes from households in the state, this matter hasn't been resolved in Sudan with providing the proper solutions addressing transportation of the solid waste materials from their sources of production to be hygienically disposed in the allocated areas for this purpose.

The main outcomes of this study are the defects in the Khartoum State experiences and practice of solid wastes management starting from house-to-house collection up to final dumping and disposal in terms of manpower, machineries, methods and available funds making it difficult to manage the daily produced waste materials of 4800 m³ (*According to Statistics of Ministry of Health and Environment*).

This study was conducted with the aim of studying the current solid waste management methods in Khartoum State covering the different locations in its three provinces (Khartoum, Omdurman and Khartoum North) with the aim to enable designation of comprehensive system for the domestic solid waste management, in terms of collection, sorting, transportation and disposition in correct manner.

The methodology of this research is based on a field research questionnaire in addition to filed visits and visual inspections of current situation of processing the domestic waste materials inside and outside houses and they were distributed in the targeted quarters. The results were analyzed and discussed accordingly using Statistical Package for Social Science (SPSS) program. It has been found that, the methods of solutions, collection tools, collection routes are inefficient.

Keywords: domestic solid wastes management, collection, sorting, transportation and disposition, house-to-house, garbage.

1. Introduction

1.1 Domestic Waste Materials

The domestic waste materials are the garbage and wastes discarded nearly every day from our houses and they are as follows:

- Food residues
- Glass
- Vegetables and fruits
- Ash
- Earth and dust
- Wood
- Papers
- Minerals
- Plastic

In general sense, waste materials are the solid byproducts resulting from the day-to-day human activities.

So, storing and transporting of waste material to the final disposal areas are considered as necessary for maintenance of human health and environment in general. As the domestic and food waste materials represent all wastes produced by families and housing complexes as well as food leftovers of houses, flats and restaurants resulted from food handling and processing (P. Aarne Veslind, *et al*, 2002).

The important properties of this type of waste material is their aptitude to putrefaction and organic disintegration during

summer season resulting in offensive odour that facilitate propagation of flies and other insects.

For government, the waste materials represent a huge responsibility and burden. If it hasn't been managed properly and disposed, the government will subject itself to serious political and social problems as the waste accumulate in streets, quarters and amusement parks causing offensive odour and restless to dwellers and visitors of those facilities as well as creating traffic problems and drainage canal pollution beside more other problems (Arnold van de Klundert, *et al*, 2001).

Moreover, the improper management of waste materials leads to declining of community public health as well as the environmental impacts with air, water and soil pollution caused by those materials. So, the most important reason for paying due interest in collection and disposal of waste materials is the maintenance of community public health ensuring satisfaction from beneficiaries, with other reasons such as: Evasion of offensive odor resulting from bacterial decomposition of organic materials found in waste materials contents; Prevention from health and relishing disorders caused by diseases that transmitted through vectors such as rats, fleas and flies and others as they are displayed in table (1-1). The link between waste materials and diseases is difficult to be clearly determined but there are 50% of diseases transmitted through flies, mosquitoes and rodents that breed in waste materials (P. Aarne Veslind, *et al*, 2002).

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Table 1-1: Shows some health and environmental impacts that may result from insecure handling of waste materials

Type of waste material	Expected health and environmental impacts
Chemicals	Fires, explosions, skin itch, harms to eye cornea, abortion, renal failure
Pesticides and their empty containers	Respiratory system disorders, eye disorders (conjunctivitis, pterygium, blindness), skin diseases, parasitic disease (Ascaris), Ancylostoma trichuris, schistosoma haematubium) accidents, injuries, back disorders, possibility of attack from a stray dogs and other animals
Hospital and health units waste materials	Infectious hepatitis, HIV, traumatic skin disease, intoxication, allergy, immunological disorders
Waste materials of technological industries and electronics	Accidents, explosions, poisonous gases, asbestos, cancer

This variation in the sources of waste materials imposes serious challenges that face the engineer in charge of the relevant institutions making him to think of disposition issues for waste materials produced in the relevant as he strives to design the unit for shelf life not less than 25 years which is relatively long period under the shadow of clear planning for waste materials handling and obliviousness about waste types and modes of production in the third world (Maria Muller, 2001).

