E- Waste Disposal in Tanzania: The Implications for Income Generation and Poverty Reduction

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Abstract: *There is increasing deployment and use of ICT materials from developed countries by the developing countries. This has been the case given the acknowledged ICT potential for economic growth, income generation and hence reduction of poverty. Because of its fast growth, the ICT industry has generated volumes and volumes of 'e - waste', which in turn, requires mechanisms and skills for disposal, notwithstanding, the necessity to explore means of using the same as a business for income generation. The study set out to investigate the existing practices and levels of understanding with regard to the business potential that could be realized from the disposal process of ICT waste, through recycling, re-use, extraction of useful parts, reassembling and repair works resulting from the used e – waste products. The intention was to establish the level with which the process could be used as a source of income generation and hence reduction of poverty. The study used the Rapid Assessment Methodology (RAM) approach, which is reckoned for its multiplicity of methods and instruments in studying given phenomenon. Twenty four institutions (24) both public and private; and the Informal sector were surveyed; and a sample of seventy five (75) respondents was involved in the study. The scope of the study spanned to five administrative regions of Dar es Salaam, Arusha, Morogoro, Mbeya and Mwanza, while the informal sector involved Gerezani, Kariakoo, Kinondoni, Msimbazi, Kigogo and Pugu – Kinyamwezi Dump. While from the institutions we involved managerial staff, ICT experts, Supplies officers, and environmentalists, in the Informal sector we involved computer vendors, refurbishers, recyclers, collectors and repairers. The study findings came to the conclusion that ICT waste had high economic and business potential, which could be harnessed to generate income, create employment and hence reduce poverty. The participants in the informal sector indicated that they had been able to generate income, pay school fees for their children and improve the standard of life. However, it was clear that there was no clear policy on the e – waste disposal, sufficient information about the process and skills for disposing the materials safely and avoid hazards. The study thus recommended for consumers' awareness campaign, capacity building for vendors to improve recycling, reassembling and extraction skills. Moreover, the informal sector should be motivated to better exploit such opportunities for improved social economic conditions and reduction of poverty.*

The study recommends the need to put in place policies which will guide the disposal of e-waste in the country.

INTRODUCTION

The electrical and electronic industries have recently emerged as the most thriving industries, not only in the developed world, but also, in developing countries, Tanzania inclusive. This has been the case because of the significant role of Information and Communication Technologies (ICTs) in stimulating economic growth and income generation among the poor. ICT is counted to be a necessary tool for sustainable social and economic development in the 21st century, which is also regarded globally as "Information Age (Fuhr and Pociask, 2007)." In essence, individuals and societies will by and large depend on the ICT for their social economic success. More over, ICT is a requirement and driver for further innovation and competitiveness in the global economy, and indeed, it will remain to be the main catalyst for changes in personal, work and community life *(op. cit.).* In view of such potential for individual and society development, the flow of ICT products and materials from developed countries to developing countries has been on the increase, hence making the ICT industry generate volumes and volumes of products for consumption by the users. This has been facilitated by undertaking deliberate policies, strategies and action plans, so as to keep pace with the changing world of ICT. In Tanzania for example, the National ICT Policy, Ministerial ICT Policies and Institutional Policies, all pronounce the centrality of and prominence of Science and Technology, in strengthening and mainstreaming of ICT in all walks of life (URT, 2003; MHEST/MOEVT, 1999 and OUT, 2004). There have also been other deliberate measures, like tax relaxation in the importation of ICT products in the case of Tanzania, which added to the proliferation of ICT equipment and allied accessories in the government offices, universities, schools as well as the private sector (ref. Figure 1 for importation data).

When the usefulness of these products comes to an end, an equal volume of electronic waste, otherwise called 'e-waste' or 'e-scrap' has been generated, which in turn requires to be disposed of. The disposal of 'e-waste' is a recent phenomenon describing the handling of surplus, obsolete, broken or discarded electrical or electronic devices (Wikipedia, 2009). The phrase may refer to the component which has been dumped or disposed of or discarded, rather than recycled, reused, and recycling operations *(op. cit.).* Much as ICT potential for economic growth and income generation has been well acknowledged, a subject closely associated with it has been the disposal process of e-waste materials. This is so because, the disposal of e-waste is both an emerging problem

(threat) to the health and environment of human beings and species on the one hand and an economic opportunity, which can be used to generate income and thus reduce poverty. The most important opportunity is a combination of the following techniques, which according to (WSIS, 2003) appear preferable: repair, re-use, upgrading of existing equipment, use of unobjectionable materials, and recycling.

Implementation of these new procedures would require concerted efforts by the government, business community and the informal sector, so that the emerging entrepreneurs can fully realize the potential and opportunities offered by the ICT industry.
This study focused on the potential economic opportunities, activities and their practical implications towards Poverty Reduction, which could be realized in the course of the ICT hardware disposal process in Tanzania. Four main research questions guided the study, namely:

(i) To investigate the volume of ICT hardware inflow with a view to determining both the potential volume of economic activities emanating from ICT hardware disposal.
(ii) To examine the existing practices and regulations for ICT hardware disposal at the national level, within the public institutions and the informal sectors,
(iii) To identify potential economic activities that may arise in the course of ICT hardware disposal process as a part of e – waste management and,
(iv) To explore the problems or drawbacks the entrepreneurs face in the course of ICT hardware disposal process.

