E-Waste Management to Eliminate Environmental Pollution for the Greater Good

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ABSTRACT

Electronic waste, commonly known as e-waste, comprises all sorts of electronic devices that are thrown away after their short useful time have been exhausted. Most electronic products contain toxic metals such as lead, cadmium, mercury and others, which contaminates the environment when they are dumped on the landscape. Toxic metals in the e-waste are usually non-biodegradable and they will create harmful long-lasting negative consequences on the environment in general and our health in particular. E-waste dumping is gradually polluting the environment and is a growing problem worldwide. Proper management of e-waste pollution is a global issue. According to the United Nations, the world is facing an e-waste crisis. The main goals of this study are as follows:

i. How to make electronic products more sustainable and environment-friendly.
ii. How to extend the life of used electronics through refurbishing/reusing and by other means.
iii. To provide a useful and flexible, cost-effective framework for worldwide e-waste management focusing on environmental protection by using appropriate methodologies, such as; recycling, refurbishing and reusing and by other appropriate means.

Our preliminary studies show that some countries, for example Switzerland has successfully implemented an e-waste program. However, it is expensive and one size may not fit all, particularly to developing countries. Our proposed framework would be flexible, cost-effective, and could be adjusted/adapted worldwide to eliminate e-waste pollution for the greater social good.

Keywords: E-waste, Environmental pollution, Recycling and reusing, Cost-effective framework, Global issues, E-scrap

PROLOGUE

In the modern, complex, digitalized world of today, environmental pollution is limitless and typically flows across international boundaries. Environmental pollution in the form of e-waste is a growing problem worldwide and its proper management is a global issue. Most electronic products contain toxic metals of different types. Some examples are mercury, cadmium, lead and others. All these metals can quickly contaminate the environment when dumped. Based on an estimate by the U.S. based Environmental Protection Agency (EPA):

- Over 130 million units of electronic devices of all sorts are "retired" every year by Americans.
- Over two million tons of e-waste are dumped on the landfill every year.
- Thrown away e-waste also known as e-scrap makes about 70% of heavy metal disposal in the United States.

All these numbers may make one scary. Moreover, over 80% of electronic products that are recyclable are shipped from the wealthy western world to countries with low resource settings, commonly known as poor countries, for examples countries in Asia and Africa. Wealthy countries include the U.S., European Union and other developed nations.

A snapshot below shows the known and suspected routes of e-waste dumping. (Source:http://library.thinkquest.org/06aug/02342/photos/webready/routes2.jpg)

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Currently, there is no tighter regulation on the movement of electronic waste, which usually find its way into Asian countries such as China and India and also in African countries.

The developed nations often export/dump their e-waste to poor countries, allowing them to be benefitted from the low labor costs in poor countries to dismantle the e-waste. In poor

countries, for example; in Africa and Asia the dismantling processes in practice are unacceptable and are major risk to the safety and health of the workers and the environment.

The Basel Action Network (BAN) is "*the world's only organization focused on confronting the global environmental injustice and economic inefficiency of toxic trade (toxic wastes, products and technologies) and its devastating impacts*" (www.ban.org). BAN tackles environmental issues at a macro level by preventing irregular and unsustainable dumping of the world's toxic waste and pollution in these developing countries. BAN also promotes green, toxic free and democratic design of consumer products while banning waste trade. Research into this increasing global e-waste crisis and how well it could be addressed by using appropriate methodologies, such as; recycling, refurbishing and reusing and by other means is key in protecting the environment from further pollution and improving the quality of life for the generations to come. In the long run we also intend sharing our findings with organizations like BAN, Greenpeace and others to promote a pollution free global environment. There is a lack of academic research in this area and such a project will place *academic research* in the forefront.

PRELIMINARY WORKS

My journey to study, create awareness, and be active in this particular area started around 2009. Since then we have been doing small projects in our courses in the MBA/IS program mostly to create *awareness* among the students about this devastating problem caused by the wasteful Information Communication and Technology (ICT) *devices*. These projects are team-based and a team usually comprised of students from different countries. The outcome of this approach was far reaching: though it was conceived locally at *Roosevelt*, awareness spread thru the students to countries like China, India, Africa and many others (including to other groups within the USA). We remember on one occasion a student from India told us (in 2012) that she wrote to the principal of her former institution about her team project in e-waste management. The principal invited her to visit India and make a presentation about the project work on e-waste management. As an outcome the institution in India now has recycling bins for e-waste collection along with the garbage collection *bins on campus*. Additionally, they are gradually extending this facility to other institutions around India.