Thus, the most important factors affecting the waste materials type and quantity are as follows:

- Standards and measurements.
- Living systems.
- The industrial stage and the advancement level with civilization degree in the region.
- Geographical location.
- Climatic factors and weather.
- Region and community size
- Season of the year and temporal changes.
- Intervals of collections and continuity
- Socio-economic factors.

- The degree of recycling and reuse beside process undergone in disposal areas.
- Current legislation's and laws.
- Popular acceptance.
- Existence of energy, gas and relevant cost (Ecology, 2005).

1.2 Sources of Solid Waste materials

Solid waste materials are produced from variable urban sources depicting it daily activities as it is shown in (table 1-2), and they are endless, including earth, food waste, the remnants of packaging such as leaves, metal, wood and glass compose. The amount of waste varies from one season to another and from one country to another (Arnold van de Klundert, *et al*, 2001), depending on:

- Economic and social situation (rising standard of living)
- Population density.
- Source quality.
- Environmental awareness.
- The different seasons of the year.
- Periods of collection
- Laws and legislation

Table 1-2: Shows the sources of waste materials production

Source	Production units	Waste materials type
House / locality	Houses, flats, villas and dwellings	Food leftovers, wastes and garbage, ash and special wastes
Commercial	Warehouses, shops, restaurants, markets, offices, buildings, hotels, printing and press, hospitals, firms.	Food leftovers, wastes and garbage, ash, construction debris special wastes and dangerous wastes.
Industrial	Buildings, production, factories, refineries, chemical stations, mines, wood cutting, thermal station, destruction, reconstruction.	Food leftover, wastes and garbage, ash, construction debris special wastes and dangerous wastes.
Squares and open areas	Streets, roads, corridors, pitches, shores, bathing areas, amusement parks.	Special wastes.
Agricultural	Crops, fruits gardens, cornflower's fields, cheese and butter laboratories, experimental fields, farms.	Food leftovers, agricultural wastes and garbage, and dangerous wastes.

One of the most important factors affecting waste materials production:

- The socio-economic positions of dwellers group.
- Consumption rate of manufactured materials and people preferences.
- Waste materials collection intervals.
- Waste materials collection systems as well as their programs and repetitions: increase in collection rates increases the annual collected quantity. Whereas the quantity of organic material is approximately

constant, the increase may be attributed to disposal of more waste materials by people in a shape of papers and leftovers.

5. Collection fees.
6. Climatic factors.
7. Existence of waste crusher devices inside houses to lighten food leftovers.
8. Social norms and customs (the reading community produces newspapers and paper waste materials ; in labour community produces, the restaurant and markets leftovers increase as eating habit inside houses decreases or use them as cooking and warming fuel).
9. Individual income and the degree of community wealth as the area of lower income rate for individual produces less waste materials with high content of food leftovers.
10. Literacy.
11. Density of population in the area.
12. Manufacturing and industrial production.
13. Development and construction
14. The geographical and hydrological characteristics of the area and climatic effects.

It is required to know the waste materials properties:

- a. Knowing the dangerous materials found in the wastes for sorting and disposition.
- b. Estimation of organic contents suitable for biogas.
- c. Estimation of materials valid for incineration and energy.

The most important waste properties are as follows:

- Material properties (particles size, contents , usage and purity)

- Natural properties (waste contents, moisture, particle size, chemical contents, biological properties) these properties affect the designation of collection, processing and disposition systems of waste materials as well as managerial frameworks of units and their performance.

1.3 Solid waste management

Solid waste management is the integrated system components that come together in order to pour in one box, which leads all outputs to achieve the objectives of the collection, transportation and treatment of solid waste, (Ecology, 2005) namely:

1. Protecting public health from contaminants
2. Environmental protection and conservation
3. Protect the health of workers in the collection and disposal

1.3.1 Domestic solid waste management system

The management of solid waste means the ability to fully control the waste from the moment it is disposed off by its owner to be processed and final disposal in ways and methods to ensure preservation perfect advancement of this process in order to eliminate the negative effects of such wastes (Justine Anschutz, *et al*, 2001).

