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Assessing the Challenges and Issues of Electronic Waste Management for Cities in Developing Countries

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Abstract – *Electronic Wastes is nowadays extremely fastest growing pollution problems in a global context. India receives thousands of tons of E-wastes from various provinces of countries like- USA, Canada, and Europe. It will have given the presence if a variety of toxic substances which can be contaminating the environment and impacts the human health. In the context of developing countries, the Electronic Industry will be boosting with the rapid pace manufacturing industry in terms of supply & demand based on the lifespan of substances throughout the world. Transboundary movement of e-waste is a major issue throughout the region. [1] This research experiments the overview of E-Waste management in India compared with other countries. It includes the effects of recycling and management of E-Wastes or human health, environment and society, risk assessment owing to pollutants released from e-waste recycling in the soil, water and air. At last, E-Waste Management Rules of India and around the globe will be compared, International Policies and Regulations of E-wastes, Life-Cycle Assessment (LCA), Integrated Waste Management (IWM), recover and recycle material by safe methods, raising the awareness of E-Wastes and forbidding the transfer of used electronic devices to developing countries will be adopted for a possible sustainable solution of E-Waste Management for reducing the ill-effects of Informal recycling.*

Key Words: **Life-Cycle Analysis, Electronic Wastes, Informal Recycling, Environment, Integrated Waste Management**

1.INTRODUCTION

1.1 E-waste management issues in developing countries

According to the studies conducted in developed countries like- the USA, Europe and Canada, the generation of E-waste is growing at a rate of 3% to 5% per annum, which is three times faster than other individuals waste streams in the MSW sector. The rapid uptake of information technology around the world coupled with the advent of new design and technology at regular intervals in the electronics sector is causing the early obsolescence of many electronic items used around the world today. [1] The growth of electronic equipment (EE) is due to the significant advances in ICT (Information communication and technology), changes in the consumption patterns of the users. Economic development and short product lifespan due to technological innovations. In developing countries, based on the income groups of people, a significant proportion of E-waste is disposed of in an unsanitary landfill site which is harmful to both environment and human health effects. The biggest reason in developing countries of E-waste is practice by the Informal sector and contributed the 95% of E-waste economy to the GDP of the country in terms of production and Regulations of substances in an improper manner. Acid extraction is also practiced retrieving precious metals like palladium, silver, gold and platinum from printed circuit boards (PCB's) such practiced can be more found in India, Bangladesh, China, Vietnam etc. The paper attempts to examining the existing scenario of e-waste in developing nations concluded that e-waste is a rising concern in many of these countries, and risks to human health and the environment from inappropriate e-waste management are not yet aware in the regions of developing countries and awareness still remains low.

1.2 Need for the Study – Why E-Waste?

Understanding the problem of Electronic waste management out there and important to know that where is the problem. In the Indian context, how much E-waste is being produced and where they are produced right now, how much they are anticipating more in future. These are model values, forecasted values, it may not be 100% current but in the bulk based we have in terms of forecasting something which we have to do it for so many years now. Electronic Waste Management (EWM) is done in an improper way may lead to several contaminations in terms of air, soil, water pollution and all these are going to affect us which is human health and environment with its all the flora, fauna, biodiversity etc. With the extreme supply and demand of electronic waste may be discarded in a large amount may also cause global warming & climate change which is one of the major challenges nowadays in developing countries to be carried out by the developed countries in terms of their research to helps developing countries out of the issues of EWM.

1.3. OBJECTIVES

This paper attempts to examine the existing scenario of e-waste and to propose an approach to e-waste management for developing countries. This can be regarded as a systematic approach are: -

1. To understand the existing e-waste management issues in developing countries.
2. To identify the environmental impacts based on the complex composition of e-waste.

3. Recommend or propose a systematic approach to introducing integrated e-waste management, market mechanisms to developing countries.

1.4 Global Generation of E-waste

With the advanced new technologies boosting with the electronic gadgets is not new for the developed countries in terms of demand and supply in a multi-purpose way. Developed countries with a more lifespan of an electronic waste are because of advanced technologies and management to recover, reuse and recycle based on their life cycle in an advanced manner. Summaries some of the available e-waste data/estimates from different sources.

Country	E-Waste Generation [Tones/ year]	Per Capita Generation [kg/person]
Germany	1,100,000 [2005]	13.3
UK	9,40,000 [2003]	15.8
Switzerland	66,042 [2003]	9
China	2,212,000 [2007]	1.7
India	439, 000 [2007]	0.4
Japan	860, 000 [2005]	6.7
Nigeria	12,500	
Canada	860,000 [2005]	2.7
South-Africa	59,650 [2007]	1.2
Argentina	100,000	2.5
Brazil	679,000	3.5
USA	2,250,000 [2007]	7.5
Kenya	7350 [2007]	0.2

Figure 1- An Estimation of a global generation of e-waste by Robinson [2009] gives an annual production of 20-25 million tonnes.

With the usage of E-Waste according to the Country based on E-Waste generation [Tonnes/ Year] and per capita generation [kg/person]. From the above graph, USA will be showing the maximum generation of E-waste [tonnes/year] with 2,250,000 of 7.5 kg/person of per capita generation because the E-waste produce [tonnes/ year] with the total number of population of country will denote the supply rates of e-waste generation [tonnes/year], while India shows less E-waste generation[tonnes/year] of 4,39,00{2007) as compared to other developed countries like USA with 2,250,000 (2007) of 0.4 kg/person of per capita generation. In India, per capita generation [kg/person] is much less due to the high population, still, 30-35% are nearly Below poverty line (BPL) who are really poor, so they cannot afford any electronics in the developing countries. Because of the high population, although the amount of e-waste producing in India is too large when we talk about per-capita like when generation divided by the population of the country the per-capita level of tonnes [kg/persons] goes down due to the high population. If we look at China, the amount of e-waste produced is very high but since the population is high, the per-capita source generation will be pretty less.

