E-WASTE MANAGEMENT PRACTICES 2018; A REVIEW OF INDIA

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ABSTRACT:
Electronic industry is the world's largest and fastest growing manufacturing industry which become leverage to the socio - economic and technological growth of a developing society. As a consequence of its consumer oriented growth combined with rapid product obsolescence and technological advances are a new environmental challenge. The "Electronics Waste" or "e waste" consists of obsolete and damaged electronic devices. At present the current practices of e-waste management in India suffer a number of disadvantages like inadequate legislation, difficulty in inventories, health hazards due to informal recycling, poor awareness and reluctance on part of the corporate to address the critical issues. Its impacts are intense when toxic materials enter the waste stream with no special precautions, creates adverse effects on the environment and human health and when economically valuable materials are dumped resources are wasted or unhealthy conditions are developed during the informal recycling. The article tried to gather the current scenario of E waste generation, data on components and hazardous substances of e-waste that are creating environmental pollution and human exposure to these chemicals, resulting adverse effects due to recycling, incineration and landfill disposal of e-waste.

Keywords: e-waste, environmental issues, health impacts and management, recycling.

CHAPTER: I

INTRODUCTION

1.1. Introduction

The discarded electronic waste is the fastest growing stream of waste in industrialized countries. The electronics are changing the lives of people everywhere; starting from the way we do business, bring up children, keeping touch with others or personal entertainments. No wonder, the electronics industry is the fastest growing manufacturing industry. The Consumers are drawn to the latest cellular phones, laptops, air conditioners and consumer electronics. Hence the obsolescence of these products leads to a unique mindset where consumers preferred to replace the products rather repair and reuse. A rapid obsolescence is also due to the rapid evolving technology but on the other hand it is clear that the throw away principle yields monetary benefits to corporate. In this 21st century revolution, this throw away principle is sure to damage the quality of our lives and the generations to come. Hence the problem of electronic waste, or e-waste, requires global action.

1.2. Objective of study

The major objective of this chapter are as follows;
• To analyze the effect of E-waste impacts for both human beings as well as environment.
• To analyze the methods which are available for the management of E-Waste in India and to find the hazardous effects associated with it.
• To analyze the challenges in which India is facing during recycling and to suggest a formal method of recycling

CHAPTER: II
LITERATURE REVIEW

The European Union (EU) defines this new waste stream as Waste Electrical and Electronic Equipment. Since there is no definition of the WEEE in the environmental regulations in India, it is simply called 'E-waste'.

Waste Electrical and Electronic Equipment. is diverse and complex in terms of materials and components as well as the manufacturing process. The characterization of this waste stream is of paramount importance for developing a cost effective and environmental friendly recycling system (Gui et al, 2003).

The E-waste is categorized by the Government of India under the broad class of hazardous waste.

Under this, there are several categories such as large and small household appliances, electrical and electronic toys and sporting equipment, tools, computers and related equipment etc. that contains metallic and non metallic elements, alloys and compounds such as Copper, Aluminium, Gold, Silver, Palladium, Platinum, Nickel, Tin, Lead, Iron, Sulphur, Phosphorous, Arsenic etc. In fraction it includes over 60% of metals, while plastics account for about 30% and the hazardous pollutants comprise only about 2.70%.

The Electronic-waste is also known as E-waste, very trendy yet casual name given to electrical and electronic appliances & gazettes, either discarded or of further use.

Computers, televisions, VCRs, Music Systems, Photo copier, wax and other printers fall under this category. But it is not very clear to add home appliances in this solid waste or not. Hence they are considered as either electronic or electrical products (California Integrated Waste Management Board 2005)

The home appliance like automatic ovens, fridge or chilling machines and many others which also work on programming and computer related activities are very difficult to differentiate from WEEE as they are also part of either electrical or electronic family (Kohler, A., Erdmann, L., 2004)

The electronic & electrical waste is actually a family and it has many branches which includes all personal, commercial, educational, transportation, private or public products which mainly work on power and have some at least sort of automation to function to meet the requirement (Wang et al., 2010)

The Greenpeace International, (2005) around 21,00,000 to 51,00,000 tones of e-waste produced annually around the globe and this number is very huge as well approximate as there is no clear cut method or technology to measure the actual quantity of waste produce and discarded. Further author said the percentage of e-waste of that of solid waste is around (UNEP, 2005).