1.3.1.1 Waste pyramid

Waste pyramid (Figure 1-1) refers to the three concepts of a reduction and recycling and reuse of waste, which are classified as waste management strategies according to their desirability. The three concepts are hierarchically arranged according to their importance.

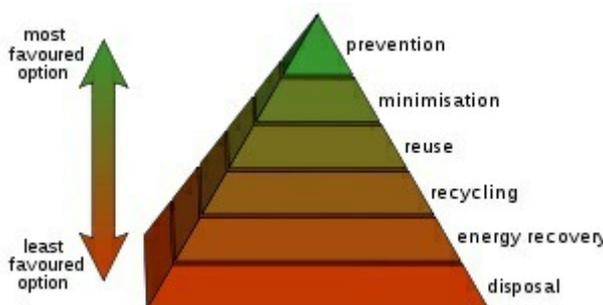


Figure 1-1: Shows the Pyramidal Sequence of waste materials.

Waste pyramid refers to the three concepts of a reduction and recycling and reuse of waste, which are classified as waste management strategies according to their desirability. The three concepts are hierarchically arranged according to their importance.

The history of the term:

Waste pyramid has taken many forms over the past decade, but the basic concept has remained the cornerstone of most of the waste reduction strategies. The aim of the waste hierarchy is to get as much of the practical benefits of the products and also make a minimum of waste (P. Aarne Vesilind, *et al*, 2002).

Modern concept:

Some experts in the field of waste management recently incorporated 'fourth concept': "rethink", which means implicitly that the current system may have fundamental flaws, and the presence of an effective comprehensive waste management system may need an entirely new way of looking at the waste. Source rationing includes efforts to reduce hazardous waste and other materials by modifying industrial production.

1.4 Solid Waste Management Trials in Khartoum State

Ensuring environmental sanitation through applying effective solid waste management system is the most pressing issue

for municipal health care department because it affects directly the human life.

For this reason most of the municipality's resources are allocated to incisive sanitation hazards. The approach to

tackling environmental problems needs the adoption of a multidisciplinary method as well as competent solid waste management.



2. Methodology

2.1 The area of study

2.1.1 Khartoum State



Figure 2-1: Khartoum Urban Territorial Level

Since the earliest of the 19th century Khartoum was known as the first administrative center in Sudan due to its geographical location. The increasing care devoted to political, educational and administrative fields encouraged the growth of trade and industry and facilitated emigration from the rural areas to Khartoum. Khartoum is a dry hot State; the temperature ranges between 43 degrees in June and drops to 14 degrees in December. The rainy season starts from June through October with scat-rated rainfalls, Khartoum being in the semiarid area is considered as one of dustiest areas in the world. Khartoum executive capital of Sudan with 2.8 million inhabitants (Aviation, 2004), situated at the junction between the Blue and the White Nile together with Omdurman to the west and Khartoum North to the north, form Khartoum Sudan's dominating urban center. (Embassy, 2005).

Omdurman serves as the legislative capital of Sudan. Khartoum is very poor, with few exclusive areas. Few streets are paved, but the center is well planned, with tree-lined streets. Khartoum is the administrative, economical and commercial centre for whole of Sudan. Among the city's industries are printing, food processing, textile and glass manufacturing. The population of Khartoum is made up of all the peoples living in Sudan, making it relatively one of the least Arabic cities in the northern half of Sudan. Khartoum has rail lines from Egypt, Port Sudan and El Obied. The river traffic on the Blue and White Nile Rivers are very important. There is also an international airport. Khartoum has 12 universities.