In this paper we report the findings of the study that set out to investigate the opportunity dimension of ICT disposal with a view to finding out how entrepreneurs had exploited the opportunities within the ICT industry, with specific reference to the e - waste disposal process, in the Tanzanian informal sector

THE PROBLEM

The ICT industry uses the materials such as chips in computers which are upgraded so oftenly due to technological changes in the computer industry. The remaining components could be upgraded based on the re-use technologies (WSIS, 2003). This could become a source of new jobs in developing countries, especially in the informal sector. Hence there could be a change from the current state of the art in dealing with electronic waste, recycling, to partial re-*use* as a future development. The disposal of 'e– waste' products is a complex process which requires specialized knowledge, skills and facilities so that those who are pursuing business motives can realize maximum gains and profits. On

the other hand those who are disposing such facilities are likely to be affected adversely by lack of requisite knowledge and skills in undertaking such activities. But most crucial is the fact that, due to lack of knowledge, skills and facilities the exercise may result in serious pollution of the environment and risks to those involved in the disposal process. Thus in spite of the perceived economic and business potentials in the disposal process of e–waste materials, the nagging question is whether the entrepreneurs in the informal sector have the requisite knowledge, awareness, skills and facilities to undertake their activities, for maximum gains and benefits from the disposal process of ICT waste, and as a result, generate income, create employment and finally reduce poverty.

METHODS

The Rapid Assessment Methodology (RAM) was used in this study. It is an approach or tool kit which combines and uses simultaneously, different methods and instruments so as to correct the short comings posed by using one method or instrument only (Rwegoshora, 2006). It involves reviewing the existing literature on the subject matter, transecting and mapping i.e. familiarization with the environment and the hosts, interviews with subjects and key informants, observation and focus group discussions. Basically this was a qualitative study, which involved 22 institutions, five (5) used ICT hardware shops, and 109 individual working informally as collectors, refurbishes, recyclers, extractors and buyers of scrap metals and plastic materials. In addition, 23 Senior Managers, twenty four (24) ICT professionals, seven (7) supplies personnel and eleven (11) environmentalists were also interviewed. Furthermore, the survey included two ICT hardware repair workshops and the visit to dump sites.

Observation method was used during the visit to the dump sites. The researchers observed the process of sorting, extraction of valuable parts, the repair work, re-cycle or re-use of the extracted parts as they were performed in those sites. In the institutions the researchers were interested to know about the acquisition process, the utilisation, the storage, and disposal processes.

Before the main research was done, a pilot study was conducted at The Open University of Tanzania (OUT), the area where researchers started observing the problem. The respondents were environmentalists, senior members of management, and ICT staff. The pilot study helped the researchers to refine some of the research questions.

In this study four research instruments were used namely: documentary review for secondary data; interviews (structured and unstructured interviews), questionnaire and observation. These were used to collect both primary and secondary data. Triangulation was also used conjointly to ensure that all the important information had been elicited. Focused group discussions (FGD) were used to concretise the initial findings through round table discussions.

Questionnaires

A questionnaire was prepared containing both closed and open ended questions and was administered to respondents by researchers and assistant researchers who were recruited from the site. The questionnaire was administered to various respondents as summarized in Table 1.

Table 1: Distribution Respondents by Regions and Specialisation

Regions	Senior Managers	ICT Professionals	Supplies/Procurement	Environmentalists	Used PC/Obsolete ICT Hardware Vendors	Informal sector (collectors, refurbishers, recycle and extractors,	Total
Dar-es-Salaam	7	8	2	8	5	109	**139**
Morogoro	3	6	3	0	0	0	**12**
Mbeya	5	2	2	0	0	0	**9**
Arusha	5	3	0	2	0	0	**10**
Mwanza	3	5	0	1	0	0	**9**
Total	**23**	**24**	**7**	**11**	**5**	**109**	**179**

Source: Survey 2008/2009 from the sites (streets and Dump)

Interviews

Interviews were conducted with key ICT informants and especially those from ICT Technical staff, supervisory, and managerial staff levels. Interviews were used to solicit information with regard to: the volume of ICT hardware inflow within their institutions, the existing practices and regulations for ICT hardware disposal at the national level, within the public institutions and the informal sectors. We also explored the potential economic activities that could arise in the course of the ICT hardware disposal process and the problems or drawbacks which the entrepreneurs faced in the course of ICT hardware disposal process.

On-site Observations

Some of the interviews took place on site, where the researchers had the opportunity to see for themselves what was going on. The method helped to generate first hand information and helped the researchers to

record phenomenon as it was observed on the spot of occurrence. The researchers observed what practices were in place in the mentioned institutions, as can clearly be seen in Figure 1.

Figure 1: One of the Researchers on site with one of the Interviewees Focus Group Discussions (FGD)

The Focus Group Discussions (FGD) was one of the instruments which had been identified for data collection in this research. FGD's were conducted for the purposes of triangulation i.e. verify further the information collected from questionnaire and interviews. Further, the FGDs discussion helped explore participants' candid opinion over the subject matter under study. The FGD was conducted within the context of focused guidelines, and the researchers were involved in posing the probing questions as had earlier been identified. The FGD had targeted 15 members, 11 (77%) distributed as follows: male 8 (53%) while female were 3 (18%) of the invited stakeholders attended. The main purpose of the session was to elicit important lessons from experienced members from the institutions mandated with environmental issues in the country and from which policy guidelines sprang. These institutions include Vice President's Office, National Environment Management Council (NEMC), REPOA and OUT.

Documentary Reviews

Review of literature was done by using published materials such as journals, books, reports, dissertations, newspapers, conference reports and government web sites. This Method was used to supplement information collected through questionnaires, interviews, observations, ending up with focused group discussion.

RESULTS AND DISCUSSIONS

Discussion on Importation of used and new ICT hardware

In our survey, we found that The Commission for Science and Technology (COSTECH) had involved in the importation of used computers between year 2000 and 2008 which were distributed to

various institutions such as University of Dar-es-Salaam, The Open University of Tanzania and in some cases to individuals. There were other sources of used computers, such as those distributed by the World Bank through the African Virtual University (AVU) project to the University of Dar-es-Salaam and The Open University of Tanzania, donation of used PCs from Swiss Government to The Open University of Tanzania in 2005. Experience of users, such as The Open University of Tanzania was that such computers lasted for about a year at best. There were no complete statistics of how many used PCs had already found their way to our country. Other sources included those brought in through NGOs, small business men and were sold at a price between Tanzanian shillings 50,000 to 150,000/= and individuals who brought them in small numbers.

