Awareness and Disposal Practices of E-waste with Reference to Household Users in Kochi City

P.S. Anusree, P. Balasubramanian

Abstract--- Exponential growth of electronic industry over the years has generated a mammoth challenge in the form of obsolete electronics or e-waste. Junk electronics pose serious threat to health and environment through toxic pollution. It also adds to space constraints leading to creation of massive dumps and illegal trans-boundary movement within economies. The evolving consumer of today must be aware of the impacts of his purchase practice, especially in the case of electronic products. Moreover, the electronic scrap disposal methods adopted by them greatly influence the magnitude of carbon footprint on the ecology. A socially responsible individual ensures that he channelizes the scrap through appropriate channels and does his bit in conserving the natural resources.

This paper is an attempt to study the awareness and practice of the household users of electronic products with regards to obsolete or end-of-life electronic items. The study is based on primary data consisting of thirty samples collected from Kochi City. In the process of data collection it was observed that majority of the respondents did not have required awareness about the concerns with used or end-of-life electronics. Hence, the survey process turned out to be rather informative to the respondents. The collected samples have been analyzed through simple percentage analysis. The study found that disposal facilities were not appropriately available to the households because of which they had to depend on junk collectors to get rid of unused or obsolete electronic products.

Keywords--- E-waste, Disposal, Environment, Household Users, Awareness.

I. INTRODUCTION

Technological developments in recent times has brought comfort and ease to our lives. However, it has also resulted in a mammoth environmental challenge in the form of electronic waste or e-waste around the globe. Waste Electrical and Electronic Equipment (WEEE) is accumulated, once electronic products become obsolete. The accumulated junks of electronics then consumes space, affects health and environment through toxic substances and the process to get rid of these leads to illegal dumping in under-developed economies.

Electronics is today a vast industry due to technological advancements and circulation of new and improved products into the market each day. So is the electronic waste management industry.

As consumers shift to new equipments, the resultant disposal of end-of-life electronics keeps multiplying. It is hence a necessity to find proper and scientific ways to dispose the scrap electronics such that the resources or rare metals can be re-utilized, thereby conserving natural resources and doing so by not harming the environment or living beings in the process.

The knowledge and awareness of users of electronic products about e-waste is essential today. The ultimate users of electronic or electrical products should understand the dangers caused by e-waste and take precautions to reduce the same from being generated. They should also be educated about the appropriate methods to discard obsolete electronics as and when they get accumulated. This paper is based on a pilot study conducted among households in Kochi City (from the State of Kerala) to analyze the awareness and practice towards electronic waste generated by them. In the process of data collection, it was found that many of the respondents were not aware about the hazards or problems involved with electronic scrap. Hence, the process became more of a learning experience for a majority of the respondents.

II. E-WASTE – A GLOBAL CHALLENGE

The racing electronic market around the world is contributing to the growth of e-waste, three times that of urban waste (Cortes et. al. 2016).

Computers, televisions, stereos, fax machines and other electronic products nearing the end of their useful life are considered as electronic waste or e-waste (ESDO, Bangladesh 2010).

Refused electronic scrap accumulates forming massive dumps occupying landfill space (Gaidajis et.al., 2010). E-waste mainly contains materials like glass, plastics and metals (Ari, 2016).

The hazardous and toxic contents emitted from e-waste in landfills leaches to groundwater and transfers to water bodies and land resources (Needhidasan et.al. 2014) polluting them.

These toxins include elements like chromium, cadmium, mercury, lead, etc. (Needhidasan et.al. 2014) which could be extremely dangerous to health and environment (Pinto, 2008), especially during treatment and recycling (Sinha, 2002).

As per various studies, it was observed that toxic heavy metals released from discarded e-waste causes serious health impacts to nervous, reproductive and blood circulatory system (Flora et. al., 2012), cancers and neurological disorders (Bhutta et. al., 2011) skin damage, vertigo, nausea, chronic gastritis, etc. (Monika and Kishore, 2010).