2.1.2 The Climate of the City of Khartoum

The city of Khartoum (lat.15 36 N long. 32 33 at. 38) is a rapidly expanding city with semi desert climate. It's affected by the rivers it sits at their confluence the blue and white Nile, it is expanding along the rivers banks in a north south direction. The climate in winter is very pleasant with dry northerly winds from October to April and relative humidity below 30%. During this period there is no rain. The mean rain for October is 7.8 mm, November 0.7 mm and for the rest of the months almost zero rain. The mean monthly temperature is lowest in Jan. about 23C, and highest in April and October about 32 C. The temperature drops steadily from October by about 4C every month from January it rises slowly during February by 1.5C and then by 4C every month until April. Jan. and Feb. are the coldest months. The coldest temperature recorded was 7.5C in Jan. From April the temperature rises to 27.5 in June. May and June are the hottest months in the city the maximum can reach 47.5C and the mean maximum is

above 41 C, by Jun the rain will be established to the south of the city and the city is under frequent dust storms with gust wind. During July the rain starts and the climate is modified accordingly yet July remains venerable to the highest temperature every other year. During august and September the city enjoys rainy condition and the temperature is suppressed slightly. Relative humidity is above 40% for July August and September the mean rain for July is 29.6, mm August 48.3 mm and September 26.7mm, and sunshine hours drop to 8hours during these rainy conditions. Outside this period sunshine hours are more than 9 hours (Embassy, 2005).

2.2 Data Acquisition

The data acquisition in the study was solely based on a field research questionnaire prepared targeting sample of 83 persons in variable quarters in the three provinces of Khartoum states , in addition to filed visits and visual inspections of current situation of processing the domestic waste materials inside and outside houses.

The above had facilitated acquisition of primary qualitative data relevant to location, transportation and storage of domestic solid waste materials produced by households in the area of study in order to give a picture about the solid waste management in Khartoum State. Also, this was coupled with field visits executed to the different residential quarters in the research area of study and photos taking, personal interviews and reporting were adopted as field study to current processing of domestic waste materials.

Equally important, the secondary data was acquired by going through reports, references, magazines, periodicals, newspapers and websites were referred to for some information in this research.

2.3 Data Analysis

The acquired primary data was analyzed accordingly using Statistical Package for Social Science (SPSS) program.

3. Results

The statistical analysis was concentrated upon the frequency tests for the qualitative data acquired from the answers of questionnaire prepared targeting sample of 83 persons in variable quarters in the three provinces of Khartoum states about location, transportation and storage of domestic solid waste materials produced by households in the area of study and that was as follows:

Table 3.1: Shows waste collection methods adopted by the targeted groups.

Percent	Frequency	Valid
5.7	5	
19.5	17	Barrels
73.6	64	Plastic bags
1.1	1	Sacks
100	87	Total