In three shops visited, it came out clearly that the imported used ICT equipment were from the United States of America, UK, Sweden and other European countries. Some came as donations, while others were purchased at minimum prices, although the importers declined to disclose the actual purchase prices.

Estimates of number of Computers based on TRA Statistics

The researchers had the opportunity to visit Tanzania Revenue Authority (TRA), the customs department. The following was the summary of findings in terms of how many computer systems were imported mostly from United Arab Emirates (Table 2).

Table 2: The Number of Computers imported to Tanzania (2003-2008)

S/n	Type of Computer Systems	2003	2004	2005	2006	2007	2008
1	Analogue Or Hybrid Automatic Data Processing Machines	7369	30880	3674	1486	3493	0
2	Portable Digital Adp Machines,Wt<=10 Kg,Comp.At Least Cpu,Keyboard&Display	17894	16539	28429	12826	47333	25202
3	Nonportable Adp Machines,Comprisng At Least Cpu & I/O Unit In Same Housing	2664	3066	26059	6508	9028	65212
4	Non-Portable Adp Machines, Nes, Presented In The Form Of Systems	18586	10152	21923	22075	31488	47170
	Total	**46,513**	**60,637**	**80,085**	**42,895**	**91,342**	**137,584**

Source: (Survey - TRA, 2009)

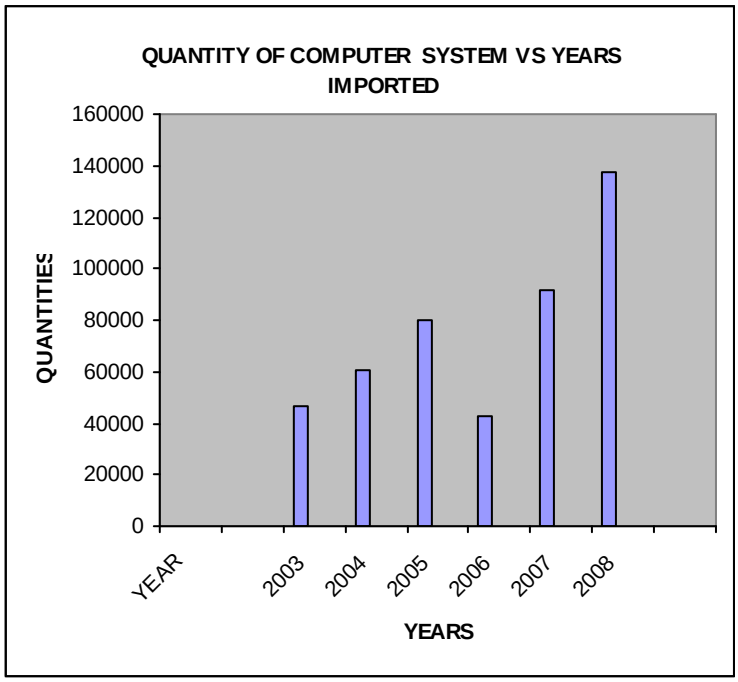

Figure 2: Quantity of Computer Distributed from 2003-2008

Source: (Survey - TRA, 2009)

It is important to note that, in 2003 the importation tax for computer was waived and this explains the nature of fast growth of the volume of computer importation. According to TRA, there were computer parts which were imported and assembled in the country. Again most of the spare parts were imported from United Arab Emirates (See Table 3 below):

Table 3: Number of Computer Spare Parts sets Imported (2003-2008)

S/n	Type of Spare Parts	2003	2004	2005	2006	2007	2008
1	Digital Processing M/Cs (Exc.847141&49) Comp.<=2units Storage/Input/Output	8647	13988	53859	7,652	13580	12173
2	Adp Input/Output Units Whether/Not Containing. Storage Units In Same Housing	74159	62916	601566	57,201	97783	63042
3	Automatic Data Processing Machine Storage Units	12407	7084	50957	13,248	24250	23767
4	Units Of Automatic Data Processing Machines Nes	3046	4047	10533	11,698	145291	13877
5	Magnetic/Optical Readers; Machines For Transcribing Data Onto Datamedia Nes	18884	24349	24334	14,831	72609	12732
	Total	**117143**	**112384**	**741249**	**104,630**	**353,513**	**125,591**

Source: (Survey - TRA, 2009)

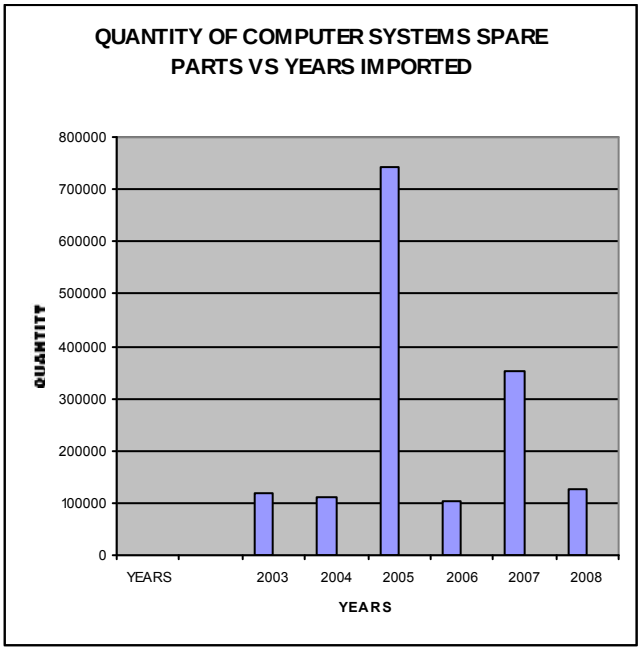

Figure 3: Quantity of Computer Systems Spare Parts vs Years Imported

Source: Survey Data

Estimates of number of Computers based on the World Bank Reports
Projections of the number of computers per population, according to the data from Word Bank (year 2000 to 2008), showed exponential growth of the number of computers for Tanzania as detailed in the Table 4 below:

Table 4: Estimates of No. Computers in Tanzania

YEARS	POPULATION	Number of Computer per 1000 People	No of computer users
2000	33,463,388	1.6	**52,800**
2001	33,756,093	2.4	**81,600**
2002	34,161,166	2.8	**98,000**
2003	34,876,231	3.3	**115,500**
2004	36,049,581	4.2	**151,200**
2005	37,267,530	5.7	**210,900**
2006	38,523,907	7	**266,000**
2007	39,816,363	9	**369,000**
2008	41,146,284		

***(Source of Population Data:** National Bureau of Statistics (NBS)*

Source of Computer Data: World Bank (2008)

What we see when plotting the data is exponential growth as indicated in Figure 4.

