E-waste management in India

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Abstract

Electronic waste or E-waste is relatively a novel addition to the ever-growing hazardous waste stream. It includes discarded electronic and electrical equipment. Developing countries are facing enormous challenges related to the generation and management of E-waste which are either internally generated or imported illegally; India is no exception to it. However, the existing management practices related to E-waste in India are reasonably poor and have the potential to risk both human health and the environment. Moreover, the policy level initiatives are not being implemented in an appropriate way. The austere problem of E-waste along with its policy level implications is looked upon in the paper. During the course of the study it has been found that there is an urgent need to address the issues related to E-waste in India in order to avoid its detrimental future consequences.

Keywords: E-waste, hazardous waste, risk, management.

- E-waste is growing in India at a rate of 10%.

- E-waste contains valuable elements and hazardous materials.

- The informal sector dominates e-waste management in India, with estimates of more than 90% of the waste being processed in this sector.

- India has had e-waste management regulations since 2011, including regulations for transportation, storage, recycling, and Extended Producer Responsibility (EPR).

- 10 states contribute to 70% of the total e-waste generated in India.

- 65 cities generate more than 60% of the total e-waste in India.
- Recycling e-waste can help promote the circular economy, ensure safe disposal of hazardous materials, create green jobs, and achieve the target of SDG 12.5.
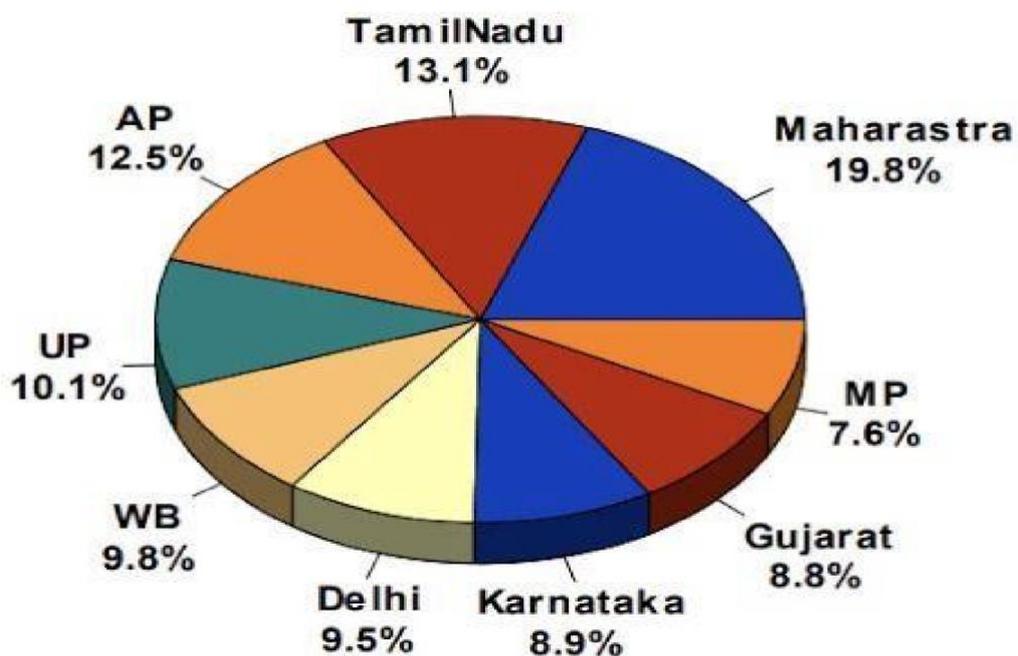
- According to the EPA, the top ten cities generating e-waste are:

o Mumbai

o Delhi o Bengaluru o Chennai o Kolkata o Ahmedabad o Hyderabad o Pune

   o Surat

State wise e-waste generation in India (Tonnes/year)

Introduction

The manufacturing of electrical and electronic equipment (EEE) is one of the emerging global activities. The main factors identified to be responsible for the increased consumption and productions of electrical and electronic equipment are rapid economic growth, coupled with urbanization and industrialization. The Indian Information Technology (IT) sector is one of the major contributors to the global economy. At the same time, it is responsible for the generation of the bulk of E-waste or Waste Electrical and Electronic Equipment (WEEE) in India. Although the global E-waste problem has been able to attract attention across the world, not much emphasis has been given to the E-waste engendered in developing countries.