The information used in writing this on-going research work was collected from various case studies and scholarly and popular journal articles and recent publications on the web and other publications. It is also based on our own works and experiences as wells as personal communications with different national and international expert groups in the field. The goal of this literature review was to determine the current state of best practices in the field. In our research findings we found that Switzerland was the first country in the world to implement a proper federally regulated e-waste management program in 1991. Currently, in Switzerland 98% of all e-waste are recycled or incinerated properly to produce energy as well as to prevent pollution in the air by using state-of-the-art technologies. The Swiss model (i.e. the Wheel of Life) for managing e-waste is a success story for recycling and protecting their environment from pollution and the rest of the world can learn *best practices* from them.

THE SWISS MODEL

Being impressed with the Swiss model (called Wheel of Life) for e-waste management I visited Sofies (www.sofiesonline.com), a leading e-waste management consultant company in Switzerland in 2011. The purpose was to gain a firsthand experience in real-life e-waste

management. I met *Mr. David Rochat*, (Senior Environmental Consultant, Marketing and Sales Director of Sofies) with extensive experiences in e-waste management in Switzerland, India and many countries in Africa. Below is a narration of the model and also schematized in figure 1 (http://www.e-waste.ch/).

The Swiss "Wheel of Life" model consists of five steps:

1. *Buy*

The first step in the Swiss e-waste process takes place when a new electronic product is purchased. For any electrical and electronic equipment, no matter what is purchased, or its point of sale, the consumer is charged an *Advance Recycling Fee (ARF)* which covers non-profitable processes required for safe disposal at the end of the product's life. The amount of the ARF is defined by the type of product and is included in its sale price. With ARF in place, consumers can return retired equipment free of charge at all collection sites in the country.

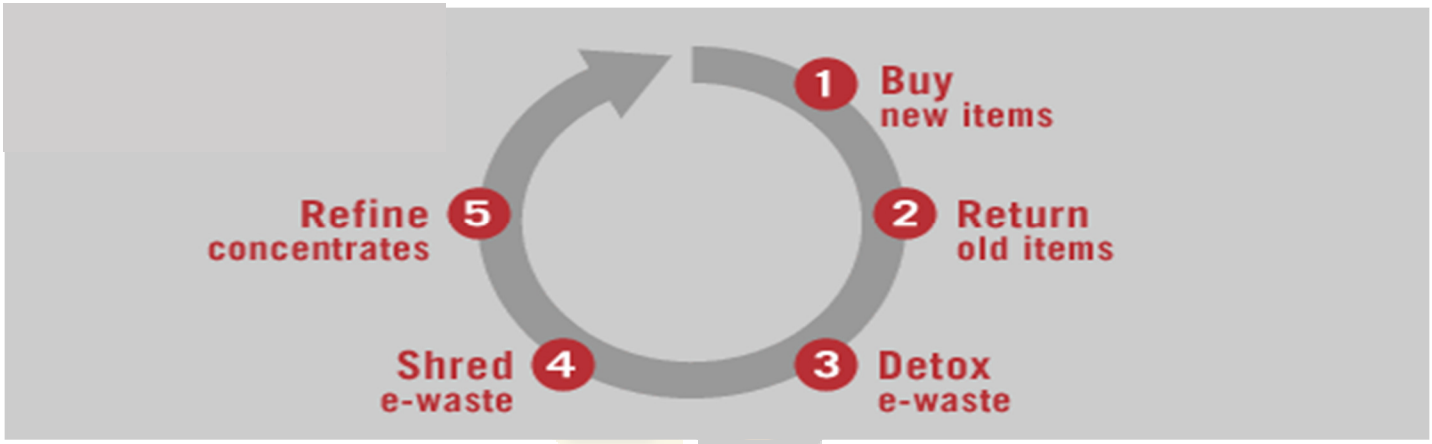

Figure 1. The e-waste "wheel of life"
Source - https://challenges.openideo.com/profiles/williamgeorg

2. *Return*

The second step occurs when a product comes to the end of its life. Consumers are not allowed to dispose of Waste Electrical and Electronic Equipment (WEEE) through any other means than dedicated *collection points*. Retailers are required to take back electronics free of cost and independent of any purchases for all types of products they sell. For instance, if a retailer only sells Dell computers, they must still take back HP computers, but not necessarily refrigerators. The producers then must dispose of the collected items safely through the four independent Producer Responsibility Organizations (PRO). These four organizations and their responsibility areas are different. Each of these four organizations handles specific categories of e-waste. The main goal here is to *prevent* electronics from reaching landfills.

3. *Detox*

In the Detox process, all the critical components are carefully removed from the e-waste in order to avoid contaminating downstream processes with toxic substances.

Detox requires a large amount of manual labor and is considered the unprofitable portion of the process. ARF is used to cover these *costs*. This manual process is often outsourced to nearby social institutions.

