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Perception and Role of Community in Solid Waste Management at Khartoum State

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Abstract

The present study was initiated with the objective to explore household role in solid waste management and willingness to participate in practical solutions to reduce waste health hazards. The area of study was the state of Khartoum including the three main cities (Khartoum, Khartoum North and Omdurman) which encompassed 7 localities. Two localities were selected from each city according to their geographical location using the random method. A questionnaire was designed as to gain information about demographic information, socio-economic status, households' solid waste management practices, solid waste collection and disposal etc. Statistical analysis that related per capital daily waste generation with household size and income as the only important factors influencing per capita solid waste generation was significant. The average calculated per capita generation rate of domestic solid waste as at 0.35 kg/capita/day for localities. Lifestyle was found to affect both solid waste amounts and characterization where plastic, papers, metal, and glass was correlated with high income families. Solid waste amounts and characterization were important in recovering recyclable materials as most showed interest in converting them into useful products. It could be concluded that since households are waste generators, and could also participate in waste management activities, they must be regarded as major stakeholders in solid waste management. They can play an active role in improving accountability and service quality of both public and private sector.

Keywords: Solid Waste Management, Community's Perception And Role

1. Introduction

Households are the main producers of solid waste and the first responsible actors for dealing with wastes in the so called 'primary phase' of the collection-transport-disposal process of flows of domestic urban solid wastes. It is within households that primary collection and short term storage of the domestic waste is organized while householders are responsible for linking and coordinating their waste activities with the activities of the (system) actors operating in the secondary phase of within the household, and their basic perceptions towards waste management. The developed conceptual framework assumes that

households as end-users of solid waste management services have a great role to play in solving the particular problems of solid waste. This gives the justification for placing household at such a strategic position within the framework. The understanding of households' activities in SWM chain can provide important clues for SWM improvement. The activities associated with managing solid wastes from the point of their generation up to the point of final disposal and treatment can include generation, waste recovery (reduction, reuse, recycling, composting), waste storage, collection, transfer and transport, disposal, treatment. As pointed out by Adedipe *et al.* (2005) the flow of wastes from their place of origin to the site of disposal has important human dimensions to it, besides the application of waste technologies. The concept of a city or region functioning as an 'anthroposphere' indicates the importance of understanding households' activities in SWM chains.

2 Materials and Methods

2.1. Area of study

The area of study was the state of Khartoum consists of three major cities, Omdurman, Khartoum and Khartoum North and Khartoum. Khartoum state includes seven localities are Khartoum , Khartoum North , Omdurman , Sharg Nile , Karari , Um Badah and Jabal Awlya , each locality has many administrative units and each administrative unit includes many neighborhoods. Two localities were selected from each city according to their geographical location using the random method. Thus, the number of selected localities were 6 localities, and from each locality two administrative units were chosen, and from each administrative unit 2 neighborhoods were chosen so that the number of the selected administrative units became twelve administrative units and the number of neighborhoods was 24 so that the distribution of the questionnaire in each locality became 64 respondents in locality and the total number of the sample was 384 sample

2.1.2 Questionnaire layout

The final questionnaire contained 32 questions grouped into 6 main parts: The following attributes were included in the final questionnaire.

Part 1 contained question 1,2,3,4,5,6,7 on demographic information which is concerned location and size of household, characteristics and status of respondents in terms of sex, marital status and age. Socio-economic status variables include education, monthly income, and income expenditure. Other variable which are included in this part are number of times the cooker and the power used in the cooker. These may affect solid waste management practices, amount of waste generated, attitudes and perception of the household towards solid waste management, households' views on the services provided to them and their participation in their management

Part II contained questions 9,10 concerning the knowledge on solid waste management. This part was included in order to learn account of waste and type. Part III contained questions 11-12-13 concerning with the households' solid waste management practices. Responses to these questions created a better understanding of waste storage, waste separation, waste type daily routine of households and the

responsibility of household members in solid waste management. Part IV contained questions 15, 16, 17, concerning with solid waste collection and disposal and garbage cart attendance. Responses to these questions are used to gain insight on waste flow to transfer stations by looking at who is providing the collection service, the schedule and frequency of collection, how households take part in primary phase of waste collection.

Part V contained question 18-20-22-23-26-27-28 concerning with the households' views on the services provided to them and their participation in their management. Responses to this question help us to understand how household would like to participate in SWM. Part VI contained question 14- 19- 21- 30- 31- concerning with the reason for the accumulation of waste inside the house , waste damage and value It , so contained question 32 concerning with the implementation of the environmental law could reduce the phenomenon of throwing waste into empty places.

2.5 Per capita waste calculation

With contribution from different localities: 648, 627, 580, 522, 373 and 348 tons for Sharg El-Neel, Khartoum North, Jabel Awlya, Karrari, Khartoum and Umbadda respectively, the per capital generation for person for week was calculated according to JICA (Japan International Cooperation Agency) standard as means of household number divided by the amount of waste generated multiplied by the time. For all localities the per capita waste generation was found to be 0.35kg/person/day

2.6. Sampling procedures

Random sampling was done according to the NEA Research Bulletin, Vol. 38, 1960, p. 99). The number of households in Khartoum State was 847336 and the number of the population was 5143513 (Center bureau of Khartoum, 2008). The sample size was then calculated as to 384. The distribution of the questionnaire in each locality became 64 (Table 2.1)

Table 2.1. Number of households, clusters and sampled households in selected research areas (based on information from Center bureau of Khartoum 2008)

City	Locality selection	Administration selection	Neighborhood selection	Number of household selection
Khartoum	2	4	8	128
Khartoum North	2	4	8	128
Omdurman	2	4	8	128
Total	6	12	24	384

2.7 Statistic analysis

The analysis of data collected from questionnaire survey was entered into the computer using Microsoft Access. Data entry was manually cross-checked to ensure accuracy. Descriptive statistics such as means, frequencies, and standard deviations were computed by the use of the Statistical Package for Social Sciences (SPSS version 16). A bivariate analysis using Pearson's coefficient (r) was used to find the correlation between household size and per capita waste generation, and also between income of the

households and per capita waste generation. Data collected from interviews, and focus group discussion were processed and edited as follows: these data were recorded by taking notes and transcribed before being analysed using content analysis. Content analysis is a method for analyzing textual data expressing key ideas, phrases and meanings in answers given to interview questions (Weber, 1990).