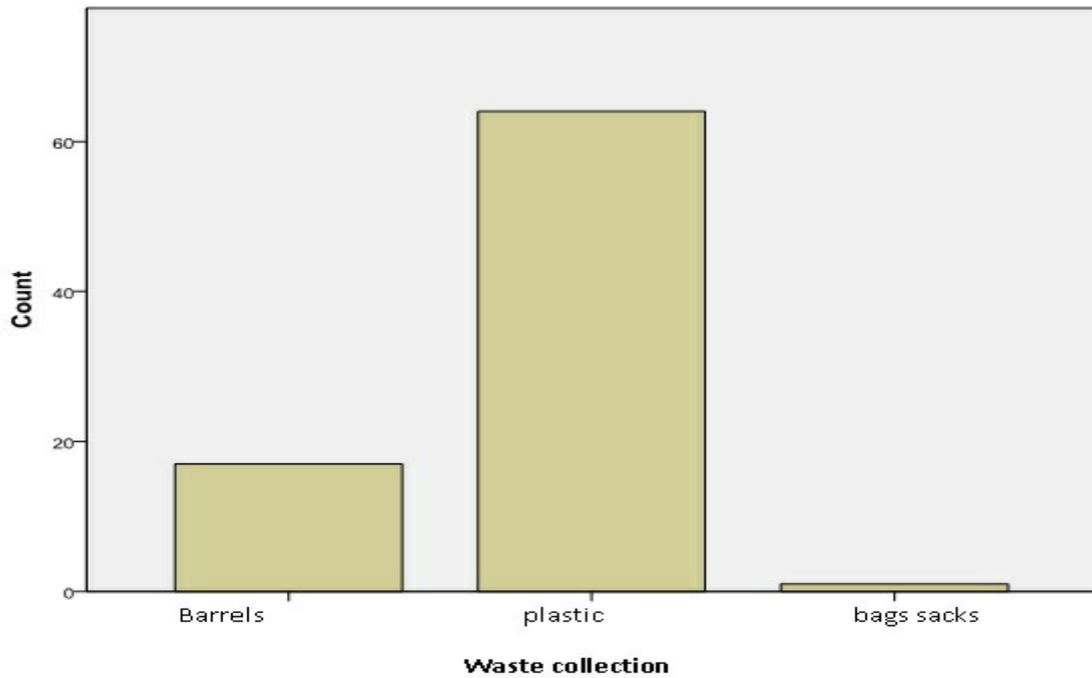


Figure 3.1: shows waste collection methods adopted by the targeted groups

As it's shown in table (3.1) and figure 3.1, the dominant methods of solid waste collection is through the plastic bags (73.6%) followed by barrels (19.5%)

Table 3.2: Shows waste location, before being transported for disposal, adopted by the targeted groups

Percent	Frequency	Valid
5.7	5	
50.6	44	House yard
6.9	6	On street
13.8	12	Inside kitchen
21.8	19	Near kitchen
1.1	1	Outside house
100	87	Total

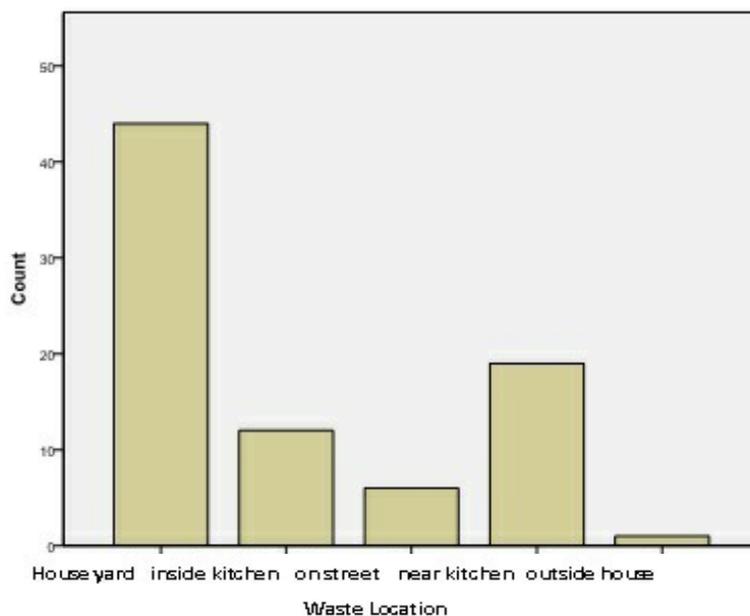


Figure 3.2: Shows waste location, before being transported for disposal, adopted by the targeted groups

As it's shown in table (3.2) and figure 3.2, the dominant waste location, before being transported for disposal, adopted is the house yard (44%). And rarely locating wastes outside houses and streets.

Table 3.3: shows domestic solid waste transportation through regularity of waste vehicles in terms of times per week for the targeted groups

Percent	Frequency	Valid
5.7	5	
1.1	1	More than three times
31	27	Once
6.9	6	Three times
55.2	48	Twice
100	87	Total

