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E-WASTE- A NATIONAL HEALTH & ENVIRONMENTAL DISASTER FOR INDIA

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ABSTRACT

Quick changes in technology, shorter life period and increased dependence on the electronic products is resultingin considerable increase in e-waste generation. E-waste is more dangerous than any other kind of solid waste. It is very important to know all about the e-waste before declaring it as health and environmental disaster. E-waste is the term used for old, end of life and discarded electronics appliances which are currently not in use. E-waste has both hazardous and valuable materials. Hazardous materials are lead, mercury, cadmium etc. On the other side, valuable materials are gold, silver, aluminium, plastics etc. The quantity of the valuable materials is very less as compared to the hazardous materials. In India, due to lack of formal reverse supply chain or formal collection channels, the e-waste is not managed properly. In this paper, various stakeholders are identified which play a vital role in making e-waste a health and environmental disaster. To understand the importance of each stakeholder in e-waste management, role of each stakeholder is explained in detail. Also various effects of e-waste composition on human health are also explained in this paper.Root cause of this disaster is the low level of awareness about the hazardous effects of e-waste. As the level of awareness in India is very low, people have no idea about how to handle their discarded electronic items.

KEYWORDS: E-waste, Health, Environmental, Disaster, India

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1. INTRODUCTION

E-waste is a very hazardous waste which needs proper attention to overcome its negative effects on human health and environment.India is the fifth largest producer of e-waste in the worldand discarded around 1.7 million tons (Mt) of EEE in 2014 (Economic Times, [7] 2015) In India, most of the people are not takinge-waste seriously;even government is no exception. Today, few of Indian states have no recycling unit for e-waste management. Even no e-waste recycling data is available with the authorities. It shows the seriousness of the government. E-waste or electronic waste is the term used for old, end of life and discarded electronics appliances which are currently not in use.In India,there is a huge scope of research on e-waste. It is very surprising to know that the majority of Indiansare not aware of the term "E-waste". This scenario exists not just in rural areas but also in urban areas. Reliance "Jio" play a vital role in generation of e-waste in year 2016-17 in India. With the launch of 4G communication network in India at very reasonable price was the game changer in the market. Peoples had stood in queues to get their Reliance "Jio" device and discarded their current devices. Peoples are also being unaware about the e-wastehazards that affect their health and environment. E-waste contains over 1000 toxic materials that contaminate soil and even groundwater. Exposure of these toxicmaterials leads to various health issues like irritability, vomiting, eye pain, headache and nausea. The recyclers might also suffer from kidney, liver and neurological disorders. All these are caused due to lack of awareness which is risking people's wellbeing as well as the environmental well being. There are no clear guidelinesprovided for the unorganized sector to handle and manage e-waste properly. Also, only 2% of individuals considerthe impact on the environment while disposing of their old electrical and electronic equipment(IRG Systems South Asia, [10] 2010). By 2020, Delhi-National Capital will generate approx 150000 metric tonnes (MT) of e-waste. According to latest findings by the Associated Chambers of Commerce of India Council on Climate Change & Environment (ASSOCHAM, [1] 2017) this is about 25 per cent from the current level of 85000 MT.

2. LITERATURE

India has been identified as as a major hub for developments in IT sector and electrical devices. These devolpmets areplaying a key role in the socio-economic growth of the nation. With help of EEE's the present innovation in business is succeding effectively. Borthakur & Sinha, [2] 2013 stated that individuals working in education and banking sector have to depend on these EEE's to a large extent either voluntarily or un-voluntarily. Reprocessing of the electronic waste

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is profitable since many elements of the electronic gadgets consist of valuable, substantial metal which could be recycled. The solid waste management is dependent on informal sectorin India. Most of the people workinghere lackin propertechnique for removing the valuable metals from e-waste, uses harmful techniques and end up in jeopardizing children and women lives by removing the harmful elements from electrical gadgets deprived of PPE's. Further Kulkarni, [12] 2017stated that formal recycling facilities are insufficient and archaic, making the electronic waste supervision as a dreary zone in India. Zeng et al. [22](2017) stated that resultant trash from WEEE or e-waste is a Universal concern particularly in regions of ecological contamination, resource reprocessing and defensible manufacturing. In previous era, a complete procedure of e-waste exploration was established by China towards severe contamination from the commencement to directive regulatory in the existing. The major creator and user of EEE do not represent China alone and even represent the countries which are highly contaminated from prohibited e-waste imports and informal reprocessing of imported waste.