2. E-Waste: Indian Context

India is the 5th biggest producer of Electronic wastes in the world, discarding 1.7 million tonnes (MT) of electronic and electrical equipment in 2014. Between 1995 and 2000, the Indian Information Technology (IT) industry grew at an annual rate of 42.4% and at the end of 2000, 5 million personal computers (PCs) were on the Indian market, while the industry's fiscal year 2001-2002 recorded the sale of 1.65 million PC units. The maximum generation of E-wastes is produced from 9 major cities which could talk next to the context. Maharashtra, NCR, Gujrat are the core hubs of generating E-wastes in a large amount and also involved in the Import and export of heavy electronic gadgets from the developed countries, but they are lacking in terms of management, latest data of E-wastes, lack of E-Waste rules in India, lack of fund, technology, labour, machinery etc.

2.1 Categories of E-Waste

- Small IT and telecommunication equipment. For example, mobile phones, GPS, pocket calculators and routes etc.
- Large equipment such as washing machines, clothes dryers, dishwashing machines, electric stoves, large printing machines, copying equipment and photovoltaic plants.
- The small equipment comprises of vacuum cleaners, microwaves, ventilation equipment, electric shavers, toasters etc.

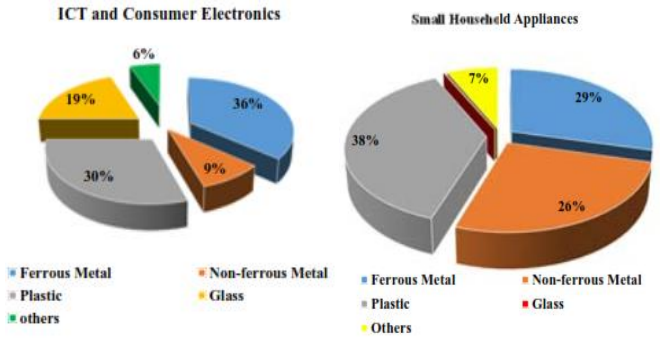
2.2. Classification of E-Wastes

E-Waste Category	Some examples of Product
Large Household Appliances	Refrigerator, Freezer, Washing machine, Cooking appliances etc.
Information and Communication Technology Equipment	Computers, Laptops, Mobiles, Computer Accessories, Printers, Copying Equipments.
Consumer Electronics	Toaster, coffee machines, clock, watches, hair dryers, TV, Radio, Video Camera, Amplifiers, Shavers etc.
Small Household Appliances	Vacuum cleaner, Watch, Grinders, Hair Dryers etc.
Electrical and Electronic Tools	Drills, Saws, Sewing Machines etc.
Lighting Equipments	CFL, Sodium Vapor lamp, Fan, Switches, Wires etc.
Toys, Leisure and Sports Equipments	Computers, Phones, Video games, Electric trains etc.
Medical Devices	Radiotherapy, Cardiology, Neurology, Dialysis equipment etc.
Monitoring and Controlling Equipment and Automatic Dispenser	Smoke Detector, Thermostat, ATM, Coffee vendors etc.

Figure 2- Classification of E-waste categories based on their uses.

2.2. Composition of E-Wastes

2.2.1 Composition of E-Wastes - Indian Scenario

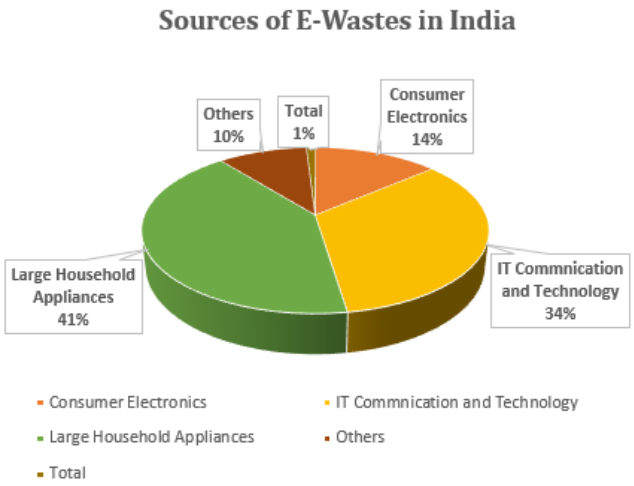


Material	Large Household Appliances	Small Household Appliances	ICT & Consumer Electronics	Lamps
Ferrous Metal	43	29	36	-
Non-Ferrous Metal	27.67	26.19	9	14.3
Plastic	19.31	37.75	30	3.7
Glass	0.02	0.16	19.3	77
Others	10	6.9	5.7	5
Total	100	100	100	100

Source - 1 - "E-Waste in India", Research Unit (LARRDIS), Rajya Sabha Secretariat, New Delhi, June 2011

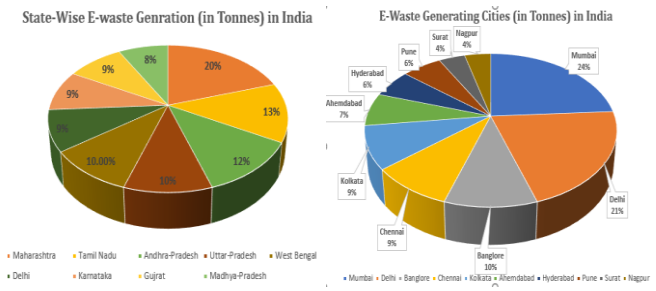
The generation of E-wastes contributed much from the sources of Small Household Appliances and ICT and consumer Appliances with the share of 29, 36 of Ferrous Metal and Plastic with share of 37.75 and 30 from both the materials which is almost high in the ratio as compared to other metals, It stated that in the present scenario of Indian context the use of Ferrous Metal include – Iron, Steel etc and Plastics include- Brominated and Non-Brominated Plastics etc are dominating the most in the category of E-wastes generation in India.

