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Full Length Research Paper

Electronic Waste Generation and Its Management in Bole and Akaki Kaliti Sub cities of Addis Ababa Ethiopia

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Abstract

This study was to assess the electronic waste generation and management in selected woredas of the Bole and Akaki Kaliti Sub cities of Addis Ababa. Proportional selection of sample respondents from various sectors and random selection for questionnaire survey were adopted along with key informant interview and direct field observations. The total sample size was 191. The study period was March 2013-February 2014. Chi square analysis showed significant difference of the total number of e-goods and the obsolete e-goods in both Sub cities. Total number of obsolete electronic items in the selected woredas of two of the ten Sub cities in Addis Ababa was 5654, pointing to the possibility of considerable volume of obsolete items in the remaining 8 Sub cities. Repair shops of e-goods in the study area contributed a major role in extending the life span of the e-goods and thus reduce the number of thrown away e-goods. Cathode Ray Tubes occupy a prime position of residues in repair shops. Low quality of electronic goods, high repair cost and availability of cheaper new goods attracts the consumers towards the throw away culture. 50% of the participants were disposing e-wastes along with municipal solid wastes. Repair shops were practicing burning and burial of electronic residues. The formal recycler in Ethiopia (CRTC) offering service, despite its limitations due to lack of aspects including technology, market flow for e-residues, work force and store spaces. This study recommends detailed research, awareness programs and action plans for the eco-friendly, safe recycling of e-wastes.

Key words: *Electronic wastes, Environment, Ethiopia, Management*

Introduction

Solid waste management has been expanding all over Ethiopia in leaps and bounds. Since Ethiopia has adopted a pathway to progress exploring Information and Communication Technology (ICT) possibilities, e-waste or the waste generated out of electronic and electric gadgets have emerged as a major constituent among the solid wastes. Gradual but conspicuous growth of e-waste demands early planned strategies for dealing with it. An e-waste component usually contains an assorted stock of hazardous chemicals that can cause multiple damages to land, air and humans. Hence as the volume of e-waste components increases, the lethality of the solid waste is amplified. Improper e-waste management is an escalating problem all over Ethiopia, but eluding necessary attention. Ample studies and investigations to sketch the ground reality are hence highly essential for proper planning toward accomplishing a sustainable way of dealing with new generation solid waste component. Ethiopia's vigor and enthusiasm to tap the ongoing technological merits demands a simultaneous foresighted approach towards e-waste management. Inclined to this wisdom, this study has tried to understand the e-wastes generation and management practices of the Bole and Akaki Kaliti sub cities of Addis Ababa.

Materials and Methods

Site Description: Addis Ababa is the capital city of Ethiopia. According to the 2007 Census of Ethiopia, the Addis Ababa City has a total population of 2,738,248. Addis Ababa lies at an altitude of 2440m and is a grassland biome, locating at 9.03°N and 38.73°E (AACG, 2006). Bole and Akaki Kaliti are two of the ten sub cities located respectively at South East and South of Addis Ababa. The researcher selected 3 and 5 Woredas in Bole and 2 and 5 Woredas in Akaki Kaliti sub cities purposively.

Questionnaire survey

Different sectors of the study location generating large amount of e-wastes were selected for the study purposively and questionnaire was prepared to get information related to the objectives of the study. Proportionate samples were taken from various sectors in the two sub cities followed by random selection was made. Since the total number of households is too large, in order to get the sample size of households, a sample technique by Cochran (1977) was applied and got the sample households number as 130. The study period was from March 2013-February 2014. The total sample size of all the sectors includes 191. In order to manage the data, the classification of electronic goods (White, Brown and Grey goods) was adopted for the study. The grey goods are comparatively more

complex to recycle due to their toxic composition (Toxic Links, 2003). Key informant interviews and direct field observations were also conducted for gathering the details.

Data Analysis

Contingency Chi square test of Karl Pearson (1904) was used to test the significance of the difference between the observed and the expected distributions of electronic goods and e-wastes in Bole and Akaki Kaliti Sub cities. Descriptive statistics was also used for assessing qualitative data.