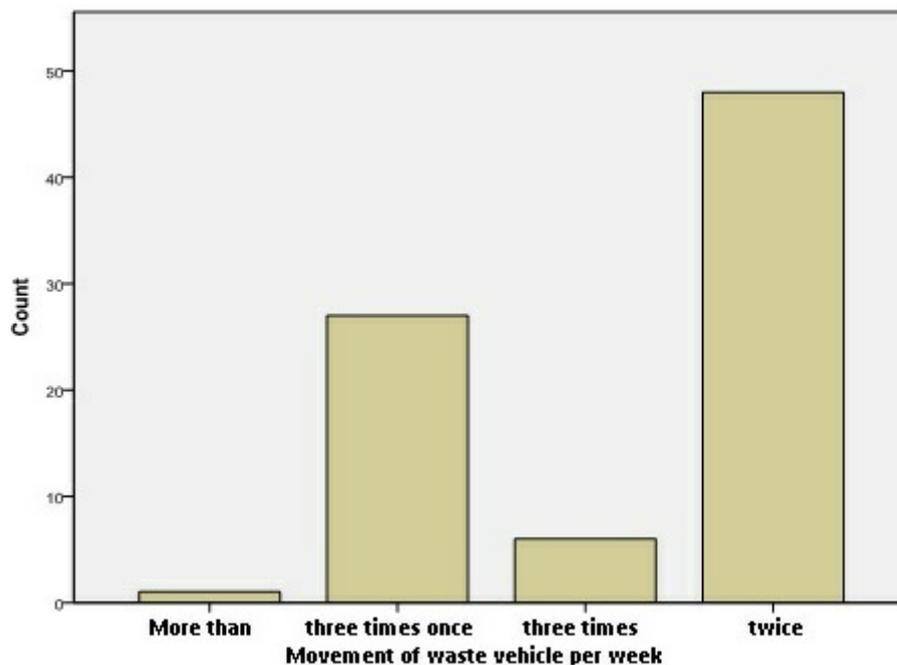


Figure 3.3: Shows domestic solid waste transportation through regularity of waste vehicles in terms of times per week for the targeted groups

As it's shown in table (3.3) and figure 3.3, the dominant pattern of regularity in transportation through waste vehicles is twice a week (48%) and once a week (27%).

Table 3.4: shows domestic solid waste alternative transportation for disposal method in absence of vehicles adopted by the targeted groups

Percent	Frequency	Valid
5.7	5	
31	27	By cart
35.6	31	By my own car
26.4	23	Other place
1.1	1	Other places
100	87	Total

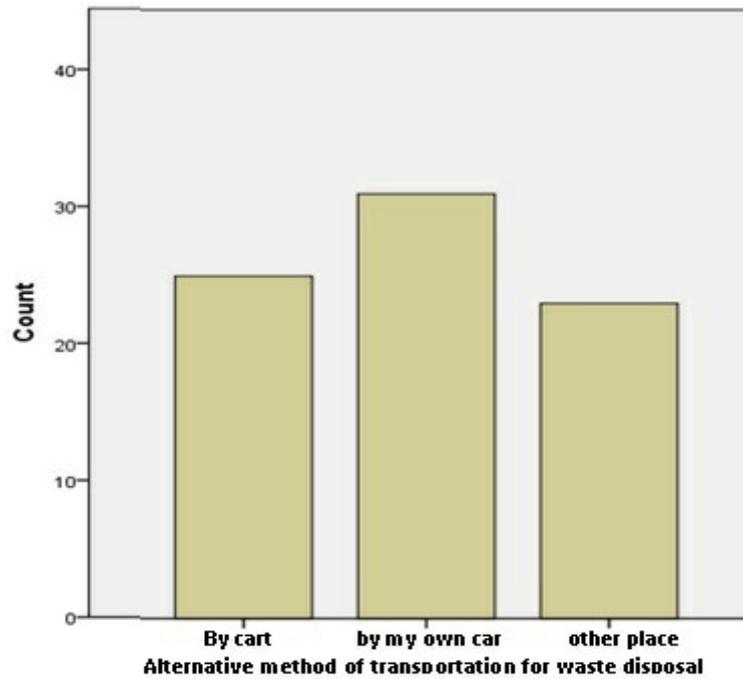


Figure 3.4: Shows domestic solid waste alternative transportation for disposal method in absence of vehicles adopted by the targeted groups

As it's shown in table (3.4) and figure (3.4), most of the targeted group transported their solid waste materials through their own cars (31%) and use draught animals through carts (27%) as two dominant methods adopted.