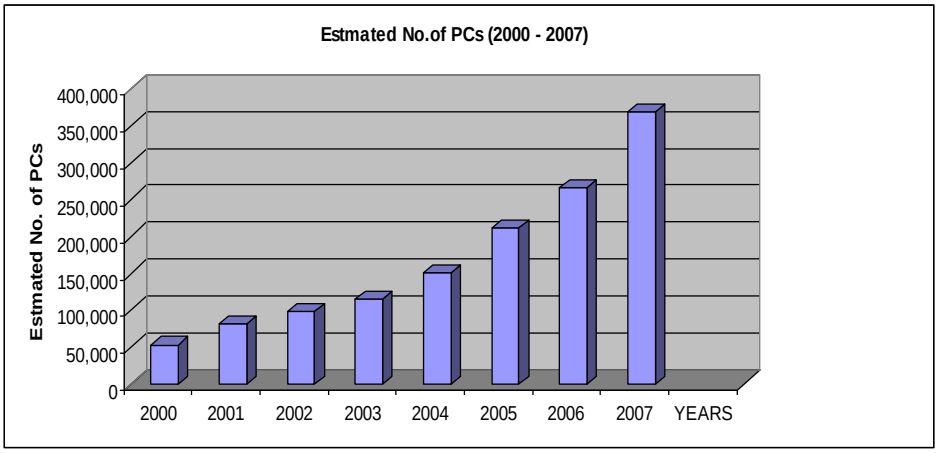

Figure 4: Estimates of No. Computers in Tanzania-(Source of Population Data: National Bureau of Statistics (NBS), Source of Computer Data: World Bank (2008)

Discussion on existing practices, regulations for ICT hardware disposal, within the Public Institutions and the Informal Sector

Current practices with the Collectors

The number of collectors involved in the study was 20 in total, and these were found in sites of collection, met in the streets and others were located across the sites and work shops of the recyclers or workshop people. From the interview it was revealed that they collected the used ICT equipment from Government Offices, Parastatal Organizations and Non Governmental Organizations (NGOs), normally at a price through auctioning and the price was 20-30 US$ per PC

The interviewed individuals who did this activity claimed to survive solely on the collection business. For example, collection was made at landfills, garden sites and other municipal collection sites in addition to places mentioned above. In relation to informal process, e-waste was sorted in an ad - hoc way from mainstream waste at the dump sites. Informal collection usually involved basic re-cycling such as burning cable to extract coppers, and manual dismantling of monitors to get the same. Thus, the informal collectors were normally found in municipal dumping sites such as landfills or scavenge on the waste disposal sites daily with carts, trolleys, sorting the e-waste.

There were both, local collectors and importer-collectors. The difference between the two was that the local collector of e-waste relied on the local environment as a source of their collection of e-waste, whereas the importer-collectors mainly relied on importation of used ICT equipment from abroad although they could also collect from the local environment when the situation warranted. These collectors normally supplied the other groups with the needed inputs—i.e. the extractors, recyclers, parts vendors, re-users and refurbishers. When asked how they got access to used equipments one of them reported:

"*We get information from 'word of mouth' (WOM) from individuals who work with computer vendors, through advertisements of sales, attending auctions or visiting used computer shops and inquire whether there are equipments for sale*".

This meant that there were no systematic flow of information with regard to access to obsolete ICT waste, as a result most e waste remained uncollected, and continued to pile up in homestead, offices and go downs. It was also interesting to note that a similar situation was found to exist in Mexico (Gonzalez, 2004), where they reported on lack of information, which resulted in many electrical and electronic products remaining in homes and shops uncollected. In Uganda, Wasswa and Schluep, (2008), also reported that there were no specific infrastructure for collecting and recycling e –waste, as a result collection of e waste was happening in very small scale. The implication was that most e waste remained uncollected in homes and stores. The main conclusion that could be drawn from this scenario was that, in general there lacked a systematic mechanism for the collection of e waste and as a consequence, it was only a fraction of e waste supposedly required to be collected that was finally collected.

It was also revealed by a member of FGD during the study that:
"*Collection of obsolete ICT equipments was also taking place in households and office premises. The informal collectors, either by word of mouth or otherwise, identified areas where there were equipments awaiting disposal and immediately visited the sites and collected them (mostly free of charge*)".

Regulations for Disposal of obsolete ICT products
From the documentary review, researchers could not come across any specific policy or regulations dedicated to the disposal of e waste. So it was just assumed that the e waste disposal regulations were implied in the major policy guides e.g. NEMC, ICT Policy etc.
Like wise, all 24 public institutions visited, 21 reported to lack any comprehensive policy guidelines and regulations, concerning the

disposal of ICT waste, except for the prevailing government regulations. One of the respondents had this to say:

"*According to government regulations, when some obsolete facilities and materials have been phased out, they have to be stored, until the time for stock verifiers to write them off. When they have been written off, we can then dispose of the materials, either through auction, distribution to staff or resale at lower prices to needy people. It is at this point when collectors of obsolete materials can come and purchase them or sometimes collect them free of charge.*"

It was revealed by an institution in the Medical industry that they had a general disposal policy of medical waste, but had no specific policy for disposal of ICT waste. In all the 24 institutions, they were in different levels of developing ICT policies, and indicated that they would also include a caption for the disposal of ICT waste. How ever good intentioned these institutions could be, there was necessity for ICT stakeholders to pressurize for government initiatives in formulating e – waste disposal policy (which by the time of the research and until now, had not and until now, has no specific policy for e waste disposal), after which institutions could derive theirs from the main policy. In the case of some waste which could not be transferred to other users, they were disposed of with other municipal waste without sorting.

