AN ESTIMATION OF ELECTRONIC WASTE IN FUTURE

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ABSTRACT

Electronic waste is defined as all the electronic items which are discarded like washing machines, TV, refrigerators, mobile phones, computers and etc. In this paper we made an estimation and analysis of future increase in the e-waste. This experiment helps us to predict the cumulative e-waste in future and necessary steps required to minimize it.

Keywords: E-waste, cumulative, toxic, biodiversity

INTRODUCTION

Industrialization and fast growing technology influenced the human life. The growing technology in the field of electronics makes an impact on the human life. However the tremendous growth in electronic technology makes a negative impact on the environment. The large volume of electronic waste is the important concern. Large heaps of electronic components which are discarded were considered as waste, which we call electronic waste. The main reason for electronic waste is that they contaminating the environment toxic materials, which effects on the biological and environmental. The waste material effect the environment by change in climate, resource depletion and biodiversity. This waste electrical and electronic waste (WEEE) [3] has been causing serious damage to environment and human health.

Managing e-waste is a challenging task not because of fast growing but it's hazardous in nature. Hazardous materials like lead, cadmium, mercury, beryllium, Brominated Flame Retardants (BFRs), PVC and phosphorus in 9% of e-waste which affects the human life. E-waste comprises waste from equipments such as mainly, computers, mobile phones, television sets, photocopiers, DVD players, washing machines, refrigerators and other household consumer durables.

Fig1: Waste Electrical and Electronic Equipment (WEEE) [5]

This warrants the need for an extensive collection network, recycling infrastructure, sound technology and a supporting regulatory framework for handling and disposal of toxic waste. Environmentally unsound recycling of e-waste in countries like India and other countries has raised concerns globally. From the table 1 we see that how these e-waste components have the toxic materials (ppm).

Material	Mercury (ppm)	Cadmium (ppm)	Lead (ppm)
Low grade steel	1000	112	510
LCD steel	3000	401	1800
Low grade aluminium	153	145	25
LCD aluminium	25	160	19
Low grade waste	46	182	59
LCD waste	66	111	22

Table 1: Post-treatment heavy metal contamination in standard e-scrap and LCD displays

INTERNATIONAL INITIATIVES ON ELECTRONICS RECOVERY AND RECYCLING

The main objective for the recycling processes of e-wastes is to recover precious metals or valuable materials such as iron and steel and minimize ground pollution of the leach ate that may contain hazardous or toxic materials.

The Japanese government [2] was one of the leading pioneers of the recycling process for the e-wastes. The Law for Recycling of Specified Kinds of Home Appliance was put into effect on April 1, 2001 to promote the effective use of valuable resources and energy, as well as to reduce waste through recycling. The main features of this law include: (1) placing an obligation on businesses and reducing costs through market competition, (2) placing an obligation on retailers to collect and deliver home appliances for recycling, and (3) assigning recycling expenses to those who dispose of appliances. These activities oblige manufacturers to use their detailed knowledge of products to recycle scrapped products, a groundbreaking system that is having a worldwide impact. Air conditioners, televisions, washing machines, and refrigerators account for approximately 80% in weight of the total home appliance disposal in Japan. Many useful resources, such as metals and glass, are contained in scrapped products, and under the law, are obliged to effectively use and recycle these resources. There are a number of countries in Europe that have already implemented EPR initiatives for discarded electronics in anticipation of the WEEE Directive, including the Netherlands, Belgium, France, Switzerland, Norway and Sweden.

The National Electronics Product Stewardship Initiative (NEPSI) [2] in the United States is a joint effort by industry, government, environmental groups, recyclers and retailers to develop a product stewardship plan for managing used electronics. The initiative would see producers, sellers and users of electronics share the responsibility for the reuse and recycling of electronics. India, with a population of over 1 billion, is a growing economy and increasing appliances consumption is estimated to generate approximately 400,000 tons of waste annually (from computers, mobile phones and television sets only), which is expected to grow at a rate of 10-15 per cent per year. The processing of this waste is largely carried out in an informal backyard set-up, which is unregulated and does not follow the prescribed environmental norms for handling hazardous substances. The EPA [4] estimates that in 2005, the U.S. generated 2.63 million TONS of e-waste. But only 12.5% of that was collected for recycling. The other 87.5% went to landfills and incinerators. Hazardous chemicals in e-waste can leach out of landfills into groundwater. Burning the plastics in electronics can emit the carcinogen dioxin. These numbers don't include the millions of stockpiled computers, monitors and TV - which are stored in basements, garages, offices, closets and homes awaiting a decision.