Results and Discussion

Among the study participants, 179 (93.71%) were males and 12 (6.28%) were females. Study results indicated that the educational status of most of the participants in both Sub cities were first degree and above. The households were categorized into high, medium and low income status followed by the Central Statistical Agency Report (2007). In Bole Sub city, 93.94% of the households come under the high income status, while in Akaki Kaliti Sub city 35.48% of households come under the medium income status. In case of electronic goods, purchase capacity due to income level is an influencing factor. Since most of the respondents from Bole households come under the high income category, they could buy more electronic goods compared to the respondents from Akaki Kaliti Sub city. Figure 1 indicates that the total number of working electronic goods in Bole Sub city was 13,202 while that of Akaki Kaliti was 8214. These values indicate the direct relation between income status and purchase power of electronic goods by the respondents in the study area.

Status of Electronic Goods in the Sub cities

Figure 1 shows a summary of electronic goods and obsolete items in the two Sub cities. The status of grey goods needs special attention, since it is very difficult to manage and recycle. The current study revealed that the total number of grey electronic goods in Akaki Kaliti was higher (5587) compared to that of Bole Sub city (3926). This may be due the fact that Akaki Kaliti Sub city is more industrial compared to Bole, and that many factories and office complexes in the area is contributing to the total grey goods. Since Bole is more a residential area, compared to Akaki Kaliti, the white and brown electronic good status of this Sub city is more compared to Akaki Kaliti. The chi square analysis of the total electronic goods in the two Sub cities showed a significant difference. The Chi Square value of total electronic goods compared for the two Sub cities is 3079.67, at 2 df, which is highly significant (the table value of Chi square = 5.99 at $P \leq 0.05$). This strongly indicated that the difference is not because of chance but because of the particular reasons such as the high income status of Bole residents contributed for the purchase power of the respondents than that of the Akaki Kaliti respondents. Total number of obsolete electronic items was 3293 in Akaki Kaliti and 2361 in Bole. The total number of obsolete items in both the Sub cities was 5654 during the study period. The Chi Square value obtained for obsolete EEEs' of two Sub cities is 775.55, at 2 df, which is many fold higher than the table value i.e., 5.99 at $P \leq 0.05$ level of significance. Again this strongly supported the difference in the number of obsolete electronic items in the two Sub cities, which was expected because of the difference in number of total electronic goods and the presence of CRTC in Akaki Kaliti which collects the obsolete electronic items from the federal offices of Ethiopia.

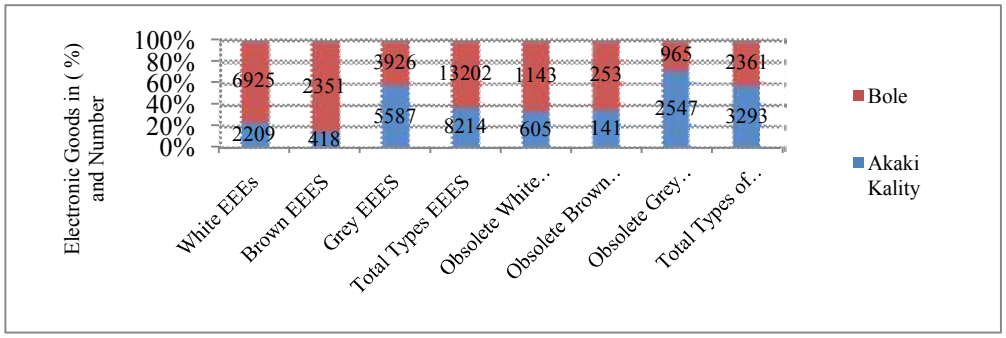

Fig 1. The number and percentage of electronic goods and obsolete items in both Sub cities

Role of repair shops in e-waste reduction

Tables 1-3 show the monthly average number and percentages of grey, brown and white damaged electronic goods received for repair purpose in both Sub cities. The repair shops of Bole receive mobile phones (43.1%) for repair than any other grey goods. Among the white goods, Bole shops were receiving high number of refrigerators (41.38%). The results indicated that the repair shops play a chief role extending the life span of electronic goods and thus reducing the number of thrown away goods. The repair shop dealers commented that the low quality of equipments is the main problem behind the damaged electronic goods they were receiving in their shops. According to Widmer et al. (2005), a major driver of the growing e-waste problem is the low quality and short life span of most electronic products—less than two years for computers and cell phones.