3 Results

3.1 Questionnaire results

3.1.1 Family information

3.1.1.1 Family size, age, sex and education

Most of the family size that within the range of 6 -9 members were observed in all localities (8 – 9%), then for the families within the range 1 – 5 members in Khartoum north, (~7%), Khartoum and Karri (~6%), less in Jabel Awlyia and Sharg El-Neel (~4%) and Umbaddaa (~3%). Most age group of 31 – 46 years in all localities ranged from 8.9 for Khartoum North to 7.6 for Umbadaa and Khartoum then 6.5 and 5.5% for Jabel Awlia and Karri respectively. for the age group 47 – 62 years, Jabel Awlya showed the highest percent (~8), then Karari (~7), Sharg El-Neel (6), Karari and Khartoum (~5). A higher age group of 14 – 30 years was found in Umbadda (Table 3.1.1.1)

Except for Sharg El-Neel and Khartoum North, males number were higher than females, for both localities females constituted more than half of males, for Karari and Jabel Awlyia males were comparable numbers to females. Education level showed highest percentages were in Karri, Khartoum North (~8%) and Khartoum. Primary education was highest in Umbadda and Sharg El-Neel (~5%). Secondary education reached ~4% in Karari, Khartoum and Jabel Awlyia then Sharg El-Neel (~3%) (Table 3.1.1.1). Pre-education and post-graduate education showed very low percentages in all localities.

3.1.1.1 Family information

Locality	Family information															
		Family size			Age (years)				Sex		Education					
	1-5 (n = 125)	6 - 9 (n= 205)	10-15 (n =44)	16 - 25 (n =10)	14 – 30 (n =54)	31 -46 (n= 163)	47 – 62 (n= 133)	63-80 (n =34)	Female (n= 182)	Male (n= 202)	illiterate (n= 22)	Kalwa (n = 24)	Primary (n= 89)	High Secondary (n=93)	University (n=149)	Post university (n=7)
Um	3.1 %	8.6 %	3.9 %	1.0 %	7.3 %	7.6 %	1.6 %	03 %	2.1 %	14.6%	4.4 %	0 %	5.7 %	3.1%	3.4%	0%
Karari	6.3 %	8.6 %	1.6 %	0.3 %	2.1 %	5.5 %	7.3 %	1.8 %	7.0 %	9.6 %	0%	0.5 %	2.9 %	4.9%	8.1%	03%
Kh	6.3 %	6.8 %	2.9 %	0.8 %	1.6 %	7.6 %	5.5 %	2.1 %	6.0 %	10.7%	03 %	1.3 %	2.1 %	4.7%	7.6%	0.8 %

Jabal. A	4.9%	9.4%	2.1%	0.3%	0.5%	6.5%	8.6%	1.0%	7.6%	9.1%	0.3%	2.1%	3.9%	4.9%	4.9%	0.5%
Kh. N	7.6%	8.1%	0.8%	0.3%	1.6%	8.9%	5.5%	0.8%	10.4%	6.3%	0.3%	1.8%	2.9%	2.9%	8.6	0.3%
S.Neel	4.4%	8.9%	0.3.%	0%	1.0%	6.5%	6.3%	2.9%	14.3%	2.3%	0.5%	0.5%	5.7%	3.6%	6.3%	0%
Total	**32.6%**	**50.4%**	**11.5%**	**2.7%**	**14.1%**	**42.5%**	**34.6%**	**8.9%**	**47.4%**	**52.6%**	**5.8%**	**6.2%**	**23.2%**	**24.1%**	**38.9%**	**1.9%**

3.1.1.2 Employment, type of houses, income

In each locality percent of employment showed that 1 to 2 of family were employed was highest in Jabel Awylia, (~14%) nearly the same in other localities (~ 10 – 13%), little percentages were found for the employment for 3 – 5 and ranged from about 6% for Sharg El-Neel to about 5% in Khartoum to about 4 and 2% for Umbadaa and Khartoum North then Karari respectively. Employment of 6 of the family members was very little in all localities. Generally 1 – 2 members of the family were employed (~72%), 2 – 5 members who were employed constituted about 25%.

Concrete houses showed highest percentages in Khartoum north (~9%) and Khartoum (8%), the Karari (6%), with little percentages found in other localities. Houses made of bricks showed the highest percent Jabel Awliya (~11%) then Sharg Khartoum (10) and Karari (~7%), with less percent in Khartoum (~5%) with little percentages in the other localities. houses made of mud were the highest in Umbaddaa (~10%), little percentages were found in the other localities, other options were negligible. Generally houses made of bricks were higher (42%) than those made of concrete (~32%) or mud (~19%) (Table 3.1.1.2).

Monthly income was found to be highest in Khartoum (~11%), then Umbaddaa (10%) for those earning less than 10000, in the other localities those who earned less than or more than 1000 or less than 5000 ranged between 5 to 2%. Khartoum North and Karari showed 5% for those earning less than 5000 and 5% for those earning more than 1000 in Jabel Awliya. Generally those earning than 10000 SDG were higher (42%) than those earning less than 5000 (~26%) the others earning less or more than 1000 SDG were around 14% (Table 3.1.1.2).