The International Association of Electronics Recyclers predictable that according to existing development & slumping trends the all personal and public electronics instruments will find its way to landfills is approximately three billion. Interpretation of current financial drift, budding nations are also going to pour more and more electronic waste into the existing amount (Cobbling, 2008).

The awareness around e-waste and the hazards posed by improper recycling is growing, the allure of inexpensive access to technology is still too great for many budding nations to want to strictly regulate electronics (Wanjiku et al. 2009).

The E-waste is divided into different categories according to Environmental Protection Act,1986.(EU 2002,S.B Wath,2010), which is shown in table 1

Table: 1: Different categories of E-Waste

Classification	Examples
Large and small household appliances	refrigerator, freezer, washing machine, cooking appliances, grinders, watches etc.
Lighting equipments	bulb, CFL
IT and telecommunication	PCs, Printers, telephones
Consumer equipment	TV,radio,video, camera,amplifiers
Electrical and electronic tools	drills, saws, sewing machine
Toys leisure, and sport equipment	computer/video games, electric trains
Medical devices	with the exception of all implanted and infected products radiotherapy equipment, dialysis, nuclear medicine
Monitoring and control instruments	smoke detector, heating regulators, thermostat
Automatic dispensers	for hot drinks, money, hot and cold bottles

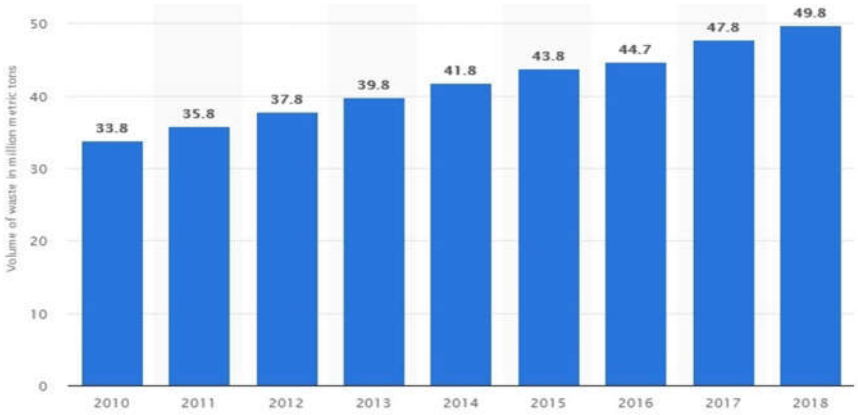
CHAAPTER: III
RESEARCH METHODOLOGY

It's a descriptive type article purely based on review of literatures. Where the data collected for this review article consisted of secondary data through literature survey. The literatures are collected to study the hazardous effect due to the Components present in E-Waste and the treatment techniques adopted presently and tables were drawn highlighting the salient features. The above literature survey clearly noted that bioremediation can be a effective method of E-Waste treatment. The present system of E-waste recycling system in India was studied and appropriate flow charts were drawn related to recycling and the challenges on which India is facing for the proper management of E-Waste. The drawbacks of current E-Waste management systems in India have been noted and its solutions were given as findings.

CHAPTER: IV.
PRESENT SCENARIO OF E-WASTE ACROSS THE GLOBE

4.1. Global generation of e-waste:

Figure1. **Forecast of electronic waste generated worldwide from 2010 to 2018 (in million metric tons)**



Source: https://www.statista.com

The above statistic displays the volume of electronic waste generated worldwide from 2010 to 2014 with a projection from 2015 to 2018. In 2018, it is predicted that some 49.8 million metric tons of e-waste will be produced globally. Majority of e-waste generated around the world are from small electronic equipment.

4.1.1. Electronic waste worldwide: additional information

The technological advancements and growing consumer demand have defined the era in which electronics have become a prominent part of the waste stream. Globally the quantity of electronic waste in 2014 was mainly comprised of 12.8 million metric tons of small equipment, 11.8 million metric tons of large equipment and 7 million metric tons of temperature exchange equipment (including cooling and freezing equipment). At the same rate the amount of e-waste is expected to grow to almost 50 million metric tons in total by 2018, with a growth rate of 4 to 5 percent year-to-year.