Table 1. Monthly average number and percentage of grey goods

S. No.	Types of Grey goods	Received for repair				Repaired goods			
		Bole		Akaki Kality		Bole		Akaki Kality	
		No	%	No	%	No	%	No	%
1	Desktops	20	34.48	-	-	15	34.88	-	-
2	Laptops	10	17.24	-	-	8	18.60	-	-
3	Mobiles phones	25	43.10	30	100	18	41.86	25	100
4	printer	3	5.17	-	-	2	4.65	-	-
	Total	58	100	30	100	43	100	25	100

Table 2. Monthly average number and percentage of Brown goods

S. No	Types of Brown goods	Received for repair				Repaired goods			
		Bole		Akaki Kality		Bole		Akaki Kality	
		No	%	No	%	No	%	No	%
1	TVs	13	46.43	21	51.18	10	45.45	18	43.90
2	DVD Players	15	53.57	30	58.82	12	54.55	23	56.10
Total		28	100	51	100	22	100	41	100

Table 3. Monthly average number and percentage of white goods

S No.	Types of White goods	Received for repair				Repaired goods			
		Bole		Akaki Kality		Bole		Akaki Kality	
		No	%	No	%	No	%	No	%
1	Refrigerators	12	41.38	-	-	8	40	-	-
2	Washing machines	5	17.24	-	-	3	15	-	-
3	Mixers	4	13.79	-	-	3	15	-	-
4	Coffee makers	8	27.59	-	-	6	30	-	-
Total		29	100	-	-	20	100	-	-

Electronic Residues production from repair shops

Table 4 shows the average weight (Kg) and percentage of electronic residues produced by the repair shops. Cathode Ray Tubes (CRTs) occupy the prime position (35Kg) followed by the computer batteries (30 Kg). Robinson et al. (2009) reported that the CRTs and batteries from various electronic appliances are rich with hazardous substances including Lead, Mercury, Chromium, Barium and Beryllium. Lead, Mercury and Chromium are the heavy metals with bioaccumulation properties, creating serious health effects in human beings including sensory impairments, dermatitis, memory loss, muscle weakness, reduced fertility, damage to lungs and kidneys. The researcher identified that in most of the repair shops, the electronic residues were kept open without proper covering and the workers were simply exposed to electronic residues without proper safety measures such as gloves or masks or safety gown and they were handling the residues and electronic parts with bare hands. This increases the health risks for the workers from toxic substances of electronic goods. Orish and Chiara (2010) reported that unscientific handling and disassembling of e-waste is a major risk to environment and public health.

Table 4: Monthly Average weight (Kg) and % of electronic residues from repair shops

S. No.	Entity of residues	Weight in Kg				
		Bole		Akaki Kality		Total
		Wt. in Kg	%	Wt. in Kg	%	Weight (Kg)
1	Plastics	15	53.57	13	46.43	**28**
2	Metals	10	62.50	6	37.5	**16**
3	Glasses	8	57.14	6	42.86	**14**
4	Cathode Ray Tubes	20	57.14	15	42.86	**35**
5	Computer battery	30	100	-	-	**30**
6	Mobile phone battery	10	41.67	14	58.33	**24**
7	Mixture of materials	16	61.54	10	38.46	**26**
	Total weight				**173 kg**	

Reasons behind the formation of electronic wastes

The study indicated that the total number of obsolete items in both the Sub cities was 5654 (Fig. 2). Table 5 shows the response among the study participants about the reasons behind the formation of e-wastes in the study area. In most of the developing countries, low quality electronic goods or fake electronic goods bearing the original company names are getting widespread these days. Ethiopia is also facing such problems. The study indicated that the high repair cost of the electronic goods combined with availability of

cheaper, new electronic goods instills a throw away culture leading to accumulation of obsolete electronic items. Some of the respondents mentioned reasons such as power failure and voltage fluctuations as also indirectly causing malfunction of many sensitive electronic items. Akhila et al. (2013) reported various reasons behind e-waste formation such as low quality of equipments, low cost of new equipments, craze towards new generation equipments and less life expectancy of electronic goods and pointed the low quality of equipments was the main reason behind formation of electronic wastes. According to Arora (2008) abundance in the volume of e-waste is primarily due to an increased growth of replacement market and high obsolescence rate.