Manuscript received June 10, 2019.

P.S. Anusree, PhD Research Scholar, Department of Commerce and Management, School of Arts and Sciences, Amrita University, Kochi, Kerala, India. (e-mail: anusree7389@gmail.com)

Dr.P. Balasubramanian, Head and Asst. Prof (SG), Department of Commerce and Management, School of Arts and Sciences, Amrita University, Kochi, Kerala, India. (e-mail: baladiwansapudur@gmail.com)

Environmental pollution of varied forms occur as toxic fumes mixes up in the atmosphere, soil and water bodies via groundwater (Jalaluddin, 2012).

E-waste is also a major business industry today more so in developing countries where e-waste is generated internally and imported illegally from developed countries (Nnorom and Osibanjo, 2008). Crude methods of extracting useful material from electronic scrap are major economic activitesy among the poor and uneducated classes of people in economies like China and India (Dawson, 2016). The economic benefits from the backyard industry lure people to continue the informal methods of dismantling and extracting materials from electronic waste (Williams et. al.,2013), however they overlook the exposure risks it has on the health of children, pregnant women, workers etc. (Grant et. al., 2013). Developed nations continue to illegally dump or unofficially export electronic scrap to poor developed nations (Perkins et. al., 2014).

Recycling of e-waste can be adopted to ensure reuse of materials from electronics using advanced technologies for sorting, testing, refurbishing and repairing scrap (Ceballos and Dong, 2016). Integrating both the formal and informal recycling practices (Kruger et. al.) can be appropriate way ahead to deal with the growing concerns in the field of electronic waste management.

III. KOCHI CITY

The city of Kochi (with an area of 94.88 km^2), classified as Tier-II city by the Government of India (Wikipedia) is also a metropolis, which is considered as a significant economic, political and cultural centre for regional & international connections, commerce and communications. Kochi is also the largest Urban Agglomeration in the State of Kerala with a population above two (2) million (Wikipedia).

Extensive employment opportunities, companies and offices, predominantly are located within Kochi city which makes the place a major employment hub for people from various parts of the country and the world.

Although, the current study does not focus on the commercial users of electronic products, the recent developments in the city over a long period, establishes the need for evaluating the individual consumer awareness and practice towards electronic products and their channelization after useful period.

IV. MATERIALS AND METHODS

Objectives of the Study

1. To understand the awareness levels of household consumers about growing e-waste problem in Kochi City
2. To analyze the practices of household consumers in terms of obsolete electronic products generated by them

Hypotheses

1. There is association between age and awareness of e-waste hazards
2. There is association between educational qualification and willingness to pay for e-waste recycling services

Selection of Location

This primary study has been conducted in Kochi, which is a city in South-West India's Coastal State of Kerala (District of Ernakulam). For the pilot study, a total of thirty (30) samples have been collected from five randomly selected locations in Kochi city based on five directions. They are as follows:

1. North – Pachalam
2. South – Thevara
3. East – Kakkanad
4. West – Thoppumpady
5. Central – Thammanam

Since five directions have been included in the study, six random samples have been collected from each location. The household users of electronic products were chosen in the study to focus the individual consumer sector of electronic products alone and not the bulk users like organizations and companies.

The household category in this study includes has a division between individual houses and residential societies or flat system houses.

Hence, out of the six (6) samples collected from each location, three (3) belong to individual houses and three (3) to residential society houses.

Hence, the total thirty (30) samples include fifteen (15) each from individual houses and residential societies.

V. METHODOLOGY

This paper is based on primary data collected by the researcher from households in Kochi City during the month of November 2018.

The collected data has been analyzed using SPSS software to generate the results. Analysis of Variance (ANOVA) and Simple percentage analysis has been used to evaluate the awareness and practices of household consumers included in the sample.

An estimation of the electronic equipments used in these houses has been conducted as a part of the study. A structured questionnaire was designed which focused on the objectives of the study.

Secondary information was sourced from research papers, journals, book and magazines.