Most of the e-waste worldwide was generated in Asia – in the country that was predicted to experience the strongest growth in the electrical and electronics industry from 2014 through 2016 – with 16 million metric tons of e-waste produced. The Americas and Europe both produced around 11.6 million metric tons. The highest per inhabitant e-waste quantity was, however, the highest in Europe, with 15.6 kilograms per person followed by Oceania at 15.2 kilograms per person and the Americas at 12.2 kilograms per person.

4.2. Indian Scenario of e-waste

As per ASSOCHAM-NEC in its recent study said found that despite the government's emphasis on Swachch Bharat Mission and Smart Cities project, India continues to be among the top five countries generating e-waste, while the other countries topping the chart of e-waste generation are China, USA, Japan and Germany. this study was published coinciding with "Environment Day" (June 5, 2018).

Figure: 4.1. India is the fifth biggest producer of e-waste in the world

Source: https://swachhindia.ndtv.com/e-waste-tackling-indias-next-big-waste-problem-6126/

4.2.1. Indian State's Scenario of e-waste:

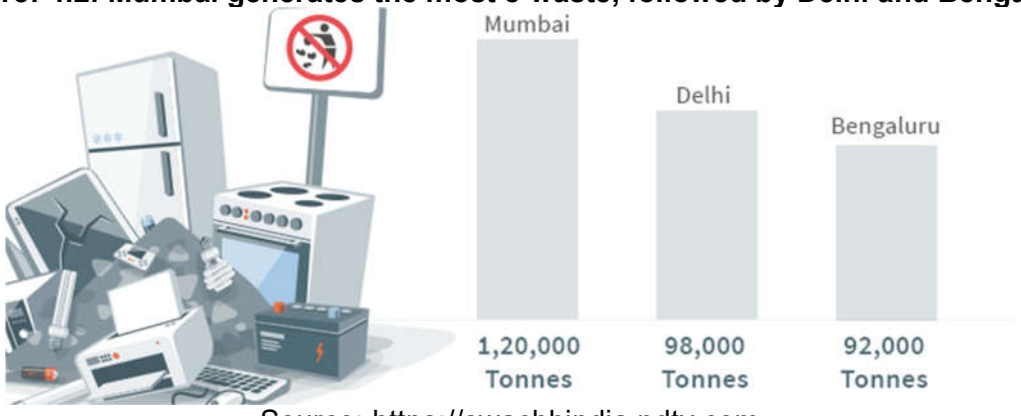
Among the Indian states, Maharashtra contributes the largest e-waste of 19.8 per cent but recycles only about 47,810 TPA (tonnes per annum) whereas as its counterparts Tamil Nadu (13 per cent) recycles about 52,427, Uttar Pradesh (10.1 per cent) recycles about 86,130, West Bengal (9.8 per cent), Delhi (9.5 per cent), Karnataka (8.9 per cent), Gujarat (8.8 per cent) and Madhya Pradesh (7.6 per cent), noted the joint study

2.1.2. Waste management practices

The E-waste generated in India is about 2 million TPA, the quantity that is recycled is about 438,085 TPA. The states like Karnataka has 57 units with a capacity to process nearly 44,620 tonnes; Maharashtra, 32 units that can process 47,810 tonnes; Uttar Pradesh, 22 units to process 86,130 tonnes; Haryana, 16 units to process 49,981 tonnes; Tamil Nadu, 14 units for 52,427 tonnes, Gujarat, 12 units for 37,262 tonnes; Rajasthan, 10 units for 68,670 tonnes and Telangana, four units to process 11,800 tonnes.

Among the cities, Mumbai topped the list as it generated an estimated 1,20,000 tonnes of e-waste annually. Delhi and Bengaluru ranked second and third, with 98,000 and 92,000 tonnes of e-waste generation respectively. Approximately 70 per cent of heavy metals found in landfills are accounted for by E-waste.

Figure: 4.2. Mumbai generates the most e-waste, followed by Delhi and Bengaluru



Source: https://swachhindia.ndtv.com

4.3. Nature of e-waste in India:

As per the ASSOCHAM-KPMG study, titled “Electronic Waste Management in India’’ identified computer equipment and mobile telephones as the principal e-waste generators in India. This study says, computers contributed towards 70 per cent of the total e-waste generated in India, while telecommunication equipment accounted for 12 per cent.