3.1.1.3 Source of energy and cooking time

Sources of energy used for cooking showed that for the different localities it ranged from 16, 15, 14, 13, 12% for Khartoum, Karari and Jabel Awliya, then Sharg El-Neel and finally Umbaddaa. Charcoal showed the least use in all localities with highest in Khartoum 4%, same for use of fuel wood which was not used in all localities except in North Khartoum (0.3%). Generally butane use was the highest (87%) compared with charcoal (~7%) and options for using both butane and charcoal (~5%).

Daily cooking was done in all localities ranging from 15, 12, 11 7, and 6% for Umbadda, Khartoum, Jebel Awliya, Karari, Khartoum North and Sharg El-Neel respectively. Cooking once a week, twice or others showed little percentage for all localities although Sharg El-Neel and Khartoum North showed higher

percentages (~7, 6%) in cooking twice a week. Generally daily cooking was the highest (65%) than cooking twice a week (~23%) (Table 4. 2.1.3).

Table 3.1.1.2 Employment, type of house and income

Locality	**Family information**													
	Employment		**Type of house**								**Income**			
	1-2 (n=279)	3-5(n=99)	< 6(n=6)	**Concrete (n=124)**	**Bricks (n=163)**	**Mud (n=74)**	**Tents (n=2)**	**Option 1-2(n=5)**	**Option 2-3(n=13)**	**Others (n=3)**	>1000 (n=44)	<1000 (n=66)	<5000 (n=87)	<1000 (n=187)
Umbadda	12.2%	4.4%	0%	1.0%	3.1%	10.2%	0.3%	0%	1.6%	0.5%	1.6%	2.1%	2.3%	10.7%
Karari	13.5%	2.9%	0.3%	6.0%	7.6%	2.6%	0%	0.3%	0.3%	0%	2.1%	2.3%	5.7%	6.5%
Khartoum	10.7%	5.7%	0.3%	8.6%	5.7%	1.6%	0%	0%	0.5%	0%	1.8%	1.3%	1.8%	11.7%
Jabal Awliy	14.1%	2.6%	0%	3.1%	11.2%	1.8%	0%	0%	0.5%	0%	1.3%	5.2%	4.2%	6.0%
Khartoum North	12.0%	4.2%	0.5%	9.6%	4.7%	1.8%	0.3%	0%	0%	0.3%	3.9%	3.1%	5.7%	3.9%
Sharg Nile	10.2%	6.0%	0.5%	3.7%	10.2%	1.3%	0%	1.0%	0.5%	0%	0.8%	3.1%	2.9%	9.9%
Total	**72.7%**	**25.8%**	**1.6%**	**32.2%**	**42.4%**	**19.3%**	**0.6%**	**1.3%**	**3.4%**	**0.8%**	**11.5%**	**17.1%**	**22.6%**	**49.2%**

Table 3.1.1.3 Energy of cooking and cooking frequency

Locality		**Energy of cooking**			**Cooking frequency**			
	Butane gas (n=334)	Charcoal(n=30)	Option 1-2 (n=19)	Wood (n=1)	Daily (n=251)	Once a week (n= 33)	Twice a week (n=90)	Others (n=8)
Umbadda	12.2%	4.2%	0.3%	0%	15.9%	0.3%	0.5%	0%
Karari	15.9%	0.3%	0.5%	0%	11.7%	1.3%	3.4%	0.3%
Khartoum	16.2%	0.3%	0.3%	0%	12.2%	1.6%	2.6%	0.3
Jabal Awliy	15.6%	0.5%	0.5%	0%	11.5%	1.3%	3.9%	0%
Khartoum North	13.0%	2.1%	1.3%	0.3%	6.5%	3.1%	6.0%	1.0%
Sharg Nile	14.1%	0.5%	2.1%	0%	7.8%	1.0%	7.0%	0.5%
Total	**87%**	**7.9%**	**5.0%**	**0.3%**	**65.6%**	**8.9%**	**23.4%**	**1.8%**

3.2.1 Waste weight

Waste weight that ranged from ½- 1kg was highest in Umbaddaa (~11%), then Khartoum (~9%) and Khartoum (~5). For the 2 -3kg waste the highest percentages were shown for both Sharg El-Neel and Jabel Awliya (~8%), then Khartoum North, (~6%), Karari and Khartoum (~5%). Bigger weights showed low percentages for all localities although Sharg El-Neel and Jabel Awliya showed about 4% for the 3 – 5 kg waste. Generally waste weight ranging ½- 1kg or 2 – 3 kg were higher and nearly the same (~40%) compared for the other weight weights (18 – 2%) (Table 3.2.1).

3.2.2 Weight composition

Waste compositions for all localities were food waste, ranged from 4% in Sharg El-Neel, to 3% for Jabel Awalyia and Karari, then 2 and 1% for Khartoum and Umbaddaa, paper, glass or iron, also soil, leaves and manure were almost nil. However, food waste, paper and plastic could account for 6% in Umbaddaa, 4 and 3% in Khartoum and Jabel Awliya respectively. All combinations of waste would account for 9% in Khartoum North, 7, 6, and 4% for Karari, Khartoum and Jabel Awliya respectively. Generally all combinations showed the highest percentages (~32%) than combination of food, paper and plastic (~22%) or food waste alone (~19%), then combination of food soil and leaves (~11%) (Table 3. 2.2).