Table 5. Reasons behind the formation electronic wastes in the study area

S. No.	Reasons behind the formation of e-wastes	Number and percentage of responses			
		Bole		Akaki Kality	
		No	%	No	%
1	High repair cost of e goods	30	25.86	20	26.67
2	Malfunction of e-goods	13	11.21	16	21.33
3	Lifespan elapsed	7	6.03	4	5.33
4	New products are cheaper	29	25.00	10	13.33
5	Low quality electronic goods	37	31.90	25	33.33
	Total	**116**	**100**	**75**	**100**

Awareness about Environmental consequences of electronic wastes

Most of the respondents from both Sub cities pointed out that regarding the safe management of the e-wastes, huge quantity of electronic waste is the main hurdle they face. Instead, they were less wary of environmental risks such as hazardous substances leach into the soil, health risks due to heavy metals, depleting natural resources (Table 6). 35 (30.17%) and 20 (26.67%) respondents from Bole and Akaki Kalitians were that the site of disposal will be polluted out of e-wastes. Most of the respondents had no comprehensive idea about the health risks due to the presence of heavy metals in e-goods. This is congruent to the assumptions made by earlier studies that gross lack of awareness about e-waste is a major problem (Akhila et al. 2013).

Table 6. Awareness about Environmental consequences of electronic wastes

S. No.	Environmental Consequences of e-wastes	Number and percentage of responses			
		Bole		Akaki Kality	
		No.	%	No.	%
1	Bad appearance to the environment	15	12.93	10	13.33
2	Hazardous substances leach into the soil	-	-	2	2.66
3	Polluted disposal area	35	30.17	20	26.67
4	Health risks due to heavy metals	-	-	2	2.66
5	Depleting Natural resources	-	-	1	1.33
6	High quantity for managing safely	66	56.90	40	53.33
	Total samples	**116**	**100**	**75**	**100**

E-waste management in the study area

Figure 2 shows the management methods adopted by the respondents in the study area. The respondents agreed that they were simply storing the e-waste with the belief that sometimes either they would extract useful spare parts from them or sell them for a good price. Usually such goods occupy considerable space in their premises. 50% of the respondents agreed that they used to throw away of obsolete electronic devices along with municipal solid wastes. Pertinent issue here is that most of the respondents do not know any proper way of disposing their e-waste. Hence there prevails the tendency to store e-waste in houses or premises or else to throw away them with other wastes. A study held in Malaysia revealed that people store or throw away e-waste with other wastes don't know how and where to dispose of these e-wastes (Molly et al. 2003). Illegal and legal repairers in the current study area agreed that they were practicing burning and burial of electronic residues. According to Wong et al. (2007), open burning and burial of e-wastes pose public health concern due to constant exposure to toxic chemicals through inhalation and oral intake of contaminated local food and drinking water. In African countries large quantities of e-waste are discarded or buried at riverbanks, where e-waste is manually disassembled. Respondents from Computer shops of the study area agreed that they were returning the obsolete items to the mother company after storing for a particular period of interval, a sustainable practice of e-waste management.