In Vietnam, e-waste is becoming an alarming problem because of increase in waste content and absence of recuperating resources. Hai et al. [9] (2017) made an outline about the e-waste, techniques in recycling and viewpoint of e-waste reprocessing in upcoming generation in Vietnam. The examination explicated that Vietnam could recuperate only certain materials like aluminium, copper, iron, etc. from the electronic waste using low competence. The recuperating procedure could have a severe influence on the ecological and human wellbeing. The elements of electronic waste are not being reprocessed in Vietnam and are being shipped to other nations illegally. Therefore, it disrupts BASEL Agreement and causes a loss for vital urban resource. Over extended years, recycling of the electronic waste has not been structured by the government of Vietnam. Henceforth, this kind of electronic waste has moved the regulation towards the informal sector; Extended Producer Responsibility System has been functioning in Vietnam from 2016. By presenting the new-fangled rule there has been a vital improvement towards the recycling sections which is being estimated to raise the effectiveness of the recycling procedures. WEEE or e-waste has been declared to be a harmful material worldwide. Although it consists of a spectrum of essential and nonessential metals. Fifth largest producer for WEEE is India, going through excessive consequences in controlling waste materials. Pathak et al. [15] (2017) stated that over past few years, Government of India has attempted to launch appropriate institutional and legislative framework to apply defensible control of WEEE. Pathak et al. [15] (2017) reviewed the Universal concerns related to WEEE and methods of tackling e-waste problem being used by other nations or regions.

In this article, the current state of scope for developments and problems being encountered during the implementation of reverse supply chain of e-waste in India is compared with the global practices (Rajya Sabha Secretariat, [16] 2011).

The systemic problems on the disposal of waste gathered attention through the Cobalt-60 radiation tragedy at Mayapuriin Delhi, where one person lost his life and six persons were admitted to hospital that served as a wakeup call for the Ministry of Environment and Forests (MoEF), which notified the Hazardous Wastes Rules (Management, Handling and Transboundary Movement) 2008, for effective management of the mounting quantity of hazardous waste including e-waste in the country. Nonetheless, such rules are not applicable to the radioactive wastes such as Cobalt – 60 that are covered under the Atomic Energy Act, 1962. In current situation, India is saddled with massive volumes of e-waste, generated domestically or imported unlawfully (Borthakur and Sinha, [2] 2013). In recent past, all Asian and African countries including India, have become the target place for E-waste shipment for OECD countries. Also, domestic E-waste is being generated in bulk by Indians (Skinner et al., [19] 2010).

Almost 75% of electronic goods are stowed because of uncertainty in management (Ramachandra & Varghese, [17] 2004). Over all, E-waste is considered as a product that causes an unwillingness for immediate disposal (Sinha, [18] 2008).

The unattended e-wastes thrown out from houses, offices, warehouses, etc. are usually blended with domestic wastes that are ultimately disposed of at landfills (Sinha, [18] 2008).In this regard, implementation of regular E-waste disposal through proper management practices is mandatory.

2.1 Objectives of the study

It is very important to check the health and environmental hazards associated with e-waste as many components of the waste produced are responsible for many serious health diseases and serious environmental hazards. There are so many stakeholders who are not doing their duty and are directly playing with the health of individuals and the environment also. These stakeholders need to be identified so that necessary action should be taken against him.

