JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

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E-WASTE MANAGEMENT: CHALLENGES AND OPPORTUNITIES

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Abstract:

Electronic waste, or e-waste in common parlances, is increasingly becoming a cause of concern in developing countries like India, due to environmental and human health hazards associated with it. Ironically constituents of e-waste can be valuable, at the same time being toxic. The practices involved in managing and treating electronic waste in India have limitations that need to be identified and resolved. Waste management can be properly executed if there are proper collection and disposal methods adopted. This can be possible only if there is proper awareness related to the ill effects of e-waste among common people. This paper highlights the status of e-waste in India the various techniques used for recycling and their limitations. The indicators assessing e-waste can be utilized as basic parameters for analysis in any nation. The valuable constituents present in e-waste can be used to create business opportunities if properly treated and recycled.

Keywords: E-waste, Environmental Challenges, Opportunities, Hazards, Recycled.

Introduction:

Electronic waste, also known as e-waste, is generated when any electronic or electrical equipment becomes unfit for the intended use or if it has crossed its expiry date. Due to rapid technological advancement and the production of newer electronic equipment, the old ones get easily replaced with new models. It has particularly led to an exponential increase in e-waste in India. People tend to switch to newer models and trending technologies, also the lives of products get reduced with time. However, the issue is left with e-waste management in India and its challenges.

Consumers are the key to better e-waste management in India. Initiatives such as extended producer responsibility design for the environment; (3Rs) Reduce, Reuse, Recycle technology platform for linking the

market facilitating the circular economy aim to encourage consumers to correctly dispose of the e-waste, with an increased reuse and recycling rates, and also adopt sustainable consumer habits.

In many developed countries, e-waste management is given high priority. In contrast, in developing countries, it is exacerbated by completely adopting or replicating developed countries' e-waste management and several related problems, including a lack of investment and technically skilled human resources. In addition, there is a lack of infrastructure and the absence of appropriate legislation, specifically dealing with e-waste. Also, there is an inadequate description of stakeholders' and institutions' roles and responsibilities involved in e-waste management, etc.

Table 1 **Categorization of e-waste**

Sl. No.	Category of waste	Application
1	Large households equipment	Air conditioner, dishwasher, washing machine, refrigerator microwave oven, etc.
2	Small household equipment	Television, alarm clocks, electric kettles, electric chimneys, etc.
3	IT and telecommunication equipment	Modern landline telephones, mobile phones teleprinters, and communication satellites.
4	User equipment	Radio receivers, digital cameras, personal computers, video recorders, MP3 players, CD and DVD players.
5	Illumination equipment	Ballast lamps, LED, and compact fluorescent lamps
6	Electrical and electronic components	Generators, transistor motors, transformers, wires, integrated circuits and batteries.
7	Toys, leisure, and sports equipment	Batteries in cars, trains, airplanes, etc.
8	Medical apparatus	Thermometer and biotechnological apparatus
9	Monitoring and controlling apparatus	Relays, thermostats, and microcontrollers
10	Automatic dispenser	Automatic water dispenser, automatic soap dispenser automatic spray dispenser etc.

Source: Garlapati (2016)

Table 2 Types of e-waste and their lifespan

Sl. No.	Electronic Equipment	Mass of the Device (in kg)	Estimated lifespan (in years)
1	Personal computer	25	3
2	Fax machine	3	5
3	High-fidelity systems	10	10
4	Cell phone	0.1	2
5	Electronic games	3	5
6	Photocopier	60	8
7	Radio	2	10
8	Television	30	5
9	Video recorder	5	5
10	Air conditioner	55	12
11	Dash water	50	10
12	Electric cooker	60	10
13	Food mixer	1	5
14	Freezer	35	10
15	Hair-dryer	1	10
16	Iron	1	10
17	Kettle	1	3
18	Microwave	15	7

Source: Gaidajis et.al. (2010)

Concept of E-Waste:

E-waste poses a huge risk to humans, animals, and the environment, E-waste typically consists of plastics, metals cathode ray tubes (CRTs), printed cables circuit boards, and so on. Valuable metals like copper, silver, gold, and platinum can be reused from –e-waste once they are scientifically processed. The presence of toxic substances like liquid crystal, lithium mercury, nickel, selenium, polychlorinated biphenyls (PCBs), arsenic, barium, brominated flame retardants, cadmium, chrome, cobalt copper, and lead makes it very hazardous, in case e-waste gets dismantled and processed crudely with the rudimentary techniques.