Developing countries like India, today, is burdened with the colossal problem of E-waste which is either locally generated or internationally imported, causing serious menace to human health and environment. The hazardous components in electrical and electronic equipment are a major concern during the waste management phase. In the context of India, recycling of Waste Electrical and Electronic Equipment is not undertaken to an adequate degree.

However, one of the major issues related to E-waste is that there is no standard definition of WEEE/E-waste. A number of countries have come out with their own definitions, interpretation and usage of the term "Ewaste/WEEE". The most widely accepted definition and description of WEEE/ E-waste is as per the European Union directive. The Directive 2002/96/EC of the European Parliament and of the Council of 27 January 2003.

1.   The categories set out in Annex IA and designed for use with a voltage rating not exceeding 1 000 Volt for alternating current and 1 500 Volt for direct current;

2.   'Waste electrical and electronic equipment' or 'WEEE' means electrical or electronic equipment which is waste within the meaning of Article 1(a) of Directive 75/442/ EEC, including all components, subassemblies and consumables which are part of the product at the time of discarding.

Categories of electrical and electronic equipment covered by this Directive within ANNEX IA are as follows:

1.   IT and telecommunications equipment

2.   Consumer equipment

3.   Lighting equipment

4.   Electrical and electronic tools (with the exception of large-scale stationary industrial tools)

5.   Toys, leisure, and sports equipment

6.   Medical devices (with the exception of all implanted and infected products)

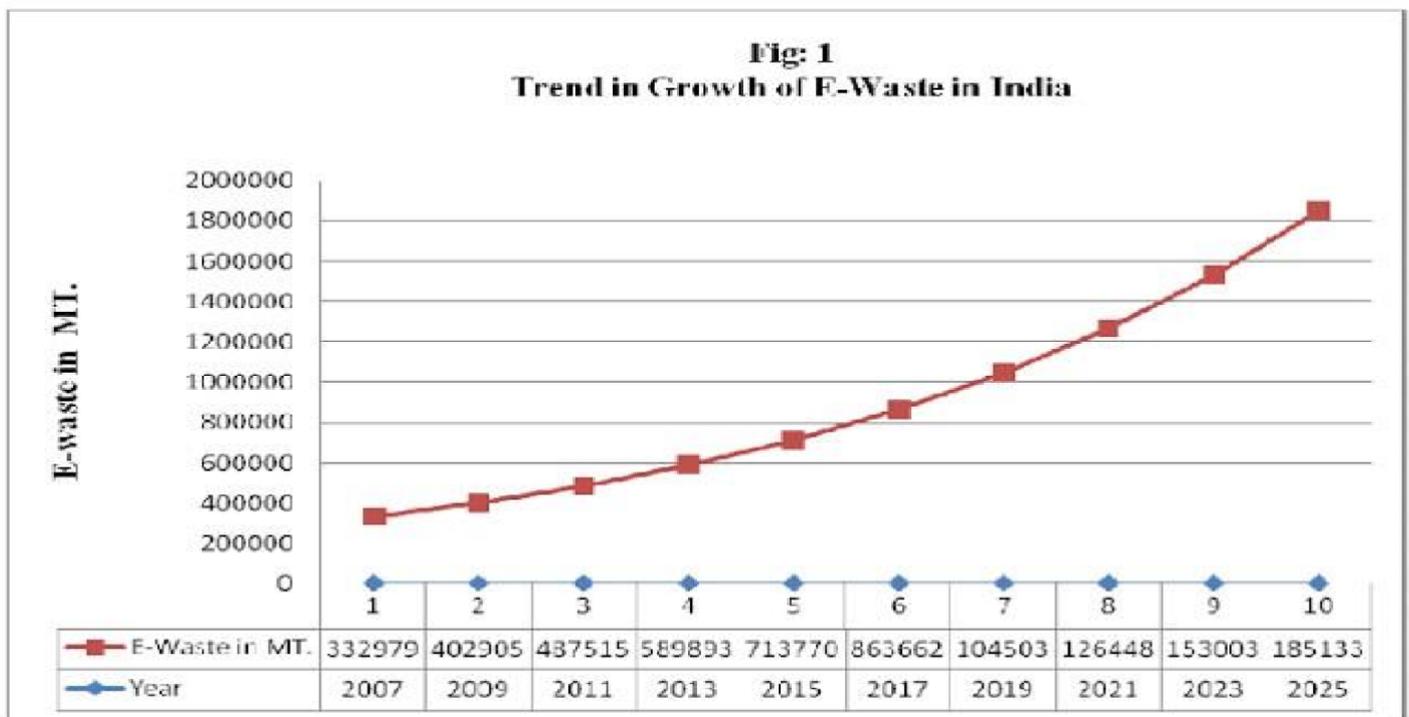7.   Monitoring and control instruments

8.   Automatic dispensers

A wide range of products are included within each category mentioned above.