The E-waste typically includes discarded computer monitors, motherboards, Cathode Ray Tubes (CRT), Printed Circuit Board (PCB), mobile phones and chargers, compact discs, headphones, white goods such as Liquid Crystal Displays (LCD)/ Plasma televisions, air conditioners, refrigerators and so on.

The high and prolonged exposure to these chemicals/ pollutants emitted during unsafe e-waste recycling leads to damage of nervous systems, blood systems, kidneys and brain development, respiratory disorders, skin disorders, bronchitis, lung cancer, heart, liver, and spleen damage," the study said.

4.4. E-waste Trends in India and across the globe:

Mere a 5 per cent of India's total e-waste gets recycled due to poor infrastructure, legislation and framework which lead to a waste of diminishing natural resources, irreparable damage of environment and health of the people working in industry. around 95% of e-waste generated is managed by the unorganized sector and scrap dealers in this market, dismantle the disposed products instead of recycling it," it added.

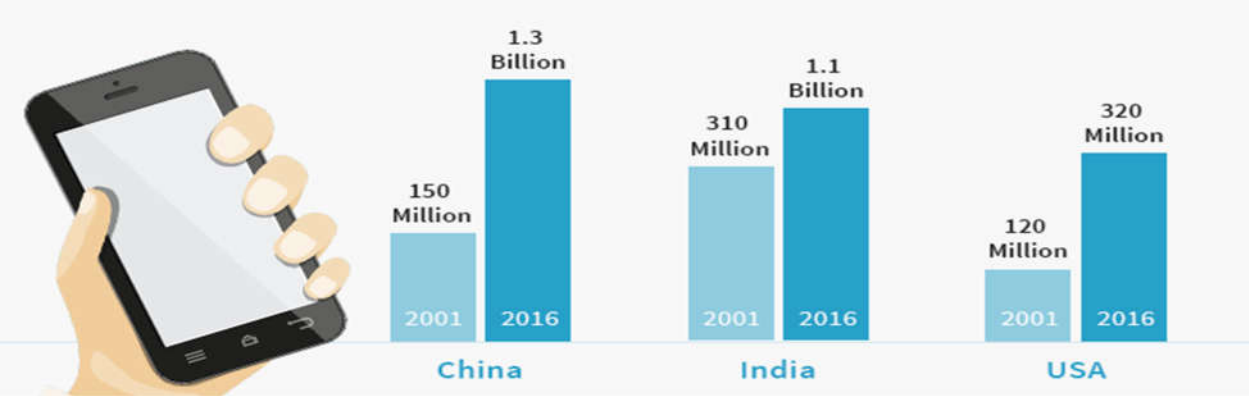
According to a joint study on 'Electricals & Electronics Manufacturing in India,' conducted by the ASSOCHAM-NEC the global volume of e-waste generated is expected to reach 52.2 million tonnes or 6.8 kg/ inhabitant by 2021 from 44.7 million tones in 2016 at a compound annual growth rate of 20 per cent, and value of all raw materials present in e-waste is estimated at approximately $61.05 billion in 2016, which is more than the GDP of most countries in the world, pointed out the joint study.

CHAPTER: V
E-WASTE ISSUES IN INDIA

5.1. Introduction:

As per a joint inspection report by Central Pollution Control Board (CPCB), Union Environment Ministry and Uttar Pradesh Pollution Control Board (UPPCB) found 27 illegal e-waste industries operational in Uttar Pradesh. All these units were dumping the waste into the Ramganga, causing irreparable damage to the river and its surrounding environment, these incidents highlights the silent crisis building up in India. Besides the country’s burgeoning population on mobile phones has seen stupendous growth in the last decade, which a 310 million subscribers in 2001 to 1.1 billion in 2016, the number of mobile phone users in India is nearly 4 times that of United States today and it is second only to China in the world, which has 1.3 billion subscribers.