4. Shred

Mechanical processing is the next step in e-waste treatment, normally an industrial, large scale operation to obtain concentrates of recyclable materials in a dedicated manner and further separate hazardous materials. Some typical machines/components include: crushing units, shredders, magnetic separators, and air separators. Gas emissions are filtered and effluents are treated to minimize environmental impact. Indoor exposure is monitored and assessed to ensure workers' safety as well.

5. Refine

The last step of the e-waste "Wheel of Life" is refinement. Refining resources from e-waste is possible and technical solutions exist to extract raw materials with minimal environmental impact. Most extracted elements must be refined (or reconditioned) before being sold as secondary raw materials or disposed of in a final disposal site. Many of these refining processes take place outside of Switzerland. The refining process focuses on three main materials: metal, plastic, and glass.

Preliminary Analysis and discussions

Apparently, the model (i.e. the Wheel of Life) for dealing with e-waste provides beneficial insights as to who to involve, how to implement its various processes, and also how to make it economically feasible. The Swiss model seems to work well for Switzerland in protecting the environment. However, technology and technological solutions are *not culturally neutral* and e-waste management needs to be adapted to local circumstances. Moreover, the ARF that is collected upfront when an item is bought (by a consumer) *may not work* in many countries, particularly in developing countries. We need to address this (*ARF*) issue from a *global perspective*.

Also the model *does not* consider *refurbishing and reusing* old electronics before being totally discarded. Refurbishing and reusing might be more economical in processing many e-wastes. Refurbished items could provide marketable goods in second hand markets. These items could be sold at lower prices to people with lower income, particularly in developing countries to combat the so called *digital divide.* This method would aim to minimize the large disparities found among different *social groups* in different locations when it comes to the accessibility of ICT devices. The sale revenue from refurbished products can also be used for recycling expenses instead of collecting an ARF.

In the quest for a useful and flexible framework for worldwide use in e-waste management to protect the environment, we would first consider an additional step: namely the integration of refurbishing and reusing into the Wheel of Life model. This additional step (2A) would be in between steps two and three (Figure 1) and new model being elaborated on under research design and analytical methods (Phase 3- Figure 2).

The purpose here is not to *reinvent the wheel* but to extend the use of a successful, existing solution and *retool* it so that it better fits upcoming and more challenging requirements *around the globe*. We also need to address how the materials from the refined process could best be utilized in designing *new* products as well as in refurbishing used item.

This proposition is based on the preliminary studies done so far. However, some more works need to be done, including looking into some other models for e-waste management before finalizing the proposition.

RESEARCH DESIGN AND ANALYTICAL METHODS

This is a work in progress. The overall purpose of the research is to find ways and means to the development and implementation of a more sustainable system for designing, producing, using, and managing electronic devices, including e-waste management. The project will be conducted in three different phases:

Phase 1: In this phase we will concentrate on how to create more sustainable electronic products. To do so, we will look into ways and means in producing *biodegradable* electronic products which are also free from toxic metals. We will also investigate on how to make light weight and slim electronic products that are easy to recycle. We also intend to explore techniques like *virtualization* and others to minimize the uses of computer hardware. In other words, computer hardware should be able to run different operating systems and program. Using virtualization, one does not need to buy different computers to run different software programs. This will result is less e-waste. When it comes to printing devices we will look into the possibilities of *3D printing*. It is claimed that they also create less waste in general and e-waste in particular. We will also look into how extended *warranty* and their purchase at the time of purchasing an electronic item can help to prolong the life of the item by repairing. This will help in reducing e-waste. The assumption here is that this (purchase of extended warranty) will force the producers to produce item that are going to last longer.

Phase 2: In phase 2 we will focus on how the life of used electronics can further be extended by refurbishing/reusing more and recycling less. Reusing saves money and the environment, recycling cost money. We also intend to study how to make new electronic products with longer life spans than those currently produced. We intend to study some major multinational companies in the USA, Europe, Japan, Korea and China as to their *best practices* in designing and producing electronic products.

Phase 3: We will put together a unified and flexible, cost-effective framework for worldwide use in e-waste management to protect the environment by using appropriate methodologies, such as; recycling, refurbishing and reusing and by other means such as adapting to another appropriate methodology. Before finalizing the proposition we also intend to look into some other models used in other countries (for example, USA, Japan and some other European countries) for e-waste management. As we pointed out earlier in our *Preliminary Analysis and discussions* sections, to make the Swiss model acceptable for wider usages we need to make it flexible and also *self-financing*. A preliminary framework for such a model is shown in figure 2. During the buy step in the framework the consumer may or may not be charged for any ARF depending on the economic resources in his/her country. ARF works in Switzerland and may also work in many countries with similar conditions. On the contrary, in countries with less economic resources, giving money back to the consumer when a purchased item is returned after its life span is exhausted may have a greater *influence* in getting the item back for refurbishing/reusing or recycling. Otherwise the item is more likely to end up in landfills.