2.2.2 Sources of E-Wastes in India



Source - MAIT, 2013

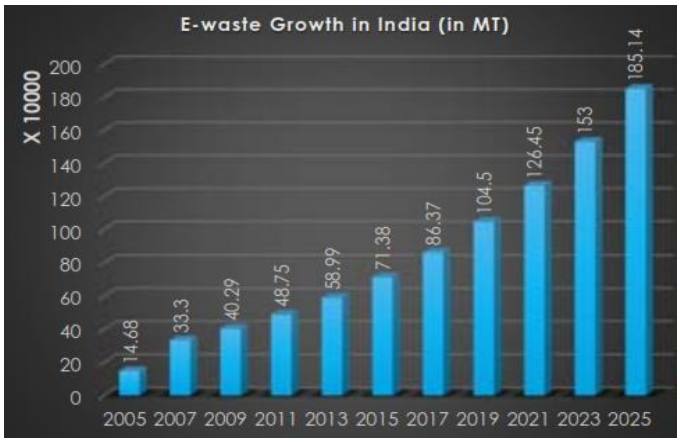
2.2.3 State and Cities Wise E-Waste Generation (Tonnes) in India



Source - Science Report, May 2013
Source – Rajya Sabha, 2011

The volume of E-Waste is expected to reach nearly 1.72 million MT by 2020 with the present annual growth rate of E-Waste in India is about 7-10% and top 9 states are generating around 65%-70%. Maharashtra is one of the leading states of E-Waste generating because of the large industries in their geographical region like Thane, Kalyan etc which is the main corporate, IT hub with thousands of small and large-scale industries setup there and it's a financial capital of India with heavy imports and exports of heavy metals around the globe from there. Whereas, according to the report of Rajyasabha,2011 Mumbai is at the top among 9 cities in India in terms of E-Waste generation (in Tonnes) which is nearly about 11017 MT. Delhi and Bangalore are not much beside the Mumbai in generating E-waste because of the industries and IT hub around there. If the growth rate of E-waste is an important factor in issues of Electronic wastes coming out to the developing nations. From the year 2005-2025(projected), how drastically a change of E-waste growth in India (in MT) from 14.68 MT to 185.14 MT which is the very large amount on which the cities are dependent on a large volume of Electronic Wastes.

- Highest Per Capita E-waste generating state- **DELHI**
- Lowest Per Capita E-waste generating state- **BIHAR**



Source - 2- Country level WEEE assessment study by the International Resource Group Systems South Asia Pvt. Ltd (IRESSA), (m/s IRG Systems South Asia Pvt Ltd, 2005

2.3 Hazard due to Improper Disposal.

Disposal Type	Hazard
Incineration	Brominated flame retardants at a high temperature of 600-800^0 C generate extremely toxic polybrominated dioxins (PBDDs) and polybrominated furans (PBDfs); PVCs generate toxic flue gas.
Landfilling	Hazardous metal (e.g. Lead, Chromium, Mercury, Cadmium etc.) OCBs, PBDEs leach into the soil and groundwater.
Recycling	It often causes hazardous emission, due to recycling of plastics, halogenated substances and heavy metals like lead, cadmium etc. Shredding without proper disassembly causes hazardous substances dispersed into environment.

2.4 Why do we need to Recycle E-Waste?

Source - www.cleanindia.org

E-Waste is just burned in an uncontrolled fashion and that leads to extremely toxic dioxins, PCB's etc. If the CRT is crushed and burned, it emits toxic fumes into the air. The one cadmium just put in a river, where the cadmium become available to the river it can pollute 600 m^3 of water. In terms of improper recycling by the Informal sector can also harm the human health and environmental effects. Nearly 95% of E-Waste is just getting dumped because of the poor technology & then things not getting into a proper hand. So that is why Govt of India (GOI) launched E-Waste Management Rules 2016, first one was revised in 2011which was supposed to be implemented in 2012. Unfortunately, nothing much happened, then again in 2016, the rules have refined a little bit and the GOI trying to implemented in the country, even struggling to implemented now to recycle more and more in a sustainable manner.

2.5 Quantification of E-Waste: Methods

For evaluating the E-wastes, various methods are available for quantifying the E-Waste generation. It can be classified into four groups:

1. **Input-Output Analysis –** It is most frequently used with multiple model variation for carrying out the E-waste generations and discarded ratio and obsolete factors. It applies to the estimation of E-Waste generation in many regional and country studies.