3. RESULT & DISCUSSION

First of all, it becomes necessary to identify the various metals present in e-waste and hazards associated with these metals. The table below shows the various health and environmental hazards associated with various components. This is the reason why e-waste is called a health and environmental disaster. Another reason will be defined later on in this paper.

E-Waste Component	Potential environmental hazard
Chips and further gold plated components	• PAHs, heavy metals, brominated flame retardants discharged directly into rivers acidifying fish and flora. • Contamination of tin and lead on surface and groundwater. • Emissions in air of brominated dioxins, PAHs and heavy metals.
Plastics from keyboards, printers, monitors, etc.	Emissions of heavy metals, brominated dioxins, and hydrocarbons

Cathode ray tubes which are used in TVs, computer monitors, ATM, video cameras, and more	Barium, Lead and other heavy metals discharged into the ground water and discharge of toxic phosphor
Printed circuit board (PCB)	Air emissions and discharge into rivers of glass dust, beryllium cadmium, tin, mercury, brominated dioxin and lead.

Source: Adopted From Khan, [13] (2017)

Table 1: E-waste Components With Their Adverse Effect on Environment

Component	Danger
Lead	The lead is released as powder and fumes during the mechanical breaking of CRTs (cathode ray tubes) and the removal of solder from microchips. It acts as a neurotoxin affecting the kidney and the reproductive system. High quantities can be fatal. It affects the mental development in children.
Brominated Flame Retardants (BFRs)	Liver problems, thyroid problems and impaired development of nervous system (United States Department of Labor, [21] 2017).
Plastics	Burning PVC, a plastic component, also produce dioxins. They are also identified in dust on computer circuit boards cabinets and cables containing carcinogenic BFRs or brominated flame retardants liberating carcinogenic brominated dioxins and furans, leaching into landfills, thereby harming reproductive and immune systems.
Chromium	It is used to protect metal housings and plates present in a computer from corrosion. Inhaling hexavalent chromium may damage liver and kidneys causing asthmatic bronchitis and lung cancer.
Mercury	Mercury is released while breaking and burning of circuit boards and switches. Through microbial activity, it enters the water bodies as methylated mercury which is toxic and may enter the human food chain, thereby affecting the central nervous system, the reproductive system and the immune system. It impairs growth of the foetus and infants through mother's milk.
Beryllium	It is present in switch boards and printed circuit boards, which when liberated acts as carcinogens affecting lungs.
Cadmium	Cadmium is released into the environment as dust powder during crushing and milling of plastics, CRTs and circuit boards, thereby entering surface water and ground water. Long-term exposure causes Itai-itai disease, resulting severe pain in the Joints and spine, ultimately affecting the kidneys and softens bones.
Acid	Sulphuric and hydrochloric acids are used to separate metals from circuit boards, which liberates fumes containing chlorine and sulphur dioxide that results in respiratory problems, corrosiveness of the eye and skin.
Americium	Leads to carcinogenic

Source: Adopted From'IT's underbelly', Down to Earth, vol.19, [11] (2010)&Khan,[13] (2017)

Table 2: Hazardous Components of E-waste and Their Negative Effects on Human Health

Another reason which makes e-waste health and environmental disaster are the various stake holders. Next step is to find out the stakeholders where high health and environmental hazards associated. These stakeholders are ultimately responsible for making e-waste "A Health and Environmental Disaster". After a detailed study of the Indian system, we find out the following sevenstakeholders:

- Service Centres (Repair Shops)
- Informal Collection
- Informal Recycling
- Inventory of E-waste
- Child labour
- Export of e-waste
- Role of Government

In the following paragraphs, we have discussed the role ofeach of the above stakeholders in playing with the health of human being and the environment.

3.1 Service Centres (Repair Shops): There are so many electrical and electronic product service centres like authorised service centres of various companies for TV/LED/laptops/ mobile phonesavailable in India. In addition to these authorized service centres, there are many non-authorized repair shops available in every district of India. They are dealing with number of electrical and electronic products which are available for repair at their service centre. They replace the defective or non-working parts with new one. Downside of this process is that they store the defective or non-working components at their service centres. They maintain inventory of defective cathode ray tube (CRT), various circuit boards, switches etc.