The other three institutions were relatively new, and had not started experiencing pile up problem of e – waste. The situation cited above was also in line with the study findings in Uganda (Schluep et.al., (2008a), where the study indicated that there was no specific policy for e – waste disposal. However the same study indicated that there were several other environmental policies, which by implication could have covered the ICT waste disposal, as was the case also in Tanzania. These conclusions were also in agreement with similar conclusions in studies by (Dittke, 2007; Schluep, et.al., 2008b). It was not surprising that studies in South Africa, Kenya, Colombia, Senegal, India, Peru and Morrocco, also found that there lacked specific policy for e waste disposal and that the e waste disposal was implied in other existing policies on environment, water, air etc (Dittker, 2008; Finlay and Lechti, 2008; Waema and Muriethi, 2008; Rochat, D. et.al., 2008; Laiisacoui and Rochat, 2008; Wone and Rochat, 2008; Espinoza, 2008; Otti, 2008 and Mathaler, 2008). The implication of such practice was that the stakeholders had to organize themselves and pressurize the government so that a coherent policy to guide their activities was put in place. Alternatively, it could also be approached through regional forums like AU Summit meetings. In a study in China, it was found that the process for legislation for a specific policy for e waste disposal had already

started, although, the process was found to be rather slow (UNU/StEP Project, 2004).

Informal Extractors

Extractors visited were 30 in total and the visited site had about 100 people self employed involved as sellers, owners, and people who dismantled the PCs and other e-waste. It was purely a business run by informal actors and there were no formalized practices in all the areas we visited. These observations were in agreement with findings by Schluep, et.al., (2008) in Uganda and Waema and Mureithi, (2008) in Kenya, who reported that there had never been efforts to formalize the activities. The situation was different in Morrocco, Peru and India where some efforts to formalize the activities had reached a good level of licensing the entrepreneurs (Rochat, et.al., 2008; Loissaoui and Rochat, 2008 and Espinoza, 2008).

Some relative prices for the extracts:

Copper 4,500/= per leg
Iron 250/= per leg
Plastics: 100-200/= per kg.—sold to plastic industries
Iron is sold per ton to steel rolling plants and SIDO.

The extractors and recyclers could be one and the same people—meaning they extracted whatever they needed from the e-waste and then recycled the same. For example they could extract the plastic or metal materials from the e-waste and sell the extracts to the metal or plastic industries for recycling. Else the two could also be two different people, whereby the extractors would only extract the needed material from the e-waste and a recycler would come to the extractors and buy from them for recycling. For example the scrap metal vendors were regarded as recyclers or recycling agents.

The materials observed as products of extraction recycling were ferrous metal, aluminium, copper, and plastics. These informal vendors then crashed the collected materials to get ferrous metals which were sold to scrap metal dealers found in all corners in the urban centers.

Refurbishers

Researchers visited 40 informal refurbishers in total, who had employed about 60 people. They refurbished used PC and re-sold them at a cost of 120,000 - 150,000 Tshs.

Schools and individuals were target market for refurbished PC. As for the number of computers they received per week for refurbishing it ranged between 10—20 PCs per week, some of the economical activities were like Upgrading the PCs, Transformation of some monitors into TV screens and resold. The UPSs were transformed into large inverters to generate electricity for home rather than for a PC. The findings of this

study did in a way corroborate the findings by Schluep et.al.. (2008b), who found that the recycling of e – waste was mainly performed in the informal sector, implying that formal refurbishment plants never existed.
The organized reburshiment of imported-second-hand PCs was done by local repair-shop owners. The refurbished PCs were in turn sold back to the private sector and individuals. These were to be used in schools for teaching purposes and by individuals for personal use. In this way the sector was creating employment opportunities to the PC refurbishers and repair shop owners.

Electronic-repair-shop owners would buy the collected obsolete ICT hardware; extract discrete electronic parts that could be re-used, e.g. resistors, transistors, capacitors and diodes or units such as power supplies, CD Rom drives, memory cards, and different interface cards, and discard the remains after extraction back to the dump sites. These in turn could be used to repair old PCs which were still in use or for the case of electronic parts, to repair other electronic home appliances apart from PCs, e.g. TVs and music systems.

These could buy their needs from the collectors, extractors, or recyclers. It was also the case where the refurbisher also functioned as a collector or a collector functioning as a refurbisher as explained above. The case of refurbishing PCs for re-sale as an activity was said to be a booming business according to the vendors who were interviewed, as one reports here under:
"*The demand is high since the relative price of the refurbished PCs as compared to that of new PCs is very low and thus affordable to many. Apart from many individuals who have benefited from acquiring refurbished PC for personal use, it was also established that many of the refurbished PCs find use into other businesses of their own.*"

Some of the businesses that had benefited from refurbishing were:

(i) Selling mouse, nuts, chips, memory, interface cards and many other discrete devices that were found to be useful e.g. transistors, resistors, capacitors and the like extracted from pc monitors.
(ii) Components extracted from UPS, find uses to those who design and manufacture DC/AC inverters of various capacities. Inverters are used to produce AC power/electricity from DC power e.g. a normal car battery.

Each of the economic activities outlined above could be turned out into its own business area and thus alleviate poverty for the members involved in them.