WASTE STATISTICS

On the general level e-waste is a term covering all end-of-life (EoL) products with either a battery or cord/circuitry. Hence, it includes TVs, computers, mobile phones, white goods (refrigerators, washing machines, dryers, etc.), home entertainment and stereo systems, toys, toasters, kettles – almost any household or business items including medical devices such as magnetic resonance tomography, etc.

Predicted Model: In order to predict the future e-waste, consider the failure rate of each item in the e-waste content. Consider the e-waste deposit intensities of white goods as λ_W , house hold item as λ_H , computers as λ_C , and TV as λ_{TV} . Now the total e-waste deposit intensity as λ_T

$$\lambda_T = \lambda_W + \lambda_H + \lambda_C + \lambda_{TV} \quad (1)$$

after the studying the many life cycle data we came to a conclusion that logistic distribution fits well for the e-waste data .

$$\lambda_T = \frac{N \times \beta \times b \times \exp(-b \times x)}{(1+\beta \times \exp(-b \times x))^2} \quad (2)$$

N : total e-waste (cumulative)
β : inflection parameter
b : e-waste deposit rate parameter
x : represents the time parameter (years)

now from the above total cumulative e-waste deposit is given by

$$F_T = \frac{N}{(1+\beta \times \exp(-b \times x))} \quad (3)$$

DATA AND RESULTS

Data used in this experiment is collected from the paper [2]. One is life cycle data of white goods and TV. Second data set from house hold e-waste data. Each of the data set gives the cumulative waste for each year. Table 2 gives the e-waste for the 15 years and table 3 gives 18 years e-waste data.

YEAR	RATE[6]	WASHING MACHINE	REFRIGERATOR	RADIO	TV	TOTAL	CUMULATIVE
		576,700.00	431,600.00	274,700.00	930,300.00	2,213,300.00	
1	0.01	5,767.00	4,316.00	2,747.00	9,303.00	22,133.00	22,133.00
2	0.005	2,883.50	2,158.00	1,373.50	4,651.50	11,066.50	33,199.50
3	0.005	2,883.50	2,158.00	1,373.50	4,651.50	11,066.50	44,266.00
4	0.005	2,883.50	2,158.00	1,373.50	4,651.50	11,066.50	55,332.50
5	0.005	2,883.50	2,158.00	1,373.50	4,651.50	11,066.50	66,399.00
6	0.01	5,767.00	4,316.00	2,747.00	9,303.00	22,133.00	88,532.00
7	0.03	17,301.00	12,948.00	8,241.00	27,909.00	66,399.00	154,931.00
8	0.07	40,369.00	30,212.00	19,229.00	65,121.00	154,931.00	309,862.00
9	0.08	46,136.00	34,528.00	21,976.00	74,424.00	177,064.00	486,926.00
10	0.12	69,204.00	51,792.00	32,964.00	111,636.00	265,596.00	752,522.00
11	0.14	80,738.00	60,424.00	38,458.00	130,242.00	309,862.00	1,062,384.00
12	0.15	86,505.00	64,740.00	41,205.00	139,545.00	331,995.00	1,394,379.00
13	0.17	98,039.00	73,372.00	46,699.00	158,151.00	376,261.00	1,770,640.00
14	0.13	74,971.00	56,108.00	35,711.00	120,939.00	287,729.00	2,058,369.00
15	0.07	40,369.00	30,212.00	19,229.00	65,121.00	154,931.00	2,213,300.00

Table 2: (data set 1) ELECTRONIC WASTES GENERATED FROM APPLIANCE SALES (2000)[5] AND RATE OF DISPOSAL BASED ON LCDA (LIFE CYCLE DATA ANALYSIS) [2]