Figure 1: E-waste Stored At Service Centre

They just make the inventory of these discarded electrical and electronic products with no safety precautions. They are just doing this to recover some working parts from the circuit boards, switches etc. but they have no idea that this tendency is more harmful for themselves also. Even the level of danger is almost equal in both types of centres.

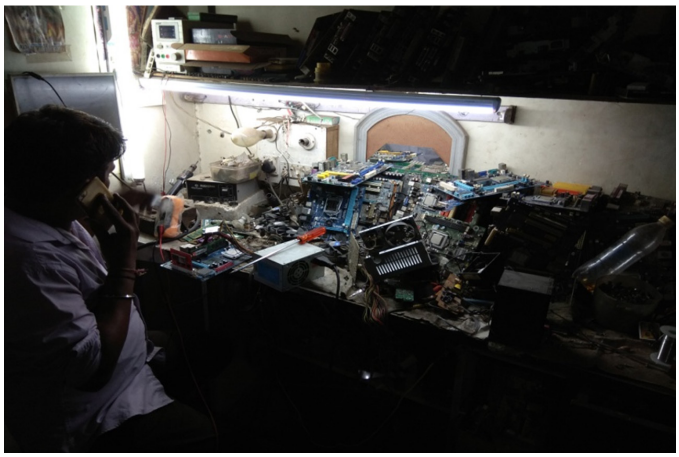

Figure 2: Repair Job At Service Centre

They spend more than 8-10 hours daily in this polluted environment. Similarly, so many people visit their service centre frequently to get their defective electrical and electronic items repaired.This type of working environment is responsible for serious health and environmental hazards. The persons working in the service centres are unaware of the negative effects of e-waste on human health and the environment also. Awareness level of the Indian citizens about the hazardous effects of e-waste is very poor. Even they are not able to understand the term "e-waste". Unknowingly the person at service centres directly playing with the health of human being and the environment. Even no guidelines are provided by the manufacturer to the authorised service centres to handle e-waste.

3.2 Informal Collection:

Informal collection is a serious issue in India as majority of e-waste is collected by informal channel in India. This is due to the absence of formal collection channel. There are no formal collection centres available in most parts of India. In India, according to Green Peace report, [8] (2008) approximately among twenty brands carrying on business in electronic equipment, nine have no take back service in India including Apple, Microsoft, Panasonic, PCS, Philips, Sharp, Sony, Sony Ericsson and Toshiba. For the whole of India, with only one collection point for mobile phones, Samsung claims to have a take-back service, whereas other brands including HCL, Wipro, Acer, Nokia, etc., have taken-back facilities though they have neither user-friendly nor adequate collection centres. In addition, brands that provide take-back services in India includes Dell and LG Electronics that do not have taken-back information on their Indian websites, which results in difficulty for Indian customers to access the information and avail themselves of the service. They are just producing the electronics products and nothing to have with e-waste recycling. This is due to the presence of ineffective legislation and absence of effective monitoring system.

Figure 3: Informal Collection of Computers

Scrap dealer is a part of informal collection system. Scrap dealers visit various organizations and houses to pick the e-waste from them. The informal collection has their own channel to collect the e-waste from homes and organizations and send it for further processing. Due to lack of awareness about the hazardous effects of e-waste on human health and the environment the informal collector do not know how to deal with e-waste, what precautions should be taken to handle it. This collection becomes more dangerous as scrap dealer store e-waste in their store for long time. They may also store e-waste up to some specified quantity as they transport the collected e-scrap in huge quantity for further processing. During this period the e-waste contaminates with the ground water and other dangerous gases released from e-waste. This process ultimately affects the human health and environment as well. So the informal collection has very adverse effect on the human health.