VI. RESULTS AND DISCUSSION

The sample has been collected from individuals or household users of electronic products. Each respondent in the sample has represented his or her own household. The following Table 1 represents the demographic information of the respondents.

Table 1: Descriptive Statistics

ATTRIBUTE	COUNTS	PERCENTAGE (%)
Gender		
Male	13	43.3%
Female	17	56.7%
Age Group		
20 - 30 years	7	23.3%
31 - 45 years	7	23.3%
46 - 55 years	7	23.3%
56 and above	9	30.0%
Qualification		
Upto class 12th	10	33.3%
Graduate	12	40.0%
Post - Graduate	8	26.7%
Professional Status		
Employed	5	16.7%
Unemployed	12	40.0%
Retired	6	20.0%
Housewife	5	16.7%
Own Business	2	6.7%
Annual Income		
Rs 1 lac to 5 lac	8	26.7%
Rs 5 lac to 10 lac	17	56.7%
Rs 10 lac to 15 lac	3	10.0%
Above Rs 15 lac	2	6.7%
No. of Family Members		
One	1	3.3%
Two	5	16.7%
Three - Four	15	50.0%
Five - Eight	8	26.7%
More than 8	1	3.3%
Residence Type		
Individual House	17	56.7
Residential Society	13	43.3

Out of the total thirty (30) respondents, majority (nearly 57 %) was females and up to 43 % were males. 30% of the respondents belonged to 56 years and above years of age and 40% of the total surveyed respondents were graduates. However, nearly 40% of them (majority) were unemployed. Nearly 7% of the respondents had own business. The individuals surveyed for the study were considered as representative for their household including other members in their houses and most of them had three to four (50%) members at their households. The annual household income of the majority of the households stood about Rs 5 to Rs 10 lakhs (57%). Interestingly, the survey included samples from households that were individually located (57%) and those which belonged to residential societies (43%).

Analysis of awareness levels of household consumers

1. Hypothesis: There is association between age and awareness of e-waste hazards

Table 2: Anova

Awareness of the hazards from WEEE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.173	3	2.724	2.300	.101
Within Groups	30.794	26	1.184		
Total	38.967	29			

Result: The p value = .101 which is higher than .05, hence not statistically significant.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Therefore alternate hypothesis is rejected; hence there is no association between age and awareness of e-waste hazards.

2. Hypothesis: There is association between educational qualification and willingness to pay for e-waste recycling services

Table 3: Anova

Willingness to pay for e-waste recycling services

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.041	1	3.041	2.216	.148
Within Groups	38.425	28	1.372		
Total	41.467	29			

Result: The p value = .148 which is higher than .05, hence not statistically significant.

Therefore alternate hypothesis is rejected; hence there is no association between educational qualification and willingness to pay for e-waste recycling services.

3. Awareness of E-waste recyclers

Table 4: Simple Percentage Analysis

Scale	Frequency	Percent
Strongly agree	11	36.7
Agree	9	30.0
Neutral	6	20.0
Disagree	3	10.0
Strongly Disagree	1	3.3
Total	30	100.0

The respondents were asked to opine about their awareness on e-waste recycling units functional across the country that help in reducing discarded materials in e-waste by ensuring reuse of components and other metals. 36.67% of the respondents said they were very much aware of e-waste recycling units although there is none in Kochi city as of now.

30% agreed that there are recycling units that operate specifically for e-waste. 20% had no idea whether there were such units or not. However, 10% disagreed and 4% strongly disagreed to the idea of e-waste recycling units functional in the country.

4. If waste collectors pick-up E-waste at home

Table 5: Simple Percentage Analysis

Scale	Frequency	Percent
Yes	15	50.0
No	9	30.0
Don't know	6	20.0
Total	30	100.0

The respondents were asked to give their opinion about e-waste collectors coming home to pick up scrap electronics. E-waste normally including junk metals alone was collected by scrap collectors (kabadiwala).