The observation made by the researchers during their site visits at different locations showed that by the time of the research, there were already some activities geared towards poverty alleviation in the course of disposal of ICT hardware. The nature of the observed activities could be said to be both formal and informal. Further the activities could be categorized in terms of the actual tasks taking place, for example collectors, recyclers, and extractors. It appears that the e-waste offers a sustainable means of generating income and developing entrepreneurial skills, although seen as a problem requiring immediate solutions. The respondents in this study did confess that they were earning income that was sufficient to take their children to school and for their meals, although they were not ready to disclose the amount per day or cycle. They also had facilities like TV sets, radio and either could rent the office for workshop or shared the premises. When these economic gains were proxied for income, they were earning far above the minimum wage. This conclusion shares the another conclusion reached by a research in Kenya, which found that the informal recycling activities earned the entrepreneurs US $ 3 a day and thus Muriuki Muthairi (2008), in Cunningham, (2008) concluded:

"*Those engaged in electronic recycling were US $ 3 richer than 49% of the population in Kenya. There is an opportunity for business on the ground, the challenge was how we make the US $ 3 a day sustainable*."

There was a sort of clear division of labour, where some informal vendors dealt with the collection of obsolete e-waste (ICT hardware) from various sources.

Figure 5: Street ICT Hardware Repair Workshops

In an interview with the street workshop owners on their experiences and how they handled the obsolete materials, one collector replied as follows:
"the amount of hardware we receive is increasing daily. We manage to repair some and for those we failed, we use them as spare parts. We deposit the final remains with other wastes and thrown away at the garbage collection sites".
This implied that more ICT products were entering the market and as a result the volume of e-waste was also increasing.

Formal Distributors and Refurbishers
In addition to the informal sector vendors there were also a number of formal sector vendors who benefited from what was supposed to be e-waste. These were mainly old computer sellers who collected them from government offices, industrial premises, house hold and NGO offices. These formal collectors had established offices where the items would first be deposited and later sorted to identify those which could be refurbished, and those which should be sent to the land fills.

Summary of Groups involved in the gainful economic activities through e-waste management
The relative size of the groups visited and the implication for poverty alleviation. Table 5 shows categories and number of respondents interviewed in the study

Table 5: Categories of Respondents

Category	No of Respondents	Target	Location
Collectors	20	20	Gerezani / Railway
Extractors	30	30	Gerezani / Railway
Refurbishers	40	30	Gerezani / Railway
Sellers of used ICT equipment	4	6	Msimbazi, Street Kawawa Road Uhuru / sikukuu
Dump site Collectors	10	10	-Kigogo Dumping -Pugu Kinyamwezi
Buyers of Scrap Metals	2	4	-Gerezani / Railway
Buyers of Plastic Materials	2	5	-Gerezani / Railway

Source: Field Survey 2009

Discussion on Potential economic activities in the course of e-waste management

From what we have seen in preceding discussions with regard to e-waste management activities, the following were regarded as the potential key players in the e-waste management process: collectors, extractors, recyclers, electronic parts buyers/component buyers, re-users

of extracted electronic component for other purposes and PC Refurbishers.

Each of the above groups could be viewed as a business of its own or an input for sustaining another business, for the case of re-users of extracted components or of refurbished PCs. That said, it meant there were potential economic activities around the e-waste management process. Incidentally, the first three groups (collectors, extractors, and recyclers) played the main role in the process, which meant if efforts would be taken to create conducive environment for the three groups, to be created in a way that was economically sustainable, they would in the process make it possible for the rest of the above groups to do their businesses and thus help in poverty alleviation.

In order to tap the potentials the researchers suggested the following for the first three groups:

Collectors

In our study, what we observed from the site was the fact that the collectors were operating as individuals and did not have any formal arrangements in performing their activities. The collectors pointed to their desire to form groups so that after registering they could establish formal premises where people could send obsolete ICT equipment for deposit or sale. Further better and suitable collection system could be put in place in which informal collection activities could be streamlined to be more formal and more involving. For example, large e-waste generators (e.g. government), should be one of the stake holders in the process. On the other hand, by formalizing their activities they could get access to credit facilities on financial institutions so that they could handle large volumes of e-waste in which case more people could get employment in the sector. It had been reported that most recycling activities were happening in small scale and that it was mainly dominated by the Informal sector in Colombia, (Ott, 2008, Matghaler, 2008) and in India it was done by low skilled workers, using low technology and as a result it left the dealers in vulnerable health and environmental hazards (Rochat, et.al. ,2008).

Indeed it was also easy to impart the sorting skills (e-waste sorting and classification) so that it becomes easier to deal with waste that will be more beneficial to them. As a result it will be much easier to manage the last unwanted e-waste bits after extraction of reusable components/material has been done; as such its final disposal will not be as hazardous as it is now.

Extractors

Extractors like collectors, operated as individuals without any formal arrangements and mostly using crude tools. This group could benefit from formal organizations like SIDO. They could also benefit from their expertise through some initial/basic training on contents and properties of materials, which would enable them to know the compositional properties of different materials used to make say a PC or a monitor and consequently be able to handle them accordingly.

Recyclers

From our study, again it was found that many recyclers were operating from the informal sector, lacking the required skills and technology and indeed lacking know how as well. The situation was some how in contrast with Brazil where, recycling was found to be a country wide activity, although also done in what was described as "cherry picking" mode, which meant it was not sustainable (EMPA, 2008). A similar situation was also reported in the case of South Africa, where formalization was taking shape, only that the recyclers were not ISO compliant, indicating that the acceptable standards had not yet been reached (Dittke, 2008). The material fact that we observed from our findings was that, the Re-users and refurbishers benefited from the recyclers group. The activities performed by the refurbishers helped in adding value to the equipments which would otherwise be deposited as e-waste. The groups could be linked to such organizations like SIDO to get basic knowledge and skills in the activities they were doing in order to improve the quality of their products while at the same time imparting more technical "know how" of the ICT related industry. A situation similar to Tanzanian was existing in Colombia, where they were contemplating establishing recycling companies (Ott, 2008; Mathaler, 2008). In a report by UNU/StEP, (2004), China was also planning to establish recycling facilities in four cities, although in the same study it was reported that the informal recyclers were using primitive methods and tools in trying to extract valuable materials from ICT obsolete materials