Computers, mainframes, servers, monitors, printers, scanners, compact discs (CDs), copiers, calculators, battery cells cellular phones, fax machines, transceivers, TVs, medical apparatus, iPods, refrigerators, washing machines, air conditioners, are examples of e-waste when they become unfit for its use.

The presence of highly toxic substances and heavy metals like mercury, lead, beryllium, and cadmium pose a significant threat to an environment even in minute quantities.

Objectives:

- To implement the extended producer responsibility under the 2016 rules, the emphasis is on the producer's responsibility for environmentally sound electronic waste management at every stage.
- To establish an efficient e-waste collection mechanism, through a buy buyback and take-back system and also to promote the same.
- To promote technologies that are environmentally sound through authorized dismantles and recyclers.
- To decrease the informal sector's illegal recycling and recovery process/operations.
- To minimize the use of hazardous substances in the manufacturing of electronic waste equipment.

Review of Literature:

Yamini Gupt et. al. (2015): Suggested that the financial responsibility of the producers and separate collecting and recycling agencies contribute significantly to the success of the extended producer responsibility-based environmental policies. Regulatory provisions. Take-back responsibility and financial flow come out to be the three most important aspects of extended producer responsibility. The presence of the informal sector hurt the regulatory provisions.

Norazil Othman (2015): the quantity of electronic waste can be controlled if there is a sustainable integrated technique in managing the electronic waste. Sustainable integrated techniques should consider electronic waste management from production until its disposal point. Implementation of new legislation and Acts should also be considered by the authority to develop human capital in managing electronic waste. The combination of human capital with a sustainable technique for managing electronic waste will lead to efficiency in managing electronic waste in the future.

Vijay'B et. al. (2014): most of the waste is inherently dangerous. It will degrade to provide leachate, which can contaminate water, and make lowland gas, which is explosive. Additionally, owing to the risks related to lowland sites, there are currently terribly strict needs for the development, operation, and medical care of such sites. Most designing authorities desire a figured-out quarry to be used for landscaping instead of a lowland website that nobody desires in their "back yard". Product style should be used to assist in reducing not solely the character and quantity of waste, but conjointly to maximize end-of-life utilization. Makers, retailers, users, and disposers ought to share responsibility for reducing the environmental impacts of merchandise. A product-centered approach ought to be adopted to preserve and shield the setting.

Sikdar and Vaniya (2014): in their research stated that the government should introduce some topics related to the disposal of e-waste materials and its recycling and the adverse effects of e-waste on the health of the human body in environmental education as a compulsory subject from lower to higher grades. The researcher realized recently that the education system alone is a powerful medium to ensure environmental protection. It should reach most parts of the population at a young age, and more e-waste-friendly behavior should be practiced daily.

Sivakumaran et. al. (2013): confirmed that public awareness and cooperation of manufacturers are essential for the advancement of e-waste management systems. And also it is the responsibility of the government to allocate sufficient grants and protect the internationally agreed environmental legislation within their borders. Licensing certifications like stewardship may ensure security to prevent illegal smugglers and handlers of e-waste. As e-waste is the known major source of heavy metals, hazardous chemicals, and carcinogens, certainly diseases related to skin, respiratory, intestinal, immune, endocrine, and nervous systems including cancers can be prevented by proper management and disposal of e-waste.