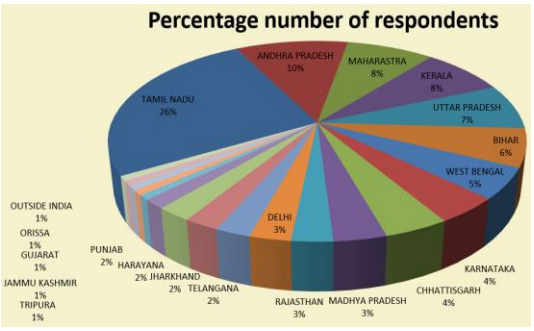
2. **Time series analysis (projections) –** Forecasted the trend of E-waste generation by extrapolating historical data into the future, because at some point we need previous historical data to match the accuracy in the current data while doing evaluation of E-wastes from last few years and it can also be helpful to fill in the gap of unknown years from available datasets.

3. **Factor Models (using determinant factors for correlation) –** Requirement of advanced modeling techniques which should be based on hypothesized casual relationships between exogenous factors like population size and income level vs e-waste generation.

4. **Disposal related Analysis –** This method requires the empirical data in e-wastes from parallel disposal streams to estimate the overall generation and disposal related analysis uses E-waste figures obtained from collection channels, disposal sites, and treatment facilities.

3. E-Waste Issues – Case Study: India

Developing Countries are not so less in the race of adopting modern technologies and advanced techniques to carry out the Electronic electricals from the developed countries in a large amount in millions of tons year every year. In 2001-2002, Ahmedabad is the largest export octroi mechanism state in India to import a large amount of electronic products from European and US countries which lead a heavy impact of electronic wastes in India due to their traditional method of dumping E-waste, discarded them into the river and ground which may contaminated into the river stream and will affect the human health and environment so long, because carrying the electricals from developed countries and stored or discard them in an improper manner is not only the solution. A recent study on Electronic waste is conducted in India through online opinion survey. Many respondents from different states of India may reflect their reasons for disposing of, recycling, collection, disposal and awareness about the E-wastes in India. A detailed study will describe below:



While conducting the survey on E-Wastes, the Maximum number of respondents are from Tamil-Nadu: 26%, Andhra-Pradesh: 10%, Maharashtra, and Kerala with 8%, which relatively shows the generating awareness towards E-wastes

in the developing countries due to the negative impact of global warming and climate change.

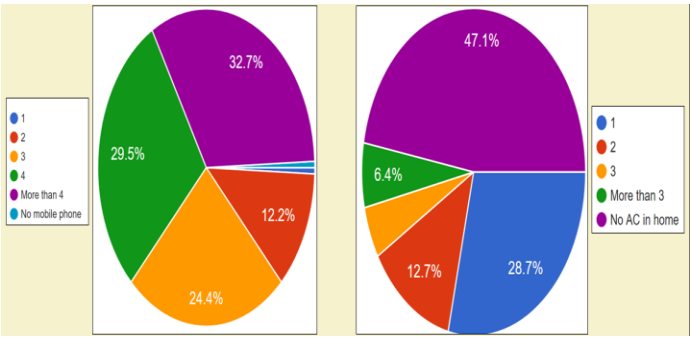


Figure 3- Number of mobile phones and AC used in home (India)

Public with 32.7% are using mobile phones in their home in the race of modern technology, only 12.2% are lacking behind due to unawareness, income-groups and disparity of slum population among the society are greater than urban population in India. Similarly, 47.1% are using ACs in their home which contributes a huge expenditure also in terms of maintenance, service product etc.

Electronic and Electrical Items in your home

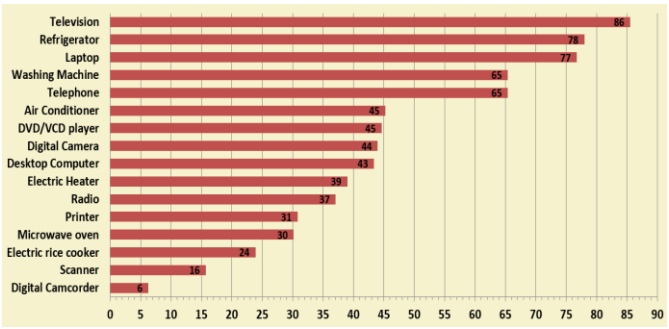


Figure 4- Electronic and Electrical Items in home

A demand for Electronic and electrical items is nowadays day to day need for every citizen in both developed and developing countries. According to an opinion survey, public with television (86%), refrigerator (78%), laptop (77%), Washing Machine & telephone with (65%) in their homes which increases the awareness of dismantling the e-wastes and make people and refurbisher more about E-waste to carry and disposed of safely.

Reason for disposing of the WEEE after usage of the product is common in every household due to introduced of new technology in the market, more lifespan, less cost repair, proper functioning with durable in nature to make environment friendlier. Not repairable and lifespan is the common issue occurring in every developing country to produce more and more E-waste categories.

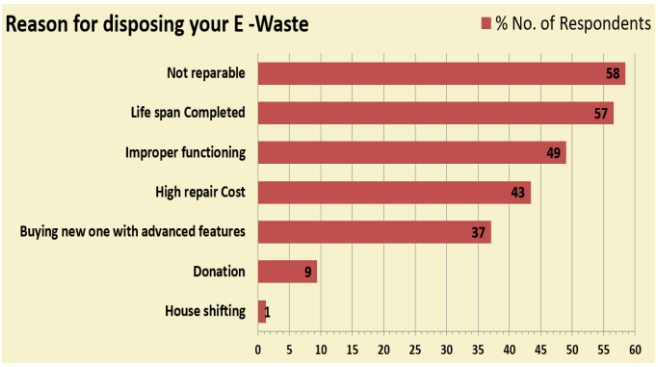


Figure 5- Reason for Disposing E-Waste

According to the study conducted, respondents with 'Interested to handover the E-wastes to registered recycling organization' adopted and 'willing to buy electronics products which can be recycled more in future', which is the cost-effective, user-friendly and best approach a person can think towards a sustainable concept of processing E-waste mechanism because it is important to know that in developing countries the informal sectors is very active in activities related to the e-waste recycling chain and these informal collectors also achieve very high collection efficiencies which are most applicable in developing countries to threat environment and public health only.