Figure 6 below presents the recommended flow of ICT hardware from the supplier to when they become obsolete slightly different from figure 3 in the sense that the former process ends with landfill, while the latter which resulted from our study findings shows that e waste management was a continuous process as the Frame work below (Figure 6) shows:

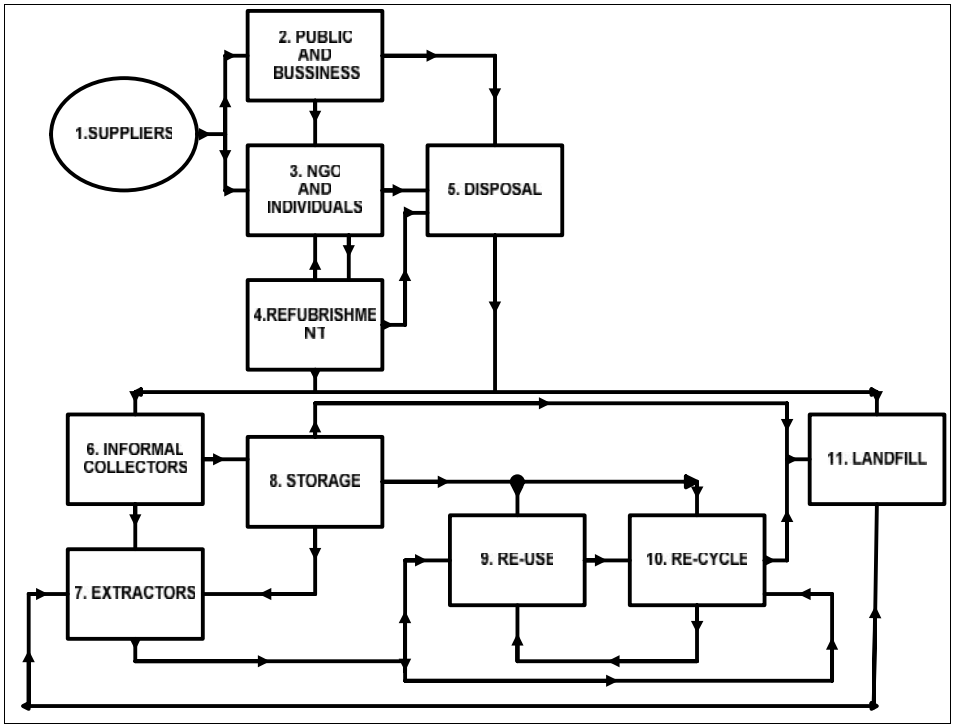

Figure 6: Flow of ICT Hardware from the Suppliers to its End of Life (Survey Research 2009)

Key: Process Description

1. Suppliers of new and used equipments.
2. Government and business as main consumers of brand new equipments.
3. NGOs and individual potential customers of used materials.
4. Refurbishers – reassemble, do minor repairs before putting them back for use.
   -At this level the generated e-waste goes into disposal facility, or straight to landfill/informal collectors
5. Disposal point for equipments from Government, Business, NGOs, Individuals.
   At this point there is waste which goes straight to dump place e.g. broken screens, irreparable monitors', the rest of the waste is collected by informal collectors [no: 6] who work very closely to extractor [no: 7]
   8. Storage is done to determine decision to be taken but also store materials extracted from no: 7
   -some waste goes straight to landfill.
9. Decision to re-use the material as it is.

10. Decision to recycle the material to produce new products or repaired products. The remaining components are again taken to dump sites (landfills).

This is the case also with the storage point where the unusable materials were sent to landfill. At point 9 and 10, the unusable materials were also sent straight to landfill. Also there was a possibility of informal collectors [no:6] to collect waste from landfills.

Discussion on Problems facing the entrepreneurs in the informal sector

Hygiene

In one of the interviews with the extractors of materials and parts from the e-waste, we asked them whether they were aware of the health and environmental risks associated with improper handling of the e-waste. Surprisingly, the extractors mainly seemed to be quite ignorant. Fumes which emanated from the plastic waste, and other e-waste materials were inhaled by the extractors during the extraction process and thus threaten their health, yet the recyclers were not conscious of the potential hazards and risks.

These findings were well corroborated with the study findings in Kenya by Berry and Hugh, (2007) and Basiye, (2008), who reported that the dealers in e waste lacked the required infrastructure, facilities and the necessary skills. They lacked mechanisms to separate e waste from solid waste. This pointed to the potential risks and hazards which the dealers were going through

Education

Technical know-how demonstrated by some of the dealers was substantial, but definitely needed to be further sharpened by training. Out of 40 refurbishers only 6 (15%) had attended formal training at VETA, the rest 34 (85%), had not had a training opportunity. This implied that most of the activities were performed with insufficient knowledge and skills, a factor which definitely limited their level of effectiveness and efficiency. In a similar study by Ott, (2008) and Mathaler, (2008) in Colombia, reported that there were only few certified recyclers, while the majority lacked know how in the whole process. This again exposed them to hazardous situations which were not only risky to human lives, but also to environment generally.

Tools/Methods

In the case of crushers/extractors, the methods used to dismantle the equipment were so crude (mostly bare handed—without gloves, glasses or other protective gears) that the potential risks of contaminating their

health were so obvious. A study on e waste disposal in India was so particular on the crudeness of tools and lack of skills to handle the recycling operations successfully. The situation was also well documented in a study on China (UNU/StEP, 2004) and India (Rochat, et.al., (2008) who clearly pointed to pathetic situations under which e waste disposal was handled. They reported on crude tools, low level of know how and inferior technologies.

Finance

Most of the activities that were observed were informal. This makes it difficult for the players to get assistance be it from the government or to secure funds from the financial institutions for the development of the sector.

The researchers were of the opinion that, the above raised issues were areas which the project could contribute say: through training programme (to sharpen their technical skills), collaboration with technical or engineering colleges, for example engineering college of the University of Dar es Salaam, SIDO, and VETA to design and manufacture simple but effective tools that could help in the crushing, and extraction of different material from the e-wastes and thus enable them perform their tasks in ways which were safer to their own health and friendly to the environment in general. This would of course help the different groups involved in the process to formalise their activities.