3.3 Informal Recycling:

Only few brands like Acer and HCL have initiated to support the e-waste legislation in India by training their frontline staffs on take-back and recycling service Dey and Jana, [5] (2014). Positions of the other brands are unclear in investing on awareness education of general customers on e-waste management. Informal recycling is more dangerous than informal collection. This is because informal recycling is done without any safety measures and even with bare hands. This is very serious issue in India. Due to lack of awareness,informal recyclers do not consider the negative effects of e-waste. To recover the valuable materials like copper and aluminium from the discarded electrical wires, they generally burn these wires in open environment.Very dangerous gases are released from this burning process which ultimately pollutes our environment. The unorganised sector is causing considerable negative impact on environment and health of the individuals. As per the ASSOCHAM, [1] study, about 67 per cent of e-waste workers in India suffer from respiratory ailments such as breathing difficulties, irritation, coughing, choking and tremors problems. As the workers working in the informal system have direct contact with discarded e-products, the chances of being affected by hazardous materials increases considerably. Informal recycling is a common way to earn income as e-products have some precious metals such as gold, silver etc. Though, these metals are present in very small quantity. The segregation of working and non-working components also takes place at informal recycling centres. This type of segregation is very dangerous as it is done without the use of safety precautions, with outdated technology and even with bare hands. The recycling process characteristically contains the segregation and disassembly followed by the shredding, pulverizing and material recovery process. The major activity in e-waste recycling is disassembling the gathered products to a component stage. Upon disassembling the segregation process for the functional components from non- functional components is carried out. The non-functioning components are additionally disassembled while the functional components are reused. When reusing the disassembling functional components the non-functional components are being separated based on their composition before the shredding process. The final level is recycling the recovered materials which include retrieving plastic, ferrous metals, non-ferrous metals and glass through numerous refining processes. It is seen that both the system and component level disassembly process of segregation iscarried out manually to a great extent. On the other side,pulverizing, shredding and recovery of materials are effectively processed

using the automated processes. Even while fractional material recovery for plastics, ferrous metals and glass may be boarded manually. The efficient and safe recovery of the nonferrous metals particularly copper and gold necessitatesmechanized processes. (Dwivedy, [6] 2013).

3.4 Inventory of E-waste:

Organizational consumers and individual consumers are the two stake holders which are responsible for e-waste generation. About 70% of the total e-waste is generated by organizational consumers.

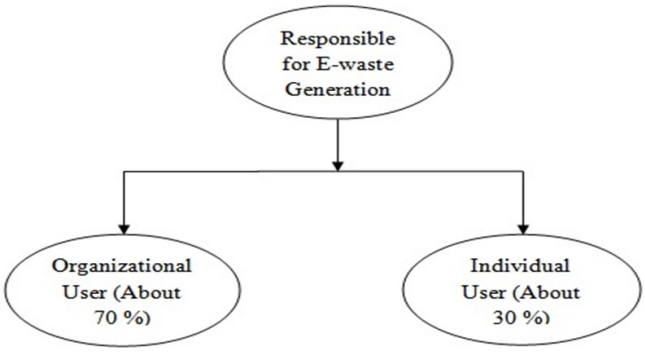

Figure 4: Stake Holders Responsible for E-waste Generation

Almost all medium scale and large scale industries have their research and development centres. Latest technological electronic products like Computers/Laptops, printers etc are required at these centres. The organizational consumers replace their old electronic products very frequently to cope up with the latest technology available.

Figure 5: Inventory of E-waste In An Organization

The organizations have two options for their discarded products either they sell their discarded products in the second hand market or sell it to the scrap dealers. Before selling the discarded electronic products, the organizationscreate inventory of the discarded electronic products in their store without use of any safety precautions. This ultimately pollutes the ground water, human health and the environment as well. The same thing happens with the individual consumers also. The individual consumers also discard their old e-equipments because of technological advancement, social esteem and need for greater features in the latest available products. Like the organizational consumers, individual consumers also store their discarded electronic e-items at home due to lack of awareness. This step has very negative effect on health of the complete family as dangerous gases release from the discarded electronic product.