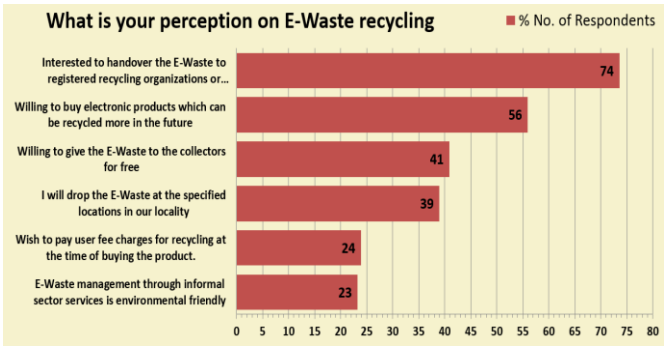
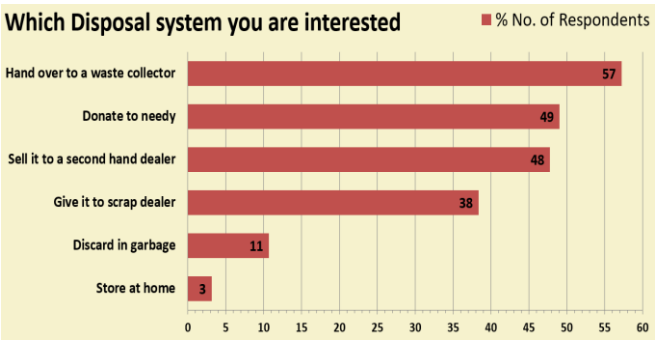


Figure 6- Perception of E-Waste Recycling

Out of these sources, handover to a waste collector and donate to needy some electronics which is not in use with someone can help the user, public health, and environment.



4. Environment and Public Health

Figure 7- Global chain movement of E-Waste

How the E-waste is moving globally developing an environmental justice issue and environmental hazards. As you can see the dots with green ones are the major source of electronic materials around the globe and also known as 'sources of e-waste produced' and dots with bigger red are the maximum amount of e-waste is produced after process of E-waste recycling part i.e disassembly, refine and upgrading by developing countries and small red dots showing where the e-wastes are being handover in a large amount for further processing. US, European Union, Japan, South-Korea are the developed countries with advanced technology in terms of best management rules, policies and approaches after estimating and supporting their wastes at the centers, they donate a large amount of CPU, computers and several electronic items to the developing countries as a grant basis which is further carried out by the 95% of informal sectors in developing countries. Thailand, China, Singapore are basically the hubs where the electronics are produced in a large amount & countries those are mostly managing the e-wastes is China, India, Pakistan, Nigeria & Brazil, Mexico, Philippine's etc. to support their needs as a grant support by developed countries.

The drawback of this Model -Most of these developing countries although the regulations are in place, there is an E-waste Management Rules 2016, but the problem is only lack of technology, management, and their implementation part. After this, In the Indian context, 95% of waste is carried out by informal sectors.

4.1 Health Hazards due to E-Wastes

Different electronic products if weight is being managed in terms of End of life management, there is an informal recycling, burning, things are not being done properly. So, the liquid is releasing into the ground and groundwater. There could be some uptake by the aquatic organisms in that waster, aquatic organisms transferred to the aquatic food and it may to the human food, then if they go to the land, it will have transferred to the animal product impacting the crop, drinking water can have a direct toxic exposure to inhalation (lungs getting affected) which is called human exposure pathways in health hazards.

5. Ghana and E-Waste Problem

Figure 8- Google Map, 2018

Ghana is north-western country (formerly known as the Gold Coast because of the vast deposits of gold) and it became the first country in Sub-African to gain independence in 1957. It is bordered by the Gulf of Guienne, Togo, Burkina Faso. It is one of the leading exporters of cocoa in the world & economy is mainly controlled by agriculture.

5.1.1 Ghana- Waste Electronic and Electrical Equipments

The demand for electrical and electronic equipment (EEE) has been increasing in the last few decades as a result of the rapid urban population, diverse economic growth with urbanization around the world. Many users in Ghana of electronic equipment are of appliances like kitchen blenders, air-conditioners, refrigerators, televisions, radio, water heater etc. While doing continuation practice in electronic equipment in mid-1990's Ghana has been remarkable growth in the consumption of EEE. Todays, Ghanaian have more access to computer facilities, washing machine, cell-phones, photocopy-machines, air-conditioners, radio & televisions which are serving a good purpose in their daily lives and supporting the development of Ghanaian economy.

5.1.2 E-Waste Products on Ghanaian Market

In Ghana, both used products and brand new are found on the market. However, may have beliefs that the used EEE products are inexpensive, higher patronage & better than the later. Currently, large volume of e-waste is imported

legally/illegally into the country items such as – electronic irons, computers, cell-phones, refrigerators, air-conditioners etc. are profolic in the Ghanaian society and the discarding of these goods have risen lately, from developed to developing nations including Ghana for reasons like – lack of technology, inadequate management, rules of e-wastes, recycling infrastructure, outrageous fees in the disposal of e-wastes and potential environmental pollution.