Table 3.5: Shows the dumping areas of domestic solid waste before applying the system of vehicles adopted by the targeted groups

Percent	Frequency	Valid
5.7	5	
1.1	1	Adjacent to waste container
1.1	1	Grave yard
71.3	62	Other places
17.2	15	Vicinity
3.4	3	Waste collection areas
100	87	Total

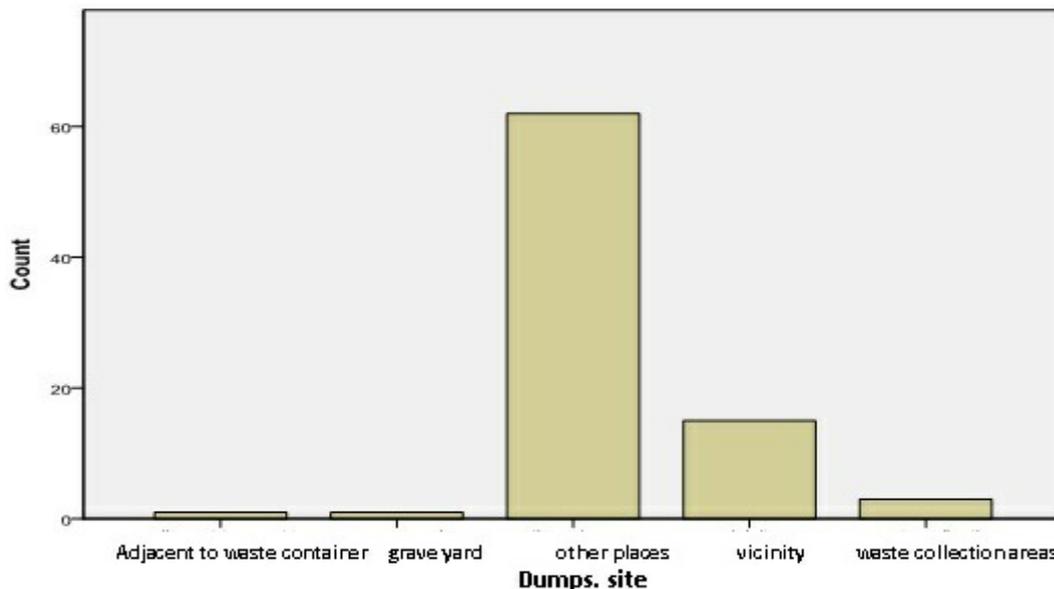


Figure 3.5: Shows the dumping areas of domestic solid waste before applying the system of vehicles adopted by the targeted groups

As it's shown in table (3.5) and figure 3.5, the targeted groups tend to use other places (62%) rather than the vicinity (15%), waste collection areas (3%) as dumping areas for daily produced solid waste materials.

4. Discussion & Conclusion

4.1 Discussion

The quantity of solid waste generated in Khartoum is 995,358.5 tons \ year at a rate of 00, 2-0,4 kg per capita for a day.

Most citizens in the study area rely on waste vehicle to get rid of their domestic solid waste and method of house-to-house collection beside the presence of containers for garbage collection upgrading and containers.

It appeared from interviews and questionnaire that waste vehicle pass on the house twice or more per week (table 3.3), and most of them use the plastic bags dominantly, table 3.1, as main collection tool and to less extent , barrels are the second choice which comprises the important part of solid waste management.

There are a considerable number of citizens, (table 3.4) retain their wastes in case of delay in the vehicle and this is evidence of the awareness of citizens in the region, although there is a small percentage of citizens throwing their waste in the process of sorting exercise.

4.2 Conclusions

It is apparent from the results reached that the current system of solid waste material management applied in Khartoum through the methods of solutions, collection tools, collection routes are inefficient. Particularly to meet the need and requirements for managing the great quantity of solid wastes that is daily produced in its three provinces (4800 tons/day) as it accelerates by 4.04% annually.

Recommendations

1. The waste materials collection systems as well as their programs and tools should be revised from time to time in order to test and upgrade their efficiency.
2. To raise environmental awareness of population about waste materials through social organizations, educational institutes and information media.
3. To introduce modern systems that help to lighten food leftovers.
4. Government should introduce and apply legislation's and laws for management of solid waste materials.

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