Hassan Taghipour et. al. (2012): suggested that a policy should be framed extending the producer responsibility (EPR) program in combination with a training program at different levels of society. An approach consisting of a mandated product take-back is proposed for implementing EPR in Iran. Meanwhile, the Health Ministry and the Environmental Protection Agency should strictly supervise E-Waste collection, storage, and recycling and/or disposal, and the trade and industry ministries must have more control over the import and production of electronic goods.

Research Methodology:

Secondary data will have been collected from different sources such as research articles, textbooks, journals, thesis, and annual reports magazines and selected the official websites to build the conceptual framework of the study.

Opportunities for E-waste Management in India:

1. The Ministry of Environment, Forest, and Climate Change rolled out the e-waste management rules in 2016 to reduce e-waste production and increase recycling. Under these rules, the government introduced EPR which makes producers liable to collect 30% to 70% (over seven years) of the e-waste they produce.
2. The integration of the informal sector into a transparent recycling system is crucial for better control of environmental and human health impacts. There have been some attempts to integrate the existing informal sector into the emerging scenario. Organizations such as GIZ have developed alternative business models to promote a city-wide collection system feeding the manual dismantling facility and a strategy towards the best available technology facilities to yield higher revenue from printed circuit boards. By replacing the traditional wet chemical leaching process for the recovery of gold with the export to integrated smelters and refineries safer practices and a higher per unit of e-waste collected are generated.
3. E-waste is a rich source of metals such as gold, silver, and copper which can be recovered and brought back into the production cycle. There is significant economic potential in the efficient recovery of valuable materials in e-waste and can provide income-generating opportunities for both individuals and enterprises.
4. The E-waste Management Rules 2016 were amended by the government in March 2018 to facilitate and effectively implement the environmentally sound management of e-waste in India. The amended rules revise the collection targets under the provision of EPR with effect from October 1, 2017. By way of revised targets and monitoring under the Central Pollution Control Board (CPCB), effective and improved management of e-waste would be ensured.

Challenges for E-waste Management in India:

E-waste recycles in India is predominantly an informal sector activity. There are thousands of poor households consuming a living from scavenging materials from waste dumps. The common recycling practice for middle-class urban households, particularly for waste paper, plastic clothing, or metal is to sell out to small-scale, informal sector buyers often known as ‘kabadiwalas’, and they further sort and sell these as an input material to artisanal or industrial processors.

E-waste management in India follows a similar pattern. An informal e-waste recycling sector employs thousands of households in urban areas to collect, sort, and repair, refurbish, and dismantle disused electrical and electronic products. However, there is a different situation in advanced countries, and there is no concept in India of consumers voluntarily donating useless electrical and electronic equipment at formal e-waste recycling centers.

The heavy reliance on an informal sector for e-waste recycling gives rise to these key challenges, as mentioned below.

1 The attempt to impose financial penalties on non-compliance or violation of e-waste handling and processing rules is ineffective.

2. Broader public knowledge regarding market prices and health safety costs of e-waste recycling is less because less paid workers who do this work do not have proper training.

3. Despite the massive increase in the volume of e-waste generated every year, there is very little investment by large-scale industrial infrastructure for recovery and recycling.

Poor Infrastructure for the Recycling of E-waste:

India has very limited infrastructure capacity for large-scale management of e-waste. There are very few government-approved approved e-waste recycling centers in the country, which only constitute about $1/5^{th}$ of the total amount of e-waste generated each year. The Indian government offers co-funded grant schemes that cover between 25% to 50% of the project costs for the e-waste management facilities and building capacity for e-waste businesses. However, the uptake of this scheme has been very limited. In addition, there is also a shortage of formally approved e-waste recycling centers as presently existing centers operate far below their capacity due to poorly organized supply chains between them and the majority of informal sector collectors of e-waste in India.