Figure 9- Brown goods displaying in Ghanaian market

5.1.3 Extensive Impact of E-waste problem: Ghana

E-wastes contain several components having toxic chemicals & substances like – lead, mercury, beryllium, cadmium which could impact human health and environment also causing diseases like- "Itai-Itai" and "Minamata" happening in Japan due to excessive intake of mercury through the environment. Open burning of e-wastes causes atmospheric pollution – fumes of mixed obnoxious, toxic gases and PM 2.5/ PM 10 emissions which may cause further global warming and climate change kind of issues. Water bodies, as well as soils, are contaminated, e-scrap spiles remain ages on the land at the mercy of the sun and rain, when chemical leachates react water bodies with ease, the consequences are untold on aquatics & other users. Serious repercussions for residences in proximity to areas where e-waste is recycled, discarded, composted or burnt. Long-term health effects on people involved due to exposure to toxic chemicals during processing e.g. dermal absorption during rummaging piled e-waste in dumps during the burning of the e-waste.

Figure 10- Section of dump site which serves both residential and dumps sites

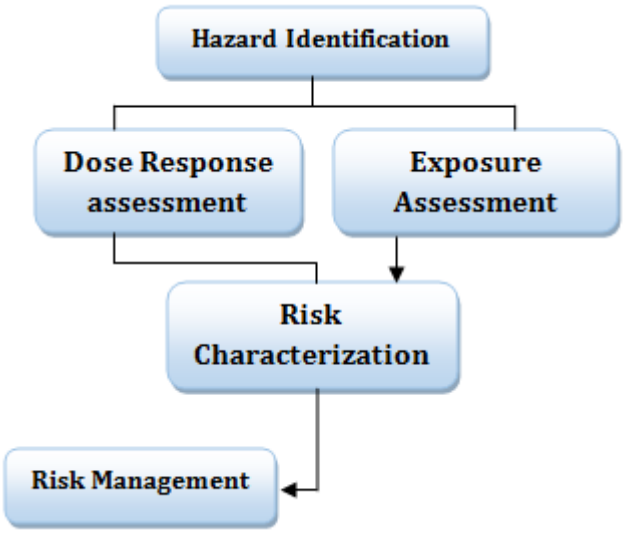
5.1.4 Challenges facing Ghana in E-Waste Management

Ghana due to the overpopulation, lack of services, infrastructure, advanced technologies, inadequate management, rules or policies they rely solely on imported used EEE and enormous quantities of e-waste generated in Ghana are poorly managed by only the informal sectors and less know formal companies. A large problem affecting the management of the E-waste are: -

- Unawareness of E-wastes is developing countries is the major cause for producing and dumping E-wastes in a large amount, no prevention of recycling methods and pollutions.
- No laws governing E-Waste management.
- No legal framework for extended producer responsibility.
- Now the government has formulating draft policies and regulation regarding e-wastes to control from a single unit to multiple units affecting the public health and environment.

5.1.4 Risk Assessment Measures

E-wastes is a misplaced resource. India and China are producing a lot of electronic wastes and they have already surpassed the developed countries. So total wastes in the developing country are more than the total electronic wastes produced in the developed countries because of most of the developing countries a higher population as well. From the perspective of E-wastes, following are the five measures of risk assessment is to be addressing to determine the electronic wastes component, generation, toxicity, upgradation etc.-



1. **Hazard Identification –** Process to determining the chemicals is linked with particular health effects such as cancer or breast diseases.

2. **Dose Response –** Process of characterizing the relationship between the dose of an agent and incidence of adverse health effects.

3. **Exposure Assessment –** Determining the size and nature of population that has exposed as well as the length of the time and toxicant concentration.

4. **Risk Characterization –** It is the integration of above three steps and determines the magnitude of public health issues.

6. Recovery of Materials from E-Waste

WEEE is a hazardous concern not only by the government, stakeholders, agencies but also by the public due to their material contents. Currently the practices for the treatment of electronic waste are reuse, remanufacturing and recycling as well as incineration and landfilling, but the main focus is more on reuse, remanufacturing and recycling happening but due to the most informal recycling happening in country like- India we have some recycling taking place but most of the e-wastes after getting some of those recover material is being dumped in landfill, even not in engineered landfill its mostly on the dump sides and incineration mostly happen in an informal sector. So, these are causing a lot of air pollution issues too. Heterogeneity of the material is causing a big problem in terms of a proper recovery.

Recycling of E-wastes can be broadly divided into three steps

1. **Disassembly** – The e-wastes than being generated into a large quantity from an individual or multiple households by selectively disassembly, basically targeting on singling out hazardous materials for special treatments is a consequential process in the recycling of E-wastes.

2. **Upgrading –** Using mechanical processing, metallurgical, biotechnological leaching process and advanced technologies to upgrade advisable materials content.

3. **Refining** – the Last stage of the process should be further carried out by refining the material contents by various physical separation methods i.e. pyrometallurgical, hydrometallurgical and metallurgical.

Existing E-wastes recycling techniques will be used to recover the metals from e-wastes like- cathode ray tubes (CRT) recycling, recovery of metals from mobile phones, metallurgical process, pyrometallurgical and hydrometallurgical processing, glass to glass recycling, glass to lead recycling and precious metal recovery mostly happen in European Union and Japan they are leading the pack in terms of precious metals recovery.

7. Results and Discussion

Estimating E-wastes quantities is also indispensable for planning an Integrated Waste Management (IWM). Reliable data should first to be acquired to determine waste characterization. Estimating e-waste generation is a necessary step for selecting appropriate e-waste management treatment and disposal options.