Table 3. 2.1. Waste weight

Locality	**Waste weight**			
	½- 1kg (n =157)	2-3kg (n =145)	3-5kg (n =71)	5-10kg (n =11)
Umbadda	11.2%	4.2%	1.3%	0%
Karari	7.3%	5.7%	3.1%	o.5%
Khartoum	9.6%	5.0%	1.6%	o.3%
Jabal Awliy	3.9%	8.1%	4.4%	0.3%
Khartoum North	5.7%	6.3%	3.4%	1.3%
Sharg Nile	3.1%	8.6%	4.4%	0.5%
Total	**40.8%**	**37.9%**	**18.2%**	**2.9%**

Table 3. 2.2 Waste composition

locality	**Waste composition**									
	1- food waste (n=74)	2- Glass &iron (n=0)	3- Paper and plastic (n=2)	4- Soil and leaves (n=4)	Manure and food (n=5)	Combination 1,3 (n=86)	Combination 123 (9)	Combination 1,4 (n=45)	Combination 1,3,4 (n=36)	All mentioned (n=123)
Umbadda	1.8 %	0%	0.3 %	0%	1.0%	6.8%	0.3%	0.8%	3.6%	1.3%
Karari	3.4 %	0%	0%	0%	0%	2.6%	03%	1.6%	2.1%	7.0%
Khartoum	2.1 %	0%	0%	0%	0.3%	4.4%	0.5%	2.1%	0.5%	6.8%
Jabal Awliy	3.9 %	0%	0%	0%	0%	3.6%	0.3%	3.1%	1.6%	4.2%
Khartoum North	3.7 %	0%	0%	0%	0%	1.0%	0.5%	1.0%	0.5%	9.9%

Sharg Nile	4.4 %	0%	0.3 %	05%	0%	3.9%	0.5%	3.1%	1.0%	2.9%
Total	**19.2 %**	**0%**	**0.6 %**	**0.5 %**	**1.3%**	**22.3%**	**2.4%**	**11.7%**	**9.3%**	**32.0%**

3. 2.3 Types of disposed container

Containers used for disposal were almost plastic bags for all localities, ranging from 10% (Sharg El-Neel), to 8% (Khartoum North), 7% (Khartoum), 6% (Karari) and little percentages for Jabel Awliya (4%) and Umbadda (2%). The use of sacks was highest in Jabel Awliya (~8%), the rest of the localities showed lower percentages that ranged from 3 to 0.8%. Baskets ranged from 4 and 3% for Karari and North Khartoum respectively to very low percentages in the other localities. the use of bag and baskets was the highest in Umbadda (~5%) and Khartoum (~4%), other means of disposal by using all combinations mentioned or others showed very little percentages in all localities. Generally used containers for disposal were higher for plastic bags (~39%) basket and sacks (14%) and (Table 3.2.3).

3.2.4 Means of waste disposal

Most of waste disposal was done by vehicles for all localities, was highest in Khartoum (~11%) and Karri (~10%), with low percentages for the other localities. use of animal cart was the highest in Sharg El-Neel (~10%), Khartoum North (~6%) and Jabel Awliya (~5%), little percentages were obtained for the other means of disposal although burning was high in Umbaddaa (~5%). Generally using vehicles was the main means of waste disposal (~38%) followed by animal cart (~24%), burning (~17%) and throwing waste in the street (~14%) (4.1.1.4.2). For most localities disposal of waste was done by vehicles (~36%), animal cart (~24%), burning (~17%) or thrown in open areas (~14%) (Table 4. 2.1.7).

Table 3. 2.3Type of disposed containers

Locality	**Disposed containers**					
	Plastic bag (n=149)	Basket (n=56)	Sack (n=77)	Bag and basket (n=56)	All mentioned (n=30)	Others (n=16)
Umbadda	2.3%	1.6%	3.1%	5.5%	0%	4.2%
Karari	6.3%	4.4%	2.9%	2.3%	0.8%	0%
Khartoum	7.0%	1.1%	1.3%	4.4%	2.9%	0%
Jabal Awliy	4.4%	1.8%	8.3%	1.6%	0.5%	0%
Khartoum North	8.1%	3.4%	3.6%	0.8%	0.8%	0%
Sharg Nile	10.7%	2.3%	0.8%	0%	2.9%	0%
Total	**38.8%**	**14.6%**	**20%**	**14.6%**	**7.8%**	**4.2%**

Table 3. 2.4 Means of waste disposal

locality	**Means of waste disposal**					
	1.vehicle (n=138)	2.Animal carts (n=94)	3.Street (n=56)	4.Burn (n=64)	5.Near home (n=21)	Options 3-4 (n=11)
Umbadda	2.9%	0.8%	2.9%	5.5%	2.3%	2.3%
Karari	10.4%	0.8%	2.3%	2.6%	0.5%	0%
Khartoum	11.7%	0.5%	2.1%	1.6%	0.8%	0%
Jabal Awliy	4.2%	5.2%	3.4%	2.9%	0.5%	0.5%
Khartoum North	4.4%	6.5%	2.9%	1.8%	1.0%	0%
Sharg Nile	2.3%	10.7%	1.3%	2.3%	0%	0%
Total	**35.9%**	**24.5%**	**14.6%**	**16.7%**	**5.4%**	**2.8%**

3.3 Participant perceptions'

3.3.1 Respondents' perceptions of vehicle frequency

Respondents' perceptions of vehicle frequency of waste and evaluation of waste collection are shown in table in 3.3.1, those who thought that vehicle came once a week were in Khartoum representing ~8%, few thought that the vehicles came twice a week for all localities, about 10% in Sharg El-Neel did not know, about ~12% in Jabel Alwiya expressed that they never come also 6 and 5% in Khartoum north and Sharg El-Neel expressed the same perception. Generally about 26% thought that vehicle visit came once a week, followed by 20% who did not know and 14% thought that they come twice a week (3.3.1). In all localities waste collection service was evaluated as to be weak varying from about 14% for Jabel Awliya to 13, 12, 10, 8 and 7% for Umbaddaa, Khartoum North, Khartoum, Karari and Sharg El-Neel respectively. the rate was good for Khartoum and Sharg El-Neel (~6%). Generally the rate for the waste collection as weak was the highest (~65%), and good (~26%) (Table 3.3.1).