Although there have been recent e-waste collection drives for offices and residents in Kochi city (under the service of Clean Kerala Company, Indian Express), none of the respondents had any clue about the same.

50% said that e-waste collectors came home to collect junk (basic scrap collectors and not specifically e-waste collectors).

30% said that no collectors came home for the same and 20% did not know if such a service existed or not.

5. Is E-waste recycling a safe option to reuse WEEE.

Table 6: Simple Percentage Analysis

Scale	Frequency	Percent
Strongly agree	14	46.7
Agree	9	30.0
Neutral	5	16.7
Disagree	1	3.3
Strongly Disagree	1	3.3
Total	30	100.0

Among the total 30 respondents, 47% strongly agree that e-waste recycling is a safe option to reuse obsolete electronics or WEEE. 30% although don't strongly agree they do agree that e-waste recycling is a safer option to save valuable resources. Nearly 17% have a neutral opinion on recycling e-waste. Almost 4% equally disagree and strongly disagree that recycling of e-waste is safe option.

6. Accessibility of E-waste collection drives to individual and residential society households

Table 7: Simple Percentage Analysis

Type	Individual Household		Residential Society Household	
Scale	Frequency	Percent	Frequency	Percent
yes	5	16.7	17	56.7
no	18	60.0	6	20.0
don't know	7	23.3	7	23.3
Total	30	100.0	30	100.0

Accessibility of E-waste collection drives to individual and residential society households

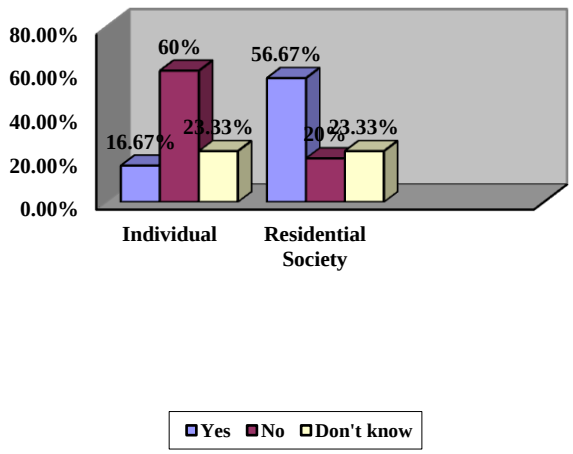

Figure 1: Simple Percentage Bar Graph

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

60% of the respondents said that e-waste collection drives were not accessible to individual households; nearly 24% said that they were not aware about such collection drives in the city. Almost 17% also had the opinion that such drives were also accessible to individual households or residences. According to majority of the respondents (nearly 57%), e-waste collection drives were easily accessible to households in residential societies. About 23% had not idea about the services available to residential societies. 20% of the respondents had the opinion that residential societies did not have such facilities for e-waste collection especially in residential societies alone.

Analysis of the practices of household

7. The disposal practices adopted by respondents

The disposal methods for obsolete electronic items used by respondents in their households have been analyzed here. The various categories of electronic items included in the data include the following:

Large household appliances **(LHA)** – fridge, air conditioner, washing machine

Small household appliances **(SHA)** – microwave oven, iron box, fan, mixer, electric cable

Information technology equipments **(IT)** – computer and accessories, laptop, tablet, cell phone

Consumer electronic items **(Cons)** – television, music system, camera, electric toys

Light equipments **(Light)** – bulb, tubes, emergency light, CFL

Other equipments **(Others)** – batteries, chargers, clocks & watches, tools

Table 8: Simple Percentage Analysis

Disposal Methods	LHA	SHA	IT	Cons	Light	Others
Sell or exchange on new purchase	36.67%	0%	40%	73.33%	0%	0%
Sell to scrap dealer	80%	60%	23.33%	40%	20%	26.67%
Sell to individual	6.67%	3.33%	3.33%	3.33%	0%	0%
Mix with household waste	0%	3.33%	0%	3.33%	10%	23.33%
Give to e-waste collection centre	6.67%	6.66%	6.66%	6.66%	0.00%	0%
Throw away in unoccupied areas	0%	0%	0%	0%	10%	23.33%
Store at home and use occasionally	13.33%	6.66%	16.67%	16.67%	3.33%	3.33%
Donate	16.67%	13.33%	16.67%	13.33%	3.33%	3.33%
Burn	0%	0%	0%	0%	3.33%	3.33%

The disposal practices adopted by respondents.