E-waste Management - The traditional waste management approaches in developing countries have accumulated over past few years which is becoming an issue due to the fast development. This traditional waste management system is not only fatal for the environment and health locally but also the nearby vicinity. The e-waste disposal has a hazardous significance due to the improper methods of generation and disposal which cause a risk for infectious diseases. The increasing e-waste problem has occurred due to increase in population, urbanization, industrial growth and changing patterns in consumption. The traditional waste management approach is also adopted due to the availability of land at low cost because of these mineral approaches initiatives have been taken to implement waste recycling and save the environment and health of the general mass by adopting Integrated waste management system.

Integrated Waste Management – The integrated waste management have been studied by various scientists and researchers. In this management systems, all the previous waste management and the existing waste management practices are being evaluated for all the alternatives and available option. This initiative aims to achieve proper waste management which reduces the environmental impacts and improving the acceptability of waste socially. This is the system which looks into the existing systems, involving various waste processes including prevention of wastes, reduction, proper sorting, collection, and transportation. The several waste management processes are recycling, composting, biomagnification, landfilling is considered. These alternatives are eco-friendly in nature.

8. International, Approaches, and Regulations related to E-wastes

8.1 E-waste regulations in China

China is one of the largest exporters of information and communication technology (ICT) products in the world and it is also one of the fastest growing economies in the world. A total of 1.11 million tonnes of e-waste is being generated per year in China including wastes such as EEE manufacturing & production processes, household appliances and Information technology products, China has become a crucial player in the world e-wastes recycling system, under which a total of 0.7 million people are being employed. Due to the increase in e-wastes generation several environmental and health issues around a sense of concern not only in the general media but also numerous scientific literature. The Chinese government

has taken a number of measures and initiatives to curb the menace of e-waste, including the prohibition of impacts of e-wastes and other hazardous since 2000. China has also recently introduced a licensing scheme for a proper e-waste recycling which prohibits informal recyclers and unorganized recycling firms to carried out informally. (Li et al., 2011a) and the complete analysis of the regulation and other regulatory measures on e-wastes in China can be found in Chung and Zhang (2011).

8.2 Policy Approaches in managing E-wastes in developing countries

The challenges faced by the developing countries to adopt ESM of e-waste have been numerous and several studies have been conducted by various organizations in this regard. The obstacles that have been identifies are: lack of e-waste inventories; lack of trained personnel to enforce ESM practices; lack of legislation (including export and import rules); inadequate infrastructure to collect, handle, recycle and recover materials from e-waste; and lack of awareness about the health and environmental impacts of unsound e-waste management practices as the main obstacles in achieving ESM of e-waste.

Informal Sector: The management of e-waste which is growing at an alarming rate and is a threatening issue for a number of developing countries who look into policies and technologies that have been adopted and implemented by developed countries as they have resources to manage e-waste. The environmental, economic, political and other social factors in the developing countries are different as compared to the developed countries hence the adoption and implementation of the policies and technologies would be varying as per the local conditions and requirements. Within the developing countries, the major portion of e-waste is generated from informal sector and the key area that the developing countries need to look into is the management and recycling of such waste. It is very important to note here that the informal sector is very active in terms of activities which relate to e-waste recycling chains. The precious materials contained in the e-waste and their market value is of high importance to these informal recyclers. The challenge for all the policymakers is to take into account the environmental and social aspects to achieve efficiency in the informal sector. The governments of the developing countries have failed to impose fines on informal recycling as this recycling is carried out physically by poor people and as such, they cannot pay heavy dues which in turn hinders government to impose fines. The governments of the developing countries suggested that the entire recycling chain must be reviewed and investigated to assess the steps which are environmentally harmless and should be adopted and those steps which are hazardous and should be discarded and changed for better environment and recycling performance.

Financing: It has been a challenging task for the developing countries around the world for managing and financing the e-waste collection initiatives and allotting responsibilities to various organizations for the same. In today's world EPR is the only effective way of managing and dealing with these e-waste issues. The implementation of EPR is a crucial task for developing countries and a challenge for policymakers. For example, in their study into applying EPR policies to e-waste recycling in China and Thailand Kojima et al., (2009) found two major difficulties in implementing EPR in developing countries. The first difficulty was in the government collecting funds from producers, or imports if the goods are smuggled into the country or if small, shop-assembled products have a large share of the market. The second difficulty was in systems that created incentives for collectors and recyclers to over-report the amount of e-waste collected to gain extra subsidies from the fund.

8.3 Best Practice of E-Waste Management: KARO SAMBHAV ORGANIZATION

Through public participation & generating awareness through campaigns of e-wastes in institutions, societies, industries will help NGO of E-waste 'KARO SAMBHAV' to successfully kept 300,000 kg of e-waste away from landfills from the informal way of collection systems. India is the fourth largest producer of e-waste in the world with the major accessibility of cheap cellphones has majorly contributed to the generation of wastes. According to Global E-waste monitor, 2017. From 650 million phones in circulation, out of 300 million smartphones, over 25% of them end up as e-waste annually. Karo Sambhav organization is founded in India to enable a sustainable and systematic transformation of India's e-waste sector. Generally, 75% if the electronic wastes generated together with government, public and private sector companies and remaining 15% is contributed by households. Due to a large amount of waste generated and lack of formal aggregator company to dispose of the material as well as E-waste management rules, 2016 Ministry of Environment has directed industrial sector to collect 10% of e-wastes through Extended Producer Responsibility Plan (EPR) plan. Then Karo Sambhav started integrating with many NGO's, agencies etc. to develop a national level cohesive e-waste movement with the aim to enable people and institution to responsible about recycling the e-wastes carefully while fortifying sustainable livelihoods for waste pickers.