3.3.2 Negative and positive perception of waste impact

Percentages of participants expressing the positive impact (~46%), were higher than those expressing that wastes had no positive impact (~53%). Nearly same percentages of participants in all localities expressed the negative impact of the waste (16 – 13%), very percentages in all localities would see the non-negative impact of the waste (3.1 – 0.3%). Knowledge about solid waste benefit showed that those who expressed that they know about the waste management were about 9% for both Karari and Khartoum north, about 8% for both Umbadda and Sharg El-Neel , 7% for Jabel Awliya but the highest for Khartoum (11%). Those who did not know about the waste management varied from 9% to 8% for Jabel Alwiya then Umbaddaa and Sharg El-Neel, to 6 and 5% for Kararri and Khartoum North respectively. Generally those who thought that waste had no positive impact were higher (~53%) than those who thought that waste had a positive impact (46%). Those who thought that waste had a negative impact were much higher (88%) than those who thought that it had a positive impact (11%). Knowledge about waste management were comparable, those who expressed that they know were higher (~54%) than those who expressed that they did not know (~45%) (Table 3.3.2).

Table 3.3.1 Respondents' perceptions of vehicle frequency of waste and evaluation of waste collection

Locality	**Frequency of vehicle visits for waste collection**					**Evaluation of waste collection**		
	Once a week (n=99)	Twice a week (n=56)	3 a week (n=5)	Don't know (n=77)	Never come (n=147)	Very good (n=33)	Good (n=99)	Weak (n=252)
Umbadda	2.1%	1.8%	0%	1.3%	11.5%	1.3%	2.4%	13.0%
Karari	9.4%	3.4%	0%	2.1%	1.8%	2.9%	5.5%	8.3%
Khartoum	**7.8%**	3.9%	0%	3.4%	1.6%	0.5%	6.0%	10.2%
Jabal Awliy	2.3%	1.8%	0%	0.8%	11.7%	0.3%	1.8%	14.6%
Khartoum North	3.9%	2.9%	1.3%	2.6%	6.0%	0.3%	3.9%	12.5%
Sharg Nile	1.0%	0.8%	0%	9.9%	5.0%	3.4%	6.3%	7.0%
Total	**26.5%**	**14.6%**	**1.3%**	**20.1%**	**37.6%**	**8.7%**	**25.9%**	**65.6%**

Table 3.3.2 Positive and Negative Impact of waste accumulation

Locality	**Information waste value**					
	Positive Impact of waste		**Negative Impact waste**		**Knowledge about solid waste benefits**	
	yes (n=179)	no(n=205)	yes (n =343)	no (n=41)	Yes (n=)	No (n=)

Umbadda	7.0%	9.6%	16.4%	0.3%	8.1%	8.6%
Karari	9.9%	6.8%	13.3%	3.4%	9.9%	6.8%
Khartoum	9.1%	7.6%	15.9%	0.8%	11.7%	5.0%
Jabal Awliy	7.8%	8.9%	14.3%	2.3%	7.1%	9.6%
Khartoum North	5.0%	11.7%	13.6%	3.1%	9.9%	6.8
Sharg Nile	7.8%	8.9%	15.1%	1.6%	8.1%	8.6
Total	**46.6%**	**53.4%**	**88.6%**	**11.5%**	**54.8**	**45.4**

3.3.3 Waste sorting

Waste sorting at home was found at very low percentages (7 – 1%), while higher percentages of those who did not sort solid at home and ranged from 15 – 9%. Sorting at home for all localities was about 24% compared with 76% who did not sort their waste at home. Willingness for sorting was higher (12 – 8%) than those who were not willing for sorting (8 – 4%). The overall for all localities showed 63% willing to participate compared with 36% not willing to participate in sorting (Table Table 3.3.3).

3.3.4 Willingness to participate

Willingness to participate in waste management varied from 9 to 7 and 6%. Unwillingness to participate showed similar ranges with the overall for all localities was ~45 willing to ~55 to those who are not willing in current management. For future solid waste willingness to participate was higher ranging from 8 – 11% compared with unwillingness which ranged from 9 – 3% with the overall for all localities showed 61 compared to 38% for those who said yes to those who said no respectively.

Willingness to convert solid to useful products showed comparable results where the range was 9 – 6%, higher for Khartoum and Khartoum north. Those who were not willing to convert solid into useful product ranged 10 – 7% with higher percentages found Umbadaa and Sharg El-Neel (10%) (Table 3.3.4).