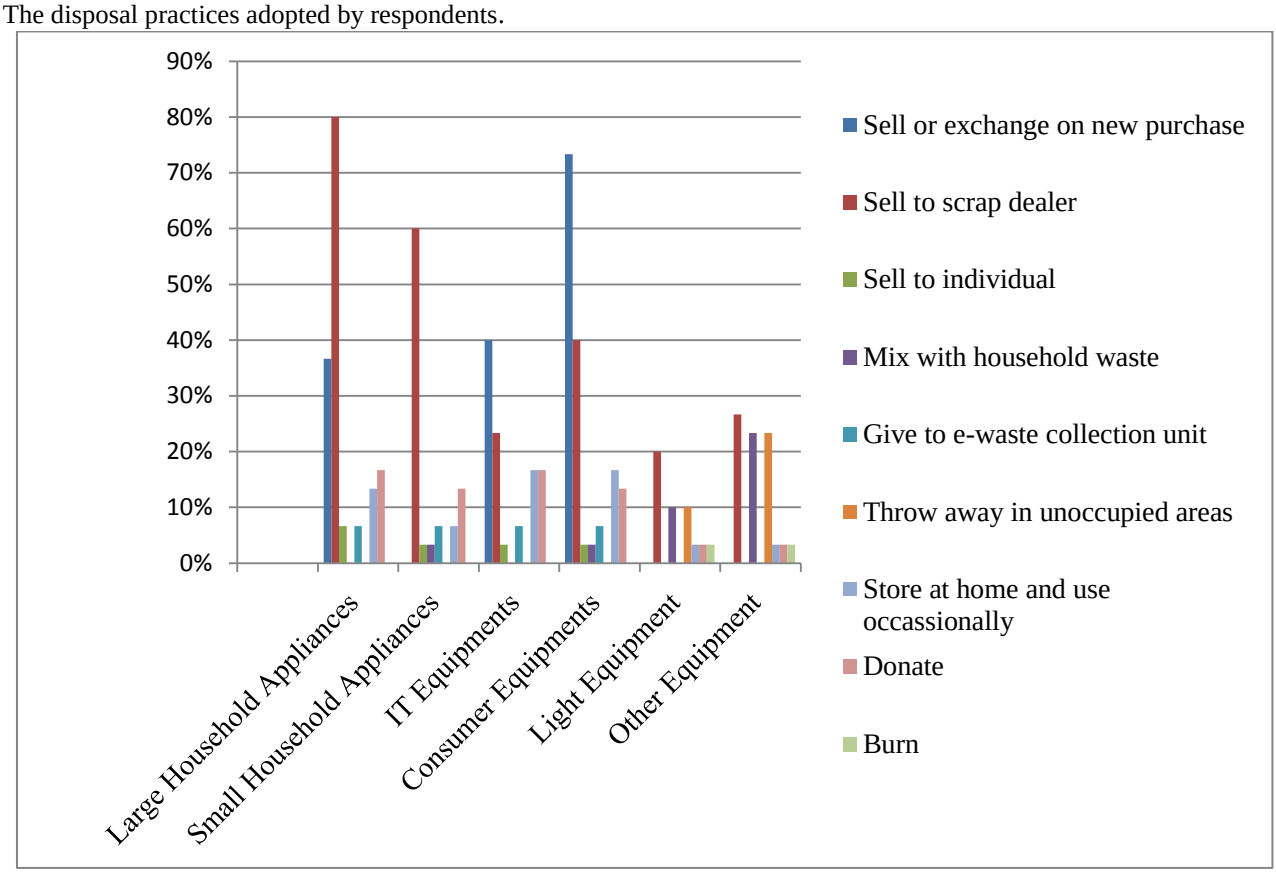

Figure 2: Simple Percentage Bar Graph

The most commonly found electronic and electric items at households were considered to understand the disposal methods adopted by households. It was found that most of the respondents although were aware of the harms caused by electronic products, were not found doing the necessary practices required to ensure that the harms are reduced considerably. In terms of Large Household Products including refrigerators, air conditioners and washing machines the majority of the respondents (nearly 37%) depended on exchanging or selling at shops were they purchased newer models. Small Household Appliances like iron box and electric fans were give off to scrap collectors (60%) for incentives. Information Technology equipments including computers and mobile phones were sold to scrap dealers (23%). Television sets and other consumer equipments were exchanged (nearly 73%) with stores during new purchases. 20% of respondents gave away obsolete lighting equipments to scrap collectors. Other electronic items like batteries, tools, etc. were mainly discarded (nearly 27%) by selling to scrap dealers.

8. Willingness to pay for e-waste recycling facilities

Table 9: Simple Percentage Analysis

Scale	Frequency	Percent
Strongly agree	11	36.7
Agree	10	33.3
Neutral	5	16.7
Disagree	2	6.7
Strongly Disagree	2	6.7
Total	30	100.0

The respondents were asked to give their opinion on willingness to pay for e-waste recycling facilities if a collection unit was provided to collect electronic wastes especially from homes and channel it to recycling units available in various parts of the country. Out of the thirty total respondents, majority (nearly 37%) said that they strongly agreed to pay if proper facilities were provided to collect e-waste from their houses. 33% only agreed to pay for such services. 17% of the respondents had a neutral opinion in the idea of paying for collection services. Almost 7% of the respondents equally disagreed and strongly disagreed to the idea of paying to the collecting agency for the services. According to these respondents, e-waste already has precious metals worth huge sums of money and giving away these to collecting agency would provide them huge returns. Further to this, paying them for the collection service was not logical according to these respondents and in fact, they emphasized to ask cash in return for the value or weight of junk given away as done by scrap or junk takers. However, they were willing to give away obsolete electronic items for collecting agencies if they provided the service free of cost.