'KARO SAMBHAV' practices: -

1. Launched a mobile-based application to provides a user 360-degree solution of their e-waste and also connects refurbishers, waste collector at one platform.
2. Ethical way of disposing of e-waste.

3. To keep obsolete and abandoned electronic products our of the wastewater streams or landfills of harmful methane gases in the air.
4. Creating awareness of social issues and decisive environment.

8.4 Life Cycle Assessment for E-wastes

The environmental impact of electronic waste (e-waste) treatment is somehow related to life cycle assessment and these are conducted to figure out their estimate. It is environmentally advisable to follow e-waste recycling as it involves end-life disposal scenario which is environmentally acceptable and beneficial because of human toxicity which generates a lower environmental burden and other toxicities include terrestrial Ecotoxicity, freshwater Ecotoxicity, and marine Eco toxicity categories. The core factors which have been adopted by developed countries for reducing the environmental impact of e-waste recycling are done through optimization of energy consumption efficiently, reduction of waste water and soil waste effluents, increase in the amount of proper e-waste treatment, reduction of disposing off e-waste in landfills and incineration sites, and involving stakeholders and defining their duties clearly.

8.5 E-Waste Management Rules, 2016

A government of India (GOI) mandate E-waste rules for electrical and electronic equipment (EEE) in 2016 for all the recyclers, consumers, retailers, manufacturer, producer, dealers involved in a sale, purchase, processing storage. E-waste rule helps to regulate the generation, collection, storage, transportation, import, export etc. reduces hazardous substances in EEE to minimize the illegal or informal recycling sector to promote safe recovery operations by channelizing e-wastes to registered e-wastes recyclers and extended responsibilities to produces to manage the system of e-wastes collection/take back and channelizing to a registered dismantler. Rules consist of total 6 chapters, 8 schedules and 11 forms which tell the procedure for authorization of producers, dismantler, recyclers, and procedure for removal of registration. [9].

8.5.1 Responsibilities of Producer

The product of electrical and electronic equipment (EEE) shall be responsible for collection of e-wastes generated during manufacturing from the 'end of life' of their products, setting up collection centers, financing and organizing, providing contact details and creating awareness about hazards through posters and social media, affixing a visible distinct symbol to prevent e-waste from being disposed in landfills, maintaining the records and filing annual returns.

8.5.2 Responsibilities of the Collection Centers

Collection centers would be ensuring that the e-waste collected is stored in a secured manner till it is sent to registered dismantler and recycler and maintaining the records.

8.5.3 Responsibilities of Bulk Consumer

The consumer of Electronic and Electrical Equipment (EEE) shall ensure that e-waste generated by them is channelized to the authorized collection centers and shall maintain the records of e-wastes generated by them in Form 2 of e-waste rules through registered recyclers in Form 3.

8.5.4 Responsibilities of Dismantler

Dismantler should obtain authorization and registration from State Pollution Control Board (SPCB) and would ensure that no damage is caused to the environment during transportation and storage of e-wastes and also ensure that dismantled e-wastes are segregated, non-recyclable/ non-recoverable components sent to the registered recycling facilities.

8.5.5 Responsibilities of Re-Cyclers

Recyclers will obtain registration and authorization and ensure that the facility and recycling processes are in accordance with the guidelines.

8.5.5 Responsibilities of SPCB and CPCB

The state pollution control board (SPCB) has been assigned in the preparation of inventories of e-wastes, granting registration and authorization and ensure that collection centers should not store e-waste for a period exceeding 180 days and monitoring of compliance of authorization and registration condition with taking actions against violations of standards and guidelines of the e-waste. Similarly, CPCB coordinated with the SPCB and ULB's or states or union territories for the status of e-wastes generation, collection and disposal pattern or systems, preparation of guidelines for environmentally sound management of e-waste, the recommendation of standards and specifications for processing and recycling e-waste. [9].

9. CONCLUSIONS

Developing countries are the major importers of e-waste in the world with their informal collection system. MSW is the dominant waste to be discussed in every country with their challenges and issues, why not to electronic wastes which I almost contributed the amount of 78% of e-waste in the developing nation than other wastes. Growing concern of e-waste is still lacking in many under-developed and developing nation with the lack of technology, skills, labor and inadequate management etc. which leads a harmful impact to human health and environment in terms of global warming and climate change. Processing of e-wastes consists of many hazardous components and this processing is undertaken predominantly by informal e-waste recycling

sector to get a large grant from developed countries to reuse, recycle the products, but industries and corporate sectors in the cities are not much aware of disposing the e-wastes instead of only generation and storage. In paper, many strategies and challenges should be discussing to remove the disparity of e-waste from the developing nation by integrating the life cycle assessment and integrated waste management approaches with dominant and successful informal e-waste recycling sectors will depends upon the innovative models whereby informal sectors are still allowed to participate in safe recycling mode in presence of some formal sector recyclers also. The government should also mandate the E-waste rules, 2016 in India to let consumer, dismantler, recycler, bulk consumer their duties of generation, collection, transportation and storage of e-waste in a sustainable manner with the presence of SPCB and CPCB. If possible, developing countries should take care to avoid this path and try attempt to design their own EPR schemes based upon their capacity to implement such rules.

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