Table 3.3.3. Sorting at home and willingness for sorting

Locality	**Sorting at home**		**Willingness for sorting**	
	Yes(n)	**No (n)**	Yes (n)	No(n)
Umbadda	1.1%	15.6%	10.7%	6.0%
Karari	5.7%	10.9%	11.5%	5.2%
Khartoum	3.9%	12.8%	10.4%	6.3%
Jabal Awliy	3.1%	13.6%	8.1%	8.6%
Khartoum North	2.9%	13.8%	11.0%	6.0%
Sharg Nile	7.3%	9.4%	12.0%	4.7%
Total	**24.0%**	**76.0%**	63.7%	36.8%

Table 3.3.4 Willingness to participate in solid waste management

Locality	Willingness to participate in SW management		Willingness to participate in future SW management		Willingness to convert SW into useful products		Willingness to pay the fees	
	Yes (n =172)	No (n=212)	Yes (n=236)	No (n=148)	Yes (n=184)	No (n=200)	Yes (n361)	No (n=23)
Umbadda	7.0%	9.6%	11.2%	5.5	6.0%	10.7%	16.2%	0.5%
Karari	9.4%	7.3%	12.6%	3.9%	%9.6	7.0%	15.6%	1.0%
Khartoum	7.0%	9.6%	9.9%	6.8%	9.6%	7.0%	15.4%	1.3%
Jabal Awliy	6.5%	10.6%	8.6%	8.1%	7.8%	8.9%	15.4%	1.3%

Khartoum North	7.6%	9.1%	7.6%	9.1%	8.6%	8.1%	15.1%	1.6%
Sharg Nile	7.3%	9.4%	11.5%	5.2%	6.3%	10.4%	16.4%	0.3%
Total	**44.8%**	**55.6%**	**61.4%**	**38.6%**	**47.9%**	**52.1%**	**94.0 %**	**6.0%**

3.4 Suggested participations solutions

3.4.1 Suggested waste management solutions and participation

Suggested waste solutions as expressed by the participants were vehicles which ranged from 13 – 3% (13 and 10% for Khartoum and Sharg El-Neel respectively, 8% Kararri, Khartoum and Jabel Awliya respectively). Other suggestions like cleaning campaign, burning and burial or combinations were little suggested. For suggested participation in recycle or reuse showed very little percentages. Monetary ranged from 12 to 6% as in Sharg El-Neel and Khartoum respectively, Umbaddaa, Kararri and Jabel Awliya showed 11, 9, 8% respectively. Generally providing a vehicle or monetary represented ~50% compared to other suggestions as burning (~14%) (Table 3.4.1).

3.4.2 Suggestions for better solution

Better solutions for waste management as suggested by the participants were sorting, burning and burial. The figures for the different locality were comparable for all suggestions, with higher percentages for Kararri and Khartoum (~5%) for sorting ~7% for both Umbadda and Jabel Awlyia for burning, recycle, reuse and recovery showed little percentage. Generally ~27% suggested burning compared with ~21 who suggested sorting. To prevent exhume waste, quick removal showed the higher percent (~67) compared to sourcing (~19%), other suggestions represented ~13% (Table 3.4.2).

Table 3.4.1 Suggested participations solutions

Locality		**Suggested solutions in waste management**					**Suggested participations**					
	Provide vehicle(N=199)	cleaning campaigns(n=14)	Burning (n=55)	Burial (n=20)	Option 1-2(n=8)	Others(n=88)	Monetary (n=223)	Tools(n=29)	Recycle (n=33)	Reuse (n=29)	Monetary & tools (n=7)	Others (n=63)
Umbadda	3.9%	0.3%	5.2 %	2.9 %	0%	4.4%	11.5 %	2.6%	0.3 %	0.3 %	1.0%	0.3 %
Kararri	8.3%	2.4%	0.5 %	1.6 %	0.5 %	3.4%	9.9%	1.8%	2.1 %	2.4 %	0%	0.8 %
Khartoum	8.3%	1.0%	1.0 %	0.5 %	0%	5.7%	6.0%	1.0%	2.6 %	1.8 %	0.8%	4.7 %
Jabal Awliy	8.1%	0%	5.2 %	0%	0.8 %	2.6%	8.3%	0.8%	2.1 %	1.3 %	0%	4.4 %
Khartoum North	13.0%	0%	1.8 %	0%	0%	1.8%	9.4%	0.5%	0.5 %	1.6 %	0%	4.2 %
Sharg Nile	10.2%	0%	0.5 %	0.3 %	0.8 %	4.9%	12.8 %	.08%	1.0 %	0.3 %	0%	2.1 %
Total	51.8%	**3.7%**	**14.2 %**	**5.3 %**	**2.1 %**	**22.8%**	**57.9 %**	**7.5%**	**8.6 %**	**7.7 %**	**1.8 %**	**16. 5%**

Table 3.4.2 Suggested better solutions in waste management

Locality	Suggested better solutions in waste management						Suggested Prevent exhume waste		
	1.Sorting (n=83)	2.Burning(n=104)	3.Burial(n=45)	4.Recycle (n=64)	5.Reuse (n=32)	6.Recovering (n=56)	Sorting at source (n=75)	Quick Remove waste (n=258)	Others (n=51
Umbadda	2.1%	7.8%	3.4%	2.3%	0.8%	0.3%	3.1%	5.2%	8.4%
Karari	5.0%	2.6%	2.9%	2.3%	1.8%	2.1%	3.9%	11.5%	1.3%
Khartoum	5.5%	2.6%	1.0%	3.6%	1.6%	2.3%	4.4%	10.2%	2.1
Jabal Awliy	2.1%	7.6%	1.3%	1.6%	0.8%	3.4%	3.7%	12.8%	0.3%
Khartoum North	3.1%	2.3%	1.6%	4.4%	2.1%	3.1%	1.0%	14.6%	0.8%
Sharg Nile	3.9%	4.2%	1.6%	2.3%	1.3%	3.4%	3.4%	12.8%	0.5%
Total	**21.7%**	**27.1%**	**11.8%**	**16.5%**	**8.4%**	**14.6%**	**19.5 %**	**67.1 %**	**13.4 %**

3.5.1 Awareness of environmental laws

Awareness of environmental laws as shown by table 4.1.1.7.1, that ~78% are aware of environmental laws, the percentages for the localilties were comparable ranging from11, 12, 13, 14% for Karari, Umbadaa and Khartoum north, Jabel Awliya and Sharg El-Neel respectively (Table 3.5.1).