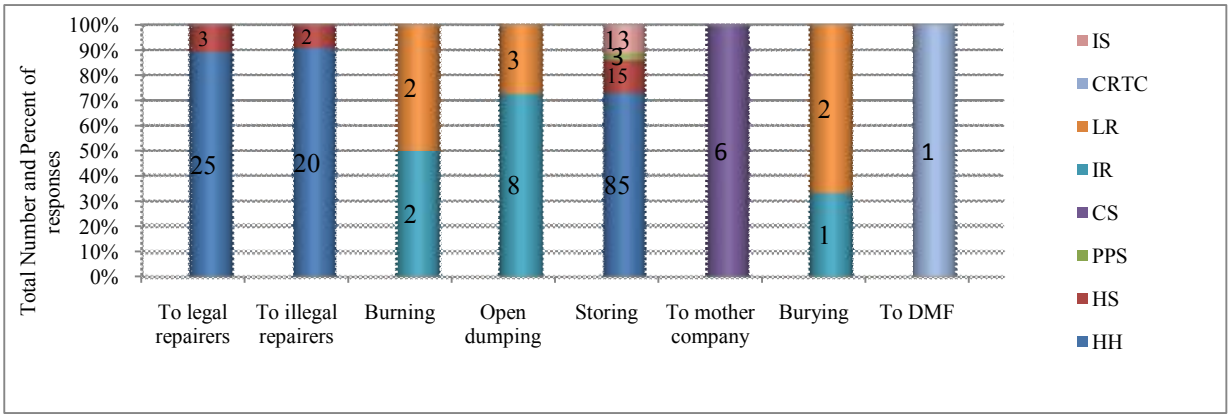

Fig 2. The methods of electronic waste management by the respondents in various sectors (HH-Households, HS-Hotels, PPS-Preparatory schools, CS- Computer shops, IR & LR-Illegal and Legal Repairers, CRTC-Computer refurbishment &Training Centre, IS-Industries).

Role of Computer Refurbishment and Training Centre (CRTC) and Dismantling Facility (DMF) in E-waste management

According to CRTC e-waste manager, 2217 desktops (out of which 11 are obsolete) were imported and 2499 were domestically collected during the study period. Out of this 193 desktops were not in a position to refurbish, hence sent to the DMF. This shows the huge production of obsolete computers in Ethiopia. Since second hand computers are widespread in Ethiopia, there is a concomitant generation of obsolete computers also. Quest for increasing incomes along with the loopholes in the law and its enforcement encourage the e-waste flow from advanced countries making a brisk business in developing and transition countries (Chaiara et al. 2010). According to CRTC Information Technology and Training Manager, the centre has several advantages in terms of saving foreign currency, creating job opportunities and environmentally responsible way of managing obsolete machines. The DMF in Akaki Kalitiapply manual dismantling as the primary treatment to separate the heterogeneous materials and components using simple tools like hammers and screwdrivers. After the dismantling pre-processing, the components with reuse value like the parts containing Copper, Aluminum, steel, plastics, printer toner, and circuit boards are classified for further treatment to extract precious metals. Due to absence of appropriate technology, sufficient number of workers and sufficient market flow, the premises of the DMF is filled with E-residues. Table 7 shows the average weight of residues generated from DMF. The results show that the steel and iron residues (25,828 Kg) are the highest. According to the e-waste manager, the DMF is simply storing these residues, since there is scarcity of market flow and insufficient guideline for e-waste residue supply to the consumers. According to Ramachandra and Saira (2004), recycling and reuse of material is one of the potential options to reduce e-wastes. Recovery of metals, plastic, glass and other materials reduces the magnitude of e-waste.

Table 7. Monthly average of residues generated in DMF

List of residues	Number of residues	Weight in kg
Transformer	217	400kg
Wires and cable	-	260kg
Aluminum heat sink	1914	346kg
Motors	827	207kg
Plastic fans	760	85kg
Steel & iron	-	25,828kg
Plastics	-	8316kg
Total	**3718**	**35, 788 kg**

Conclusion

The current study revealed that the total number of grey electronic goods in Akaki Kaliti was higher compared to that of Bole Sub city. Total number of obsolete electronic items in the selected woredas of two of the ten Sub cities in Addis Ababa was 5654, pointing to the possibility of considerable volume of obsolete items in the remaining 8 Sub cities of Addis Ababa. The results showed that the repair shops of electronic goods of the study area contributed an important role in extending the life span of electronic goods and thus reduce the number of thrown away e-goods. Among the residues produced in repair shops, CRTs occupy the prime position followed by the computer batteries. This pointed towards the serious health risks for workers associated with the improper handling of highly hazardous CRTs and batteries. The study participants from both the Sub cities responded that the low quality of electronic goods as the main reason behind the formation of e-wastes. The study indicated that the high repair cost of the electronic goods and availability of comparatively cheaper new electronic goods with more features attracts the consumers towards the throw away culture, leading to accumulation of obsolete electronic items. Considering safe management of e-wastes, major challenge felt by the respondents was the quantity of e-waste than the principal environmental impacts. The study participants were simply storing, burring or throwing e-wastes

with other municipal solid wastes. The study observed that CRTC offers its service to manage the e-wastes even if it is facing problems of lack of technology, lack of market flow for e-residues, lack of work force and a scarcity of store spaces. So strengthening of formal recycling of e-waste is very essential for attaining sustainable development.

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