YEAR	UNITS	CUMULATIVE
2001	254,047	254,047
2002	136,420	390,467
2003	132,671	523,137
2004	141,781	664,918
2005	136,988	801,907
2006	264,012	1,065,919
2007	776,804	1,842,723
2008	1,812,259	3,654,982
2009	2,110,581	5,765,562
2010	3,159,131	8,924,693
2011	3,744,097	12,668,790
2012	4,030,317	16,699,108
2013	4,588,045	21,287,153
2014	3,610,768	24,897,920
2015	2,060,384	26,958,304
2016	241,052	27,199,357
2017	131,247	27,330,603
2018	67,094	27,397,697
TOTAL	27,397,697	

Table 3 (data set 2) EXPECTED E-WASTES PER YEAR FROM 2002-2003 APPLIANCES SALES AND HOUSEHOLD OWNINGS [2]

Parameters of the equation 3 are estimated by fitting the above data using excel solver. The goodness of fit is also evaluated. In order to estimate our model fits well for the data we use SSE value and R^2 .
SSE(sum of square) : if the value of this parameter is low is gives model fits well for the data.
R^2 is parameter represents how well the estimated curve its well for the actual data.

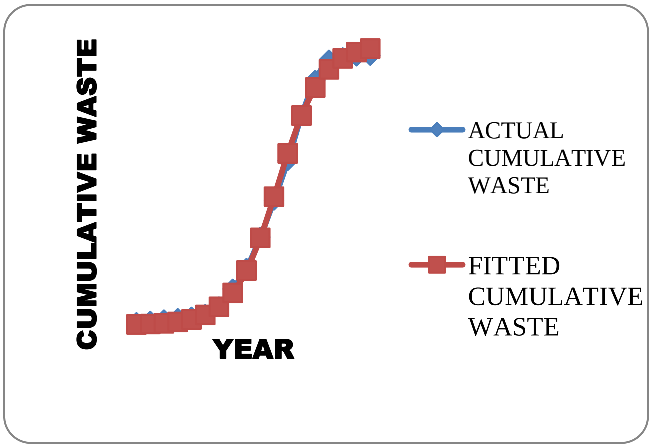

Fig 2: Cumulative waste for data set2

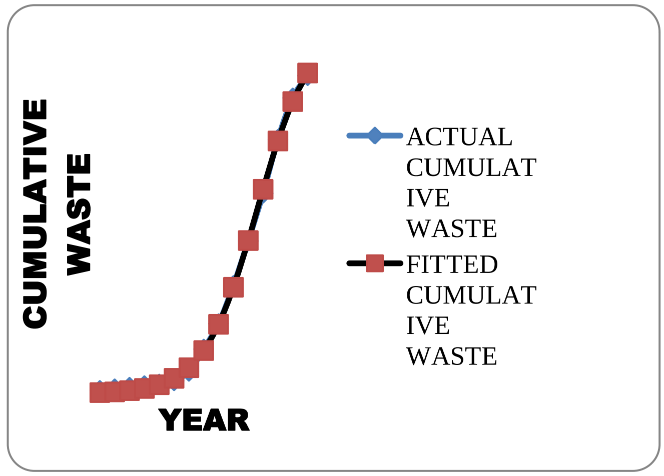

Fig 3: Cumulative waste for data set1

Table 4: Estimated parameters

Data set	N	β	b	SSE	R^2
1	2.566e+006	670.5	0.5605	4.82e+009	0.9995
2	2.852e+007	1169	0.6265	3.564e+012	0.9984

Form the table 3 data set 2 we have predicted the e-waste for the 19th year 28296170.25 and from the table 2 data ste1 the e-waste for the 16th year predicted as 2364024.86.

CONCLUSION

E-waste had tremendous effect on environment as in terms of toxic chemicals which dissolve in water, soil and air. From this experiment we have predicted the cumulative e-waste in future. By using this prediction we can estimate required necessary recovery mechanisms. In future we design a better mathematical model to predict e-waste in a given year with recovery mechanism.

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