Table 3.5.1 awareness of environmental laws

Locality	Environmental law	
	Yes (n=)	No (n=)
Umbadda	12.0%	4.7%
Karari	11.2%	5.5%
Khartoum	14.1%	2.6%
Jabal Awliy	13.6%	3.1%
Khartoum North	12.5%	4.2%
Sharg Nile	14.9%	1.8%
Total	**78.3%**	**21.9%**

4.3 Correlations

Correlations of waste disposal with Family size, age, sex, occupation, house, income and cooking time was found to be significant (P<0.000) for most of the localities. Similarly waste weight was significantly (P<0.000) correlated with occupation and family size. Similar results were obtained for storage with occupation and family size as well as sex, type of house and income. Sorting of waste was highly (P<0.000) correlated with type of house and income.

Significant correlations (P<0.000) were obtained between income and recognition of waste benefits. Willingness to participate in improving solid waste management was significantly correlated with income. Logistic regression for the relationships for the variables under studies, showed that for the different localities willingness to pay for waste collection was highly correlated to family size (0.018), employment (0.037), gender (0.027), and amount of waste collected (0.013) Willingness to participate in waste management, was highly correlated with employment (P<0.036), gender (P<0.08), income (P<0.011) and education (P<0.00). Willingness to participate in future solid waste management and other variables showed significant differences for job (P<0.015) and income (P<0.05). Willingness to turn waste into useful products were significant for employment (p<0.048) and age (P<0.084)

4. Discussion

4.1 Family information

In this study, demographic information showed that; location and size of household, sex, age, were significantly correlated with amount of waste disposal. Socioeconomic status variables include education, source of income, monthly income occupancy status. These variables may affect solid waste management practices, amount of waste generated, attitudes and perception of the household towards solid waste management. The geographical information was also used to provide background for the data analysis.

Most of the respondents in all localities are willing to participate in Solid waste management either by sorting and segregation at home or converting it into useful materials. Most are aware of the negative impact of solid accumulation although many are aware of environmental laws dealing with solid management, they are less confident in the government support in waste management. Most still think that the services provided by the government in providing vehicles and frequency of scheduling are poor and many will resolve to burn of their wastes

4.2 Household solid waste characteristics

Waste characterization as defined by Mwai *et al.* (2008) is the quantification of various waste components. According to Dahlen (2005) the output of waste characterization is the weight and the composition of the various waste fractions. Data from waste characterization are essential for waste disposal facilities planning and waste management policy formulation (Chung and Poon, 2001). Bolaane and Ali (2004) attributed that knowing the waste characteristics is important to waste policy making and monitoring in order to determine the per capita per day generation. Qu *et al.* (2009) and Magrinho *et al.* (2006) indicated that compositional studies are important, for several reasons, such as the need to estimate material recovery potential, to identify sources for component generation, to facilitate the design of processing equipment, and to maintain compliance with national laws. In addition, Al-Khatib *et al.* (2010), pointed out that the composition of solid waste is an important issue in waste management as it affects the density of the waste, the proposed methodology of disposal. For example, if solid waste generated at household level consists of large portions of kitchen or food waste, this indicates that frequent collection is needed due to its nature of decomposing rapidly and bringing foul smell. Information on the composition of solid waste is important in evaluating equipment needs, systems, and management programs and plans.

The waste generation is usually represented by waste generation rate, the quantity of waste generated per person per day (kg/day/capita). According to Bandara *et al.* (2007) the per capita waste generation rate is needed to predict future waste generation rates and for evaluating the waste generation trends in given communities. Regarding the factors that influence per capita daily waste generation and composition, several studies have shown that a relationship exists between per capita waste generation and household

size. In this study it was shown that, generally waste weight ranging ½- 1kg or 2 – 3 kg were higher and nearly the same (~40%) compared for the other weight weights (18 – 2%). Positive correlations were obtained with occupation for some localities (Jabel Awliya and Umbaddaa) while for other localities positive significant correlations with family size (Umbaddaa and Kharoum North).

The studies of Parizeau *et al.* (2006), Bandara *et al.* (2007) and Ojeda-Benitez *et al.* (2008) concluded that as the number of household members' increases, waste generation per capita has been found to decrease. Bandara *et al.* (2007) also concluded that as the number of people in a household increases, there is a reduction in the per capita waste generation rate, thereby establishing the fact that when waste generation parameters are considered, per household waste generation is as important as the per capita waste generation rate. Other recent studies with similar observations include Pieter van Beukering *et al.* (1999); Sujauddin *et al.* (2008). Mosler *et al.* (2006), and Qu *et al.* (2009). Abu Qdais *et al.* (1997) found a statistically significant but weak negative relationship between waste generation per capita and household size in Abu Dhabi. While Bolaane and Ali (2004) showed that there is a poor relationship between the number of persons in a household and the waste generation rate. They concluded that the number of persons in a household has a minor but discernible influence on the household waste generation rate. However, all these studies used statistical analysis to relate per capital daily waste generation with household size and income as the only important factors influencing per capita solid waste generation.