Suggestions

The study analyzed two major objectives viz. – awareness and practices of users of electronic products about end-of-life or obsolete electronics. This study attempted to find out the levels of awareness among people about the hazards in e-waste and the steps that can be undertaken to reduce the same. Further to this, the consumer practices in terms of disposal or discarding of e-waste was also studied. Many of the respondents (especially women) also had no clue about electronic items being called as waste when it reaches useful end. For them, this study turned to be very informative. The following are few suggestions with respect to the study:

1. Foremost need in ensuring proper e-waste management is educating or creating awareness among masses about the hazards associated with e-waste.
2. Classes of people who are aware of e-waste problems are not able to adopt appropriate disposal methods as such services are not made available to them.
3. The willingness of people to pay for proper services highlights the necessities to get rid of e-waste in the society.
4. Authorities from the waste management departments should make use of their capabilities and powers to introduce efficient systems that would make it easier for people to give back old electronic items conveniently.
5. A proper and effective system of e-waste management is no doubt requires huge investments from stakeholders including the government.

VII. CONCLUSION

The study attempted to analyze the awareness of household users of electronic products, the dangers associated with obsolete electronics. The authors tried to analyze the practices of respondents and their families to discard junk electronics. It was observed that the respondents had basic awareness of e-waste dangers. However, there were also a few of them (especially females) who did not have any idea about the concept of e-waste or electronic waste. The most common practice observed to discard obsolete electronics among the respondents was giving away to scrap collectors or exchanging during new purchases. People consider e-waste a burden at homes and are generally willing to pay for e-waste collection services.