However, the formal sector recycling is limited to manual sorting and mechanical dismantling of e-waste management in India. At present, there is a lack of industrial e-waste managers with appropriate environmental controls, which are required for large-scale recovery of precious and base metals. A few emerging Indian companies extract metals from e-waste, but they have limited processing capacity. Most of the e-waste processed by a formal sector is exported from other countries with the necessary large-scale infrastructure for metal extraction. In contrast, the informal sector extracts metals using methods such as open-air incineration and acid leaching, which are hazardous and exacerbate environmental pollution and health risks.

a. Lack of Awareness and Financial Incentives:

There is a lack of public awareness of e-waste hazards in India, and recycling is, therefore, very low. Most consumers do not know or have less knowledge about the hazardous nature of e-waste components or the penalties for improper disposal. They do not know that e-waste management in India is done by urban municipal or state government agencies.

Several cities have very few dedicated collection depots or formal recycling centers where consumers can voluntarily drop off the e-waste. The majority of people and urban household consumers used to sell e-waste or get some discount in exchange when they purchased any new electrical or electronic products from small-scale retail shops. Since consumers lack market information about prices for e-waste and various e-waste components, they have few financial incentives for the responsible disposal of their waste.

b. Less Information on E-waste Generation Rates:

It is acknowledged that there is a lack of e-waste inventories and all the responsibility is placed on the state-wise e-waste inventories of the respective State Pollution Control Boards (SPCBs). The sales data on electronic products is an important input in the estimation of e-waste quantities. It is often available at a national-level aggregation, which makes it challenging to produce inventories at the state level. In addition to domestic generation, the e-waste is imported from developed countries, often illegally.

c. Mismanagement in Market for the End-of-life Products:

The ability to reliably source e-waste quantities create economies of scale and restricts the entry of private players to set up e-waste management systems in a formal sector. For instance, employing effective recycling technologies for e-waste management in India may require significant upfront capital expenditures, which cannot be justified for private entities in the absence of certainty about sourcing enough quantities of e-waste. Also, these markets suffer from information barriers.

1. Environmentally unsustainable informal sector practices:

Despite the formal dismantling and recycling sector's growth, the actual waste processed in the formal sector is still very low. Most of these formal facilities are operating below the approved capacities because of the inability to source enough waste. The lack of awareness regarding e-waste and the costs of returning end-of-life equipment to formal collection centers is reducing the willingness of household and institutional consumers to return their waste to the formal sector. Most importantly, through the convenience of household collection and monetary incentives, the informal sector makes this attractive for customers to return their waste, relative to the formal sector, which is yet to invest in robust collection and processing systems.

2. Inadequate Regulatory Design and Enforcement:

The mandatory take-back systems for producers without accompanying collection targets as no incentives to take responsibility and therefore induced little improvements in e-waste management practices. Certain amendments were proposed, which provided more regulatory certainty by specifying gradual and increasingly stricter collection targets. However, the regulatory design places a significant burden on the already ill-equipped regulatory agencies. The regulators must review the EPR plan submitted by the producers, grant authorization, and enforce the EPR plan's provisions.

Conclusion:

E-waste management in India is a great challenge for governments of many developing countries. It is becoming a huge public health issue and is exponentially increasing by the day. It has to be collected separately, treated effectively, and disposed of e-waste, it is also a diversion from conventional landfills and open burning. It is essential to integrate an informal sector with the formal sector. The competent authorities in developing countries like India need to establish mechanisms for handling and treating e-waste safely and sustainable manner.

The hazardous nature of e-waste is one of the rapidly growing environmental problems of the world. The ever-increasing amount of e-waste associated with the lack of awareness and appropriate skills is

deepening the problem. A large number of workers are involved in the crude dismantling of these electronic items for their livelihood and their health is at risk; therefore, there is an urgent need to plan a preventive strategy for health hazards of e-waste handling among these workers in India. Required information should be provided to these workers regarding the safe handling of e-waste management many technical solutions are available, but to be adopted in the management system, prerequisite conditions such as legislation, collection system, logistics, and manpower should be prepared. This may require operational research and evaluation studies.

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