Figure: 5.1. Mobile Users across the globe in million units:



Source: https://swachhindia.ndtv.com

That is just not mobile phones; there are 57 million computers in use and plethora of other gadgets and consumer electronics. The mass scale use of electronic goods has a huge flip side. India is now in the global list of highest electronic waste generators, posing grave threat to the environment and public alike. The electronic waste or e-waste, as it is popularly known, causes toxic emissions and poses several health hazards. Following are the issues identified from the assessment.

5.1.1. Increasing amount of E- Waste

The Product obsolescence is becoming more rapid since the speed of innovation and the dynamism of product manufacturing / marketing has resulted in a short life span (less than two years) for many computer products. The Short product life span coupled with exponential increase at an average 15% per year will result in doubling of the volume of e-waste over the next five to six years.

5.1.2. Toxic components

The e-waste are known to contain certain toxic constituents in their components such as lead, cadmium, mercury, polychlorinated bi-phenyls (PCBs), etched chemicals, brominated flame retardants etc., which are required to be handled safely. Most of the recycling practices were found inconsistent in informal sectors leading to uncontrolled release of toxic materials into the environment as a result of improper handling of such materials.

5.1.3. Lack of environmentally sound recycling infrastructure

E-waste, in the absence of proper disposal, find their way to scrap dealers, which are further pushed into dismantler's, supply chain. Current environmentally sound recycling infrastructure in place is not equipped to handle the increasing amounts of e-waste. Major dismantling operations are occurring in unorganized/informal sector in hazardous manner. The scope of increased e-waste generation and lack of adequate recycling facilities have attracted the attention of a number of recyclers globally, expressing interest to start recycling facility in India.

5.1.4. Impacts on environment

The E-wastes constitutes heavy metals, persistent organic pollutants, flame retardants and other potentially hazardous substances which can cause risks to the environment if not managed properly.

While recycling and material recovery, three main groups of substances are released in to the environment which needs high priority attention as they are highly hazardous in nature.

- The first group (the original constituents of equipment such as lead and mercury)
- The second group (cyanide, added during some recovery processes) and
- The third group (are formed during recycling processes such as dioxins and furans).

When these are improperly managed, such substances may pose significant human and environmental health risks.

5.2. Occupational health impacts of e-waste

We have few regulations for the informal sector to safeguard the health of those who handle e-waste. In general the workers are poorly protected in an environment where e-waste from PC monitors, PCBs, CDs, motherboards, cables, toner cartridges are burned in the open and release lead and mercury toxins into the air, besides many of these workers complain of eye irritation, breathing problems and constant headaches.

Some of the critical occupational health issues are inadequate working space, poor lighting and ventilation, straining the eyes and breathing polluted air, sitting cramped on the ground for long hours, inhaling toxic fumes, exposure of body parts to fire, acid and other chemicals and unavailability of clean drinking water and toilets.

5.3. Regulatory regime for e-waste

There are specific environmental laws or Guidelines for e-waste exists. The e-waste (Management and Handling) Amended Rule, 2018 has come into force from March 2018 having the following highlights:

Amended e-waste rules for **eco-friendly effective management** of e-waste in the country. The changes in Rules In order to streamline **e-waste** disposal in the country, it has been done for the purpose of validating and organizing the units engaged in the task of recycling or dissolving e-waste. As per the changes in the rules, the arrangements for productive accountability expansion have been redefined and the new targets for e-waste collection have been set for recent e-growers who have started selling.

5.4. E-waste management (amendment)

- Set new targets for **e-waste** collection will be considered effective from 01 October 2017. **E-waste** collection targets in various stages will be 10% of the waste generated during 2017-18, which will increase by 10% per year by 2023.
- Down 2023, this target will be 70 percent of the total waste generated.
- In case the product of a producer is less than the average age of its products in the year of operation, different targets will be set for e-waste collection for such new e-consumers.
- Rules regarding average age of the products will be determined from time to time by the **Central Pollution Control Board.**
- The expenditure of investigating such products under the hazardous substances (ROOs shall be bear by The government, if the product is not in accordance with the ROH's arrangements, then the production needs to be borne by the producer.
- The Productive Accountability Organizations have to apply before Central Pollution Control Board to register themselves for working under new rules.
- **E-Waste Management** Rule 2016 has been revised under the notification GSR 261 (E) on March 22, 2018.