In the present study also the effect of lifestyle was linked with daily waste generation and the composition of household waste. Determining the per capita daily waste generation and the composition of the household linking with the effect of social factors, makes a recent contribution to the knowledge of understanding the role of households as waste generators. Unfortunately, few studies in the published literature have attempted to systematically relate lifestyle related factors to household waste generation. Yusof *et al.* (2002) pointed out that the effect of lifestyle is on the amount of waste generated by households. Tadesse *et al.* (2008) found that dust/ash and organic matter constitute the major components of household wastes as a result of the day-to-day lifestyle and consumption behaviour of residents. The per capita waste generation was found to decrease while the household income increased. The reasons for this surprising pattern may be contributed to the lifestyle, their living standard and the type of food consumed. Households with very high income may generate significant proportions of packaging waste, whereas, households with high and middle income generate wet food waste and significant amount of residual waste (sand, sweepings) which generally weighs more than the predominantly dry packing waste which may be common in households with very high income. It may be expected that households with very high income are more likely to buy packed foodstuffs and reading materials such as newspapers or magazines, than households with middle income who often prepare very basic meals. A study by Hockett *et al.* (1995) indicated that wealthier people often use and discard more paper, particularly as they read more newspapers. It is also possible that households with very high income are aware of environmental degradation and, therefore, have a culture of reusing or recovering waste, which would decrease the amount of waste generated. For example, recoverable materials such as plastic and glass containers are given to others, and food leftovers are kept in refrigerators and consumed at later times. Another possible reason of decreasing the per capita daily waste generated by households with very high income is possibly that members of these households dine outside (restaurants or hotels). This would reduce cooking activities at their households and lower the amount of waste produced by them.

The low-income and middle income households are more often involved in informal businesses. These businesses serve as supplementary income generating activities which individuals working in the formal

or informal sector employ as coping strategies to address the adverse effects from inflation or supplement their income. The existence of informal businesses within household premises generates income and at the same time tends to contribute to more domestic waste in the same household. Households with very low income have no reliable source of income and are therefore likely to generate less waste than those with regular sources of income. Abu Qdais *et al.* (1997) showed that family income was positively related to the rate of household waste generated.

4.3. Cooking and eating habits

Another lifestyle related activity which affects household waste generation is the energy use and the specific eating habits. In almost all localities under study, butane gas is the major source of energy used for cooking. The study also found that the specific lifestyle with respect to food consumption affects waste generation and composition. From the personal observations I realized that the high proportion of kitchen/food waste was found to be contributed by the habit of eating unprocessed food such as vegetables and fruits, and the low content of aluminum waste materials was, among other reasons, the result of not eating canned products. It is worth emphasizing as a conclusion that social and lifestyle related aspects have a strong influence on waste volumes, composition and also waste management practices of households. Getting to know these social factors in more detail can be of great importance for future waste management policies and services.

4.4 Waste characterization

The waste characterization study has provided useful data on the physical composition of household waste in the areas under study. Seven major components of the household waste have been presented with their relative percentages. These components are: kitchen waste, plastics, papers, metal, glass, and residual waste. Observation indicated kitchen waste constituted the highest proportion in all localities.

There is no recent waste characterization study which has been carried out to document the per capita daily waste generation and composition of household waste. The earlier studies which were performed to characterize domestic waste include Kaseva and Mbuligwe (2005), who calculated the average per capita generation rate of domestic solid waste as at 0.42 kg/cap/day, while 0.39 kg/capita/day was reported by Kaseva and Gupta (1996) for low income households. These studies used door-to-door collection methods for assessing residential waste generation per capita, although it was not specified whether commercial wastes from home businesses were also present in the residential waste stream.

A summary of the composition of household waste studies carried out by JICA (1997), Shengena (2002) and ERC (2004) showed that the percentage composition in low income household waste for the 1997, 2002 and 2004 surveys in Dar es Salaam. As can be noted, there was a slight increase in the percentage of kitchen waste from (39.8%) observed by JICA (1997) to 42% indicated by Asia (2011). The study by ERC (2004), showed the same percentage of kitchen waste (42%). In general, the composition of household waste contains more kitchen waste and residual waste than other materials, which is a typical households waste characteristic in developing countries. According to the World Bank (Cointreau, 1982), low income countries should have a household waste composition by weight of 40-85% organic, 1-10% paper and glass, 1-5% metals, plastics, rubber, textiles and 1% residual waste.

Paper, plastic and glass amongst others increased yearly. Plastic increased the high percentage of paper, plastics and glass can be explained from the fact that the use of the materials especially for packing has increased, and become a source of environmental deterioration. Such materials provide recycling opportunities, while at the same time, a high fraction of kitchen waste must be considered both in terms

of the additional problems it presents (such as foul smell, flies, etc.), as well as the potential opportunities for income generation.

Conclusion

Households generate various types of waste which include kitchen waste, papers, plastics, metals, aluminium, glass and residues such as ash and sweepings in different proportions. They were also involved in solid waste management though various activities, such as waste storage, collection and the transfer and disposal of domestic wastes. Since households are waste generators, and also participate in waste management activities, they must be regarded as major stakeholders in solid waste management. People are often overlooked in the service delivery framework, while they can contribute significantly to service delivery. But more importantly, they can play an active role in improving accountability and service quality of both public and private sector.

Functional links between households, community-based activities and the municipal system are very important, even where municipal waste collection services are provided in a regular and formal way, the cooperation of householders is essential to efficient SWM operations. To make solid waste management work at the local level, there is a need of gaining legitimacy and support from households, and to understand their perceptions towards solid waste management. When support and legitimacy are absent and perceptions negative, one can expect householders to resort to open burning of wastes, when materials are simply set on fire and left to burn. When support is lacking, we see householders not becoming involved in waste separation or householders not willing to deliver domestic wastes to a transfer station or communal facility. Considering these examples, it also becomes important to understand how householders perceive the waste management services provided to them, and also to better understand the perception they have about their own actual and potential roles in solid waste management.

Recommendations

1. Promote sustainable alternative approaches to solid waste management such as composting and recycling by adopting serious initiatives from households, associations or individuals. This will also contribute to improvement of income generation.
2. Optimize modes of waste collection and transportation.
3. Public awareness through social media to enhance the concept of sorting at the source and how to make benefit of waste and turn it into useful products.
4. Develop a database for solid waste characteristics

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