3.5 Child Labour:

Another downside of this informal system is the involvement of child labour in recycling process. D S Rawat, Secretary-General ASSOCHAM, [1] told Down To Earth, "In India about 4-5 lakh child labourers in the age group of 10-15 years are engaged in various e-waste activities, without adequate protection and safeguards in various yards and recycling workshops". As immune system of children of this age group is not strong they are affected more severely by the hazardous materials of the discarded electronic devices. As it is clear from the study, the involvement of child labour is considerable in India. This is due to the fact that they are living below poverty line. To earn some money, parents of these children push them to the well of death. Child labour is a crime in India even than due to lack of effective monitoring system children are working in various organizations and homes.

3.6 Export of e-waste:

In India e-waste is generated at a very alarming stage. On the other side various developed countries like USA; Japanexports their discarded electronic waste to the developing countries like India and China. Toxics Link, [20] (2004) report stated that in New Delhi the recycling unit itself has 70% of the total e-waste collected which was exported or dumped by the developing nations since most of these countries find it as a commercial profit by delivering their e-waste for recycling or reusing in the emerging nations. For example, the price for recycling a single computer in the United States costs around $20 whereas if the same recycling process in India costs only for $2 US which is a gross saving of $18 US if the computer is exported to India (Chatterjee & Kumar, [4] 2009). India fails to cease the illegal import of e-waste into the country though it is a participant in the Basel Convention for controlling the Transboundary Movements of the Hazardous wastes and their disposals where one of the important component is e-waste (Manda, [14] 2008). Though importing e-waste is illegal and being often shipped it is impractical to anticipate the exact count or statistics of the imported quantity to India (Skinner et al., [19] 2010). Bearing in mind the above facts, it is apparent that the quantity of e-waste engendered in the country is prospering at an alarming rate towards the management practices and policy level initiatives which are being still in the early level (Borthakur, [2] 2014). Another disadvantage with this type of export or dumping is that majority of the dump electronic scrap is managed by the informal channel.

3.7 Role of Government:

Government plays a very important role in managing all these stake holders. Legislation to manage the e-waste is present in India but not implemented effectively. This is the main cause which is responsible for the failure of legislation. Also monitoring system is also not effective in India. Government should take some strict action to make the legislation and monitoring system effective. As monitoring system is the root of any successful system, but in India root is not maintained

properly. If the root will maintain properly than the various organization will follow legislation strictly. Public awareness programmes should be conducted at regular intervals so that the end user's awareness level can be enhanced. Government should design a effective e-waste recycling system with the help of various stake holders like manufacturer, collector recyclers etc. Government should define the responsibilities of each stake holder clearly to make current e-waste recycling effective.

4.0 CONCLUSION

1. As the level of awareness is very poor in India, govt should take some initiatives to run awareness programmes via print media or electronic media at regular intervals to increase the level of awareness about the adverse effects of e-waste on human health and the environment.
2. Government should design an effective monitoring system to control the informal collection and informal recycling. An effective, formal collection and recycling channel should be designed with the involvement of manufacturer. Responsibility of each stake holder like manufacturer, distributors, retailers, end users, collectors and recyclers should be fixed with clarity of objectives.
3. Legislations should be designed in such a manner that nobody keeps their discarded electronic products at their home or store for long time. Recycling fee should be charged in advanced from the end user at the time of purchase of e-products as is being done in Japan. Another factor which also plays a very important role to pull out the electronic products inventory towards recycling unit is the financial incentives. Financial incentives should be considerable.
4. With the help of effective monitoring system, involvement of child labour should be controlled. Heavy fines should be imposed on the recycling unit which hire child labour.
5. Government has to make some strict legislation to control the over dumping of e-waste from developed countries. Also illegal dumping must be controlled.

If the above mentioned steps are taken, we can save India from the potential health and environmental problems of e-waste.

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