The electronic equipment after prolonged used of it, by throwing it first on change / deterioration, and using another new device, this useless bad device is called e-waste. Computer, Mobile Phone, Printers,

Photocopy Machine, Inverter, UPS, LCD / Television, Radio / Transistor, Digital Camera etc. for generating.

CHAPTER: VI
MANAGEMENT OF E-WASTE

6.1. Introduction:

In the context of e-waste management, it is pertinent to assess the e-waste recycling scenario in India, where recycling of e-waste to recover items of economic value is carried out. The performance evaluation of e-waste recycling sector in India indicates that e-waste trade starts from formal dismantling sector and moves to informal recycling sector.

The e-waste movement from formal to informal sector is driven by trade and can be tracked by trade value chain. The e-waste trade value chain can be mapped based on material flow from formal sector to informal sector. The same was identified considering bottom-up approach with three levels of e-waste generation hierarchy. Three levels of e-waste generation hierarchy give rise to three types of stakeholders involved in e-waste trade as described below.

[1] 1st Level – Preliminary e-waste Generators.
[2] 2nd Level – Secondary e-waste Generators.
[3] 3rd Level – Tertiary e-waste Generators.

6.2. e-waste management steps:

Following steps are involved in an e-waste management facility. Generally in a formal sector the e-waste is segregated into different streams depending on their material composition and recycling potential followed by the hazardous nature is checked to understand its reuse or disposal options.

6.2.1. Composition and recycle potential

On the basis of composition of e-waste and its recyclable potential is specific for each appliance and in order to handle this complexity, the parts or materials found in e-waste may be divided broadly into six categories as follows:

Category1. Iron and steel, used for casings and frames
Category2. Non-ferrous metals, especially copper used in cables, and aluminum
Category3. Glass used for screens, windows
Category4. Plastic used as casing, in cables and for circuit boards
Category5. Electronic components
Category6. Others (rubber, wood, ceramic etc.).

6.2.2. Methodologies

The methodology and approaches to determine the hazardousness has been described in following steps. The same follows the basis used by “Department for Environment, Food and Natural Affairs”, Government of United Kingdom to classify E-waste. However, it has been customized as per Indian situation.

- Step 1: Identification of E-waste category
- Step 2: Identification of E-waste composition or determine it
- Step 3: Identification of possible hazardous content
- Step 4: Identifying whether the E-waste component is hazardous or the entire E-waste item is hazardous.

6.3. Follow Zero waste hierarchy strategy:

"Zero Waste" is no longer a stranger to all of us. Since over the years, leading a zero waste life has been advocated by numerous environmentally conscious individuals worldwide. The question is how exactly do you achieve it? some of the facts about the zero waste hierarchy and tips on how each level is practiced is presented below.

The zero waste hierarchy is defined as the "progression of policies and strategies to support the Zero Waste system, from highest and best to lowest use of materials". These 5 levels are: Reduce (Most preferred), Reuse, Recycle, Recover and Landfill (Least preferred).

Figure 6.1.the Zero waste Hierarchy

Source: https://thesustainabilityproject.life

6.3.1. Step1. Reduce: The amount of waste produced

The reduction of our waste might be one of the most difficult steps in the hierarchy. Some of small steps have to be taken to practice this in our daily lives to reduce our waste, a key question to ask yourself before purchasing an item would be "**Is this a need or a want?**".

The item that we wish to purchase is more likely to be a want than a need. Other questions that can be taken into consideration could be: the extent to which do we foresee ourselves using the item? Will it truly add value in your life? Are there any other alternative eco products?

Simply by avoiding the act of impulse buying, you can help to prevent the wastage of resources and at the same time, save your money!

6.3.2. Step2. Reuse: Materials as much as possible

An important notion of "**waste nothing, use everything**" can aid in the habit of reusing. Mostly we disregard the power and ease of reusing as we fail to see that almost everything and anything can be reused! E.g., pasta sauce that comes in a glass bottle can be reused to store your snacks (after cleaning it properly first). Hence forth, before throwing something away, take a moment to reconsider if the item can be reused for any other purposes!

6.3.3. Step3. Recycle: Everything you can

The act of recycling is definitely not a stranger to anyone. We are used to recycling bins found in almost in every city and country and nothing should be stopping you from recycling!