CONCLUSION

The electrical and electronics industries have recently emerged as the most thriving industries, not only in developed countries, but also, in developing countries like Tanzania. This has been the case because of the significant role the ICT industry can play in stimulating social and economic development, and ultimately reducing poverty and vulnerability among the poor. In view of the potential associated with ICT, there has been an escalation of the mass flow of ICT materials and products from developed countries to developing ones, in a bid to address social and economic problems on the one hand, but also in a bid to bridge the digital divide on the other. Resulting from the mass flow of ICT products and materials, a corresponding volume of obsolete electrical and electronic waste, usually known as “e – waste” is created which requires means to dispose of the same. The study set out to investigate the disposal of practices of e waste and their implications for income generation and poverty reduction. Guided by our four research questions, we intended to ascertain the volumes of ICT inflow into the country, with a view to ascertaining whether that constituted a concern or not. We also had an intention to highlight the existing practices, policies and regulations for the disposal of ICT waste. We further

investigated the potential economic activities that emerged in the course of the e waste disposal of process. Finally, we intended to elicit the entrepreneurs' experiences and challenges they faced.

Through the data that was collected from different sources and mainly from TRA, it can be concluded that there was an escalation of mass flow of ICT products and materials into the country from various sources, e.g. governmental, companies, NGOs and even individuals. This was facilitated by the relaxation of rules and conditions of importation, but also by the tax relieve incentive given to importers. This, necessarily contributed to pile up volumes of e waste that was generated, as the products become obsolete or reach the end of life cycle. Under such a situation, there was challenge to balance the trade offs, of the potential that ICT generally has for social economic development on the one hand, and the threat that e waste pose to society in general. Generally there seems to be a consensus that societies and individuals should continue to tap the potential of ICT for their social economic success, and at the same time by ensuring safe and proper management of e waste disposal.

The study further investigated the existing practices, rules, regulations and policies that guided the disposal of e waste at national level and institutional levels. Taking queue of the accumulating volumes of e waste in institutions, the study came to the conclusion that situation varied from one country to another and from one institution to another. The study findings pointed out those policy frameworks for the disposal of e – waste were available in few countries like China, India and Europe. However, in a majority of countries, in the developing countries including Tanzania, there were no policy guidelines specific to the disposal of e waste. There seemed to be regulations which only guided the disposal of obsolete equipment as per standing government orders. In view of such regulations, they seemed to be insufficient for the disposal process, because the process ended by shifting the waste from one end point to another. The situation was similar in the institutions visited. While some had not started thinking of a policy for the disposal of e waste, others were in the stage of drafting such policies. The implications of this lacuna were the fact that e waste was likely to be disposed of in ways which could harm the individuals and society. Indeed this we considered to be a disastrous situation, because the e waste disposal would continue to be performed in ad hoc manner, a situation which was vulnerable to all sorts of risks.

Furthermore, the study findings had a positive conclusion that, the process of e-waste disposal was full of business potential, through the

works of the collectors, extractors, recyclers and those who reassembled the components. These activities were potential source for creating employment for the various social groups including women, children and un-employed youths whom we found to be actively involved in the process. The activities also mentioned above, were a reliable source for the generation of income through sale of spare parts, payment for reassembling and repair works. However the level of awareness of local entrepreneurs regarding these opportunities was still low.

Through the investigations in the study, we explored the challenges that the entrepreneurs were facing in their activities. The study findings established that the entrepreneurs were operating on informal basis and totally lacked any financial and technical assistance.
Moreover, it was also established that they lacked sufficient information on the full potential that they could tap from e waste due to lack of training and exposure. Further to that effect, entrepreneurs were found to be totally ignorant of the potential hazards that faced them in the course of the extraction, crushing, reassembling and interacting with electronic accessories. This, points to the potential danger and risks which faced them, if no intervention was instituted.

In view of the findings from the study it was evident that e-waste management was an important activity and was emerging as a fast growing industry of its own. The more the society consumed the ICT products the higher the volume of e-waste that was generated, and hence the necessary to manage the generated volumes of e-waste. Thus e-waste is both a problem that needs management, and an opportunity that needs to be taken advantage of. That the escalation of ICT will continue to rise as days go by, is a 'fait accompli'; the nagging question that needs to be addressed is the way to continue harnessing and exploiting the potentials of e waste for poverty reduction, while at the same time ensuring safe and appropriate ways of e waste disposal.

RECOMMENDATIONS

In view of the above conclusions, the study recommends for the following:

- It is an imperative to revisit the existing legal instruments with a view to rationalizing on how e waste disposal could be openly articulated and covered by an independent policy or regulation.
- Ideally, some governmental institutions like cleaner production units, Institute of Production Innovation, VETA and SIDO would be assigned roles for capacity building for the nascent

entrepreneurs, so that they could grow and perform their activities in more professional approach.

- Moreover, some financial allocations would be directed towards the activities of these entrepreneurs, so that they would benefit from more advanced technologies from other parts of the world. Training should be an important component in the whole process of empowering the sector.
- There should be efforts to formalize the activities of the collectors who are big enough to collect all the volumes of e-waste generated. This would involve their registration and licensing procedures so that they can be recognized by the financial institutions and other government agencies.
- Existing industries such as plastic, and metal industries can also benefit from such an arrangement as the plastic or metal that need to be recycled will be collected from a few defined spots—the collection points.
- Proactive initiative measures should be in place to support the establishment of local sustainable e-waste recycling facilities. In this way, opportunities for employment and economic gains will exist to different groups and revenue to Government through taxes collection.

The bottom line is that, e-waste was and still is a problem that needs a control (e-waste management) in place and at the same time, if the control mechanism would be established; e-waste management could provide opportunities for gainful activities that could contribute substantially to income generation, employment creation and ultimately lead to Poverty Alleviation.

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