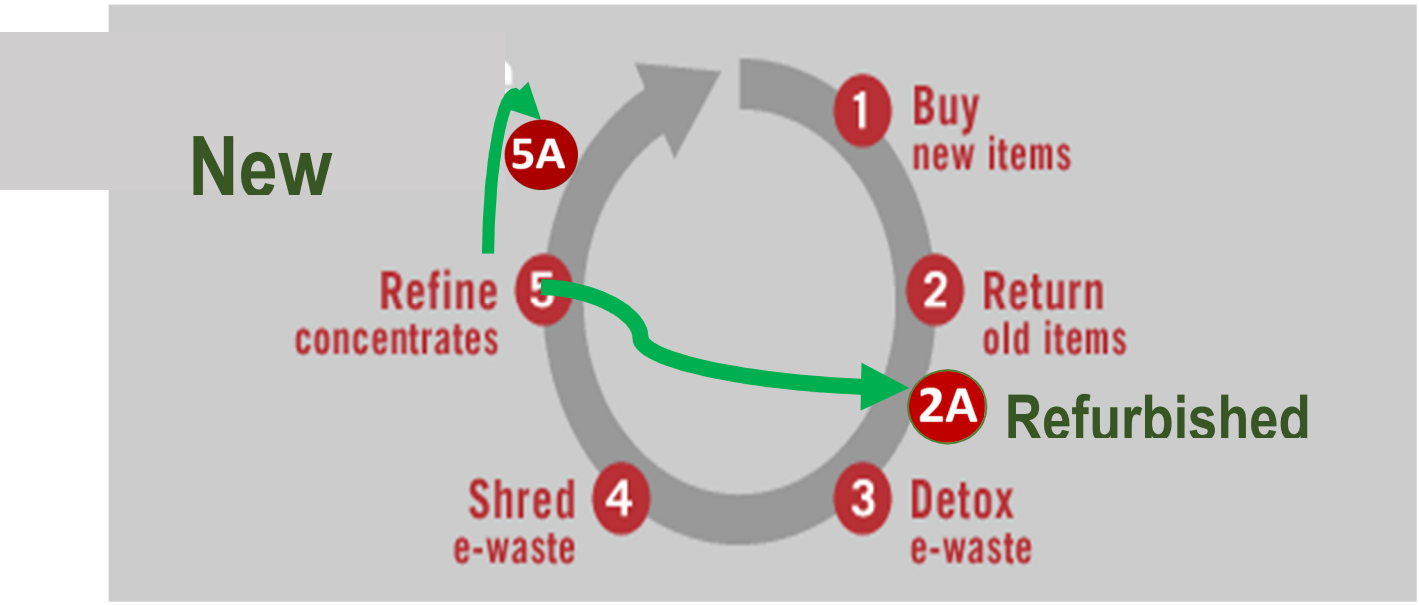

Figure 2: A preliminary self-financing framework for e-waste management. Modified from the e-waste "Wheel of Life"

In the framework we have introduced two new steps, namely 2A and 5A. In 2A returned items in good condition would be considered for refurbishing, possibly using materials recovered in step 5. Refurbished items would be sold in the market at a lower price. Refined materials from step 5 should also be used in designing new products (5A) to the extent possible.

- In the Refine steps of the new model we will focus on regaining all reusable materials. The idea is to obtain as many raw materials as possible with the smallest amount of environmental impact. In recycled electronics valuable metals, like gold, silver and copper can be found. In each ton of recycled cell phones there are about 8 pounds of silver, more than 12 ounces of gold and about 286 pounds of copper.

It is a known fact that one ton of e-scrap from discarded computers contains more gold than can be produced from 17 tons of gold ore. Over 220 milligrams of gold can be extracted from a single desktop pc. To extract all these valuable metals and to discard the invaluable components properly is a challenging task and could be expensive as well. However, it could also be a profitable business opportunity for many countries. Some in the ICT industry believes that E-waste recycling will be the next dotcom boom.

Based on these facts, we assume that the precious metals gained from the refining step in the model would *add* more values to the value chain and it would be self-financing and possibly be a profitable *social business* over time. Once the three phases of work are completed we will begin the work of writing professional papers on the results. We also plan to submit proposals to present our work at the national and international meetings on e-waste management and other interested groups. Our belief is that the on-going project will make a substantial contribution in the field.

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