6.3.4. Step4. Recover: Energy from waste

Recovery of energy from waste is a novel concept as it is not a widespread practice. But in some countries, they have facilities that convert their waste to energy which contributes significantly to the concept of recovery. E.g. Norwegians residents are encouraged to sort their waste into various categories (organic, plastic and others). Then, the organic waste is then transformed into biogas which can be used as bio fuel for buses in Oslo. Besides the fact that recovery might be difficult without the help of the government or large corporations, we still can contribute individually by repairing our items instead of throwing them out!

6.3.5. Step5. Landfill

This is the last level of hierarchy. The landfill is probably the option in the hierarchy that is viewed as the last choice where unless you really cannot practice the 4 levels of the hierarchy aforementioned, then it will end up in the landfill.

CHAPTER: VII
ANALYSIS OF WASTE MANAGEMENT STRATEGIES

7.1. Policy level initiatives

At the governmental level the Policy shall address all issues ranging from production to final disposal, including environmentally sound technology for the recycling of electronic waste. The regulations to control both legal and illegal exports and imports of e-wastes must be clear in the policy. The loop holes in the prevailing legal frame work also to be addressed to prevent or reduce the trans-boundary movement of e-waste from developed to developing countries. General practice of disposing e-wastes in municipal landfills must be prohibited in the regulations strictly. The owners and generators of e-wastes should be encouraged to properly recycle their wastes by providing financial incentives.

The manufacturer of products must be made financially, physically and legally responsible for their products. The policy must emphasis management of restricted substances through awareness among producers and manufactures in the new product development. The environmental hazard labeling of products to create awareness among the general public must also to be covered in the policy. A competent national level inventory, covering all the cities and all the sectors must be initiated. The initiatives like, public-private participatory forum in E-waste management must be developed.

7.2. Extended producer responsibility

The Extended Producer Responsibility (EPR) is an environmental policy approach in which a producer's responsibility for a product is extended to the post consumer stage of the product's life cycle, including its final disposal (Joseph,2007).

The vendors of electronic devices shall provide take-back and management services for their products at the end of life of those products. All old electronic product should then be sent for recycling or re-use, either in a separate recycling division at the manufacturing unit or in a common facility.

The collection systems are to be established through collection centers to ensure proper collection and transportation directly to the recycling unit. The recyclers that are having authorization for handling, processing, refurbishment, and recycling meeting environmentally sound management guidelines should only be given permission.

7.3. Training and awareness programmes

A successful e-waste management in the future depends not only on the effectiveness of policy level initiatives from the government, effectiveness in recycling services, but also on the attitude of buyers. The lack of awareness among the residents to segregate e-waste from municipal waste is increasing the magnitude of e-waste problem in India.

The community participation must be initiated in order to understand the key role of manufactures and bulk consumers in e-waste management. different awareness raising programmes and activities on issues related to the Environmentally Sound Management (ESM), health and safety aspects of e-wastes may be conducted in order to encourage better management practices among different target groups.

The consumers need to be educated to buy only necessary products that utilize emerging technologies such as use of lead-free, halogen-free products to be identified through eco-labeling. The ESM of e-wastes can be well organized with a help of technical guidelines which emphasis on better collection, recycling and disposal options.

CHAPTER: VIII
CONCLUSION

The Present article summarizes the scenario of e-waste generation in India and in other countries. The definition, material composition, current disposal methods, hazardous nature of e-waste is also presented to understand the hazardous nature of e-waste in the form of heavy metals and halogenated compounds. The improper handling and management of these waste during recycling and other end-of-life treatment options seems to have potential risks to both human health and the environment.

Lack of public awareness regarding the disposal of electronic goods and inadequacy of policies to handle the issues related to E-waste enhance the problem in India. We don't have any large scale organized E-waste recycling facility in India and most of the recycling exists in unorganized sector. Also, the management practices are often poorly designed and have a lot of health and environmental issues.

There is an urgent need for a detailed assessment of the current and future scenario including quantification, characterization, existing disposal practices, environmental impacts and occupational health hazards.

E-waste collection, transportation, treatment, storage, recovery and disposal, need to be established, at national and/or regional levels for the environmentally sound management of e-wastes.

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