REFERENCES

1. Miguel Aguilar Cortes and Martha Lilia Domínguez Patiño (2016).Recycling of Electronic Waste, Using Basic and Acid Leaching, Open Journal of Applied Sciences, 6, 169 – 176. http://dx.doi.org/10.4236/ojapps.2016.63018
2. Shahriar Hossain, Siddika Sulatan, Farida Shahnaz, Asrafi B. Akram, Maherun Nesa and James Happell (2010).Study on E-waste: Bangladesh Situation, Environment and Social Development Organiation (ESDO), Dhaka, Bangladesh,
3. G. Gaidajis, K. Angelakoglou and D. Aktsoglou (2010). E-waste: Environmental Problems and Current Management, Journal of Engineering Science and Technology Review 3 (1) 193 – 199
4. Vidyadhar Ari (2016). A Review of Technology of Metal Recovery from Electronic Waste, E-Waste in Transition - From Pollution to Resource, Dr. Florin-Constantin Mihai (Ed.), InTech, DOI: 10.5772/61569. Available from: https://www.intechopen.com/books/e-waste-in-transition-from-pollution-to-resource/a-review-of-technology-of-metal-recovery-from-electronic-waste

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

5. Santhanam Needhidasan, Melvin Samuel, and Ramalingam Chidambaram (2014) Electronic waste – an Emerging Threat to the environment of Urban India, Journal of Environmental Health Science and Engineering, Vol. 12: 36
6. Vilote N. Pinto (2008). E-waste Hazard: The Impending Challenge, Indian Journal of Occupational and Environmental Medicine, vol 12 (2), 65–70
7. Sinha-Khetriwal D. (2002).The management of electronic waste: A comparative study on India and Switzerland. St. Gallen, Switzerland: M.S. thesis, University of St. Gallen.
8. Gagan Flora, Deepesh Gupta and Archana Tiwari (2012).Toxicity of Lead: A Review with recent updates, Interdisciplinary Toxicology, 5(2), 47-58
9. M. Khurrum S. Bhutta, Adnan Omar, and Xiaozhe Yang (2011). Electronic Waste: A Growing Concern in Today's Environment, Economics Research International, vol. 2011, Article ID 474230, 8 pages, 2011. doi:10.1155/2011/474230
10. Monika and Jugal Kishore (2010). E-waste Management: As a Challenge to Public Health in India, Indian Journal of Community Medicine, vol. 35 (3), 382-385
11. M.D. Jalal Uddin (2012) Journal and Conference Paper On (Enviornment) E – Waste Management, IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE), Volume 2, Issue 1 (July-Aug 2012), 25-45
12. I.C. Nnoroma, and O. Osibanjo (2008) Overview of electronic waste (e-waste) management practices and legislations, and their poor applications in the developing countries, Resources, Conservation and Recycling 52 (6) 843–858
13. Krista E. Dawson (2016). The Ethical Issues of Dumping Electronic Waste in India, Augustana Center for the Study of Ethics Essay Contest.
14. Eric Williams, Ramzy Kahhat , Magnus Bengtsson , Shiko Hayashi , Yasuhiko Hotta and Yoshiaki Totoki (2013) Linking Informal and Formal Electronics Recycling via an Interface Organization, Challenges, 4, 136-153
15. Kristen Grant, Fiona C. Goldizen, Peter D Sly, Marie-Noel Brune, Maria Neira, Martin van den Berg and Rosana E Norman (2013). Health Consequences of exposure to E-waste: A Systematic Review, The Lancet Global Health, vol.1, no.6, 350 -361
16. Devin N. Perkins, Marie-Noel Drisse, Tapiwa Nxele and Peter D. Sly (2014). E-waste: A Global Hazard, Annals of Global Health, vol. 80 (4), 286-295
17. Ceballos D.M. and Dong Z (2016). The Formal Electronic Recycling Industry: Challenges and Opportunities in Occupational and Environmental Health Research, Environment International 95(2016), 157 -166
18. Kruger C, Raghupathy L, Chaturvedi A, Arora R and Henzler M.P, E-waste Recycling in India,
19. Bridging the Gap between the Informal and Formal Sector.