In India, E-waste is covered in Schedule 3 of "The Hazardous Wastes (Management and Handling) Rules, 2003". Under Schedule 3, E-waste is defined as "Waste Electrical and Electronic Equipment including all components, sub-assemblies and their fractions except batteries falling under these rules". "Guidelines for Environmentally Sound Management of Ewaste" formulated by the Ministry of Environment and Forest, Government of India, in the year 2008 followed the same definition.

According to the very recent "the e-waste (Management and Handling) Rules, 'electrical and electronic equipment' means equipment which is dependent on electric currents or electromagnetic fields to be fully functional and 'e-waste' means waste electrical and electronic equipment, whole or in part or rejects from their manufacturing and repair process, which are intended to be discarded.

A wide range of literature is available on the generation and management of E-waste, especially in the developed countries. However, the work done on the Indian scenario of E-waste management is comparatively fewer. Sepúlveda, A.; Schluep, M.; Renaud, F.G.; Streicher, M.; Kuehr, R.; Hagelüken, C.; Gerecke, A.C.(2009) say

Fig: 1
Trend in Growth of E-Waste in India

	1	2	3	4	5	6	7	8	9	10
E-Waste in MT.	332979	402905	437515	589893	713770	863662	104503	126448	153003	185133
Year	2007	2009	2011	2013	2015	2017	2019	2021	2023	2025

that with the increasing global legal and illegal trade of waste electrical and electronic equipment (WEEE) comes an equally increasing concern of poor WEEE recycling techniques. Authors Oyuna Tsydenova and Magnus Bengtsson (2007) stated that along with many other issues such as components and hazardous substances in Waste Electrical and Electronic Equipment's (WEEE), the hazards and risks associated with treatment of WEEE in both developed and developing countries should be addressed in detail.

Objectives

•   Potential Opportunities for E-Waste Management in India.

•   This study shows how changes in e-waste management contribute to your company's sustainability goals.

•   The Study focuses on how businesses navigate their e-waste management path.

Research Methodology

The study was conducted in the framework of "Waste and Risk" as proposed by Joost Van Loon in "Risk and Technological Culture: Towards a sociology of virulence" (2002).

Waste represents uncontrolled matter out-of-place, freely interacting and reacting, cultivating bacteria, fungi and toxins that may pose direct threats to our health (Loon 2002). Waste is regarded as that matter which is to be discarded or made to disappear, often by simple means of removal such as refuse collection, landfill dumps, incineration etc. According to Loon, waste is perhaps the most universal example of ecological risks in everyday life. Nearly all ecological risks relate in one way or another to waste, more specifically to pollution. One can have the example of "solid-waste pollution" in this regard.

Whether it is nuclear waste, biomedical waste or electronic waste, risks are always embedded in the materials involved in these waste. Two of the reflections specified by Loon are considered for the purpose of the study. The reflections are Principle of "Out of Sight, Out of Mind" and "Cause and Effect" Relationship. Attempt has been made to connect these reflections to the problem of E-waste.

Principle of "Out of Sight, Out of Mind"

The principle of out of sight, out of mind has for a long time been useful in keeping the lid on the negative sideeffects of industrialization (Loon, 2002). During this period, toxicity was allowed to build up in the soil, in the air and in the water. Only periodically the toxic sideeffects are noticed in terms of epidemiological anomalies of clusters of chronic illnesses, cancers or miscarriages. Unlike the spectacular examples of accidents and catastrophes, these largely escaped the news media (Loon, 2002).

This principle is applied to the issues related to E-waste in Indian context. Most of the people in India do not know how to dispose their obsolete electrical and electronic gadgets. Generally, the obsolete electronic goods lie unattended at the Indian houses and offices because of lack of knowledge about the management of the same. Often, the gadgets are sold to the scrap vendors at certain cost. Otherwise, these are discarded with the regular municipal solid waste. Few people practice "extended producer responsibility" and indulge themselves in "takeback" systems. But none of these consumers pay attention to the processes these electronic goods must go through once these are discarded. The real trouble with electronic goods begins once discarded. As soon as the wastes are out of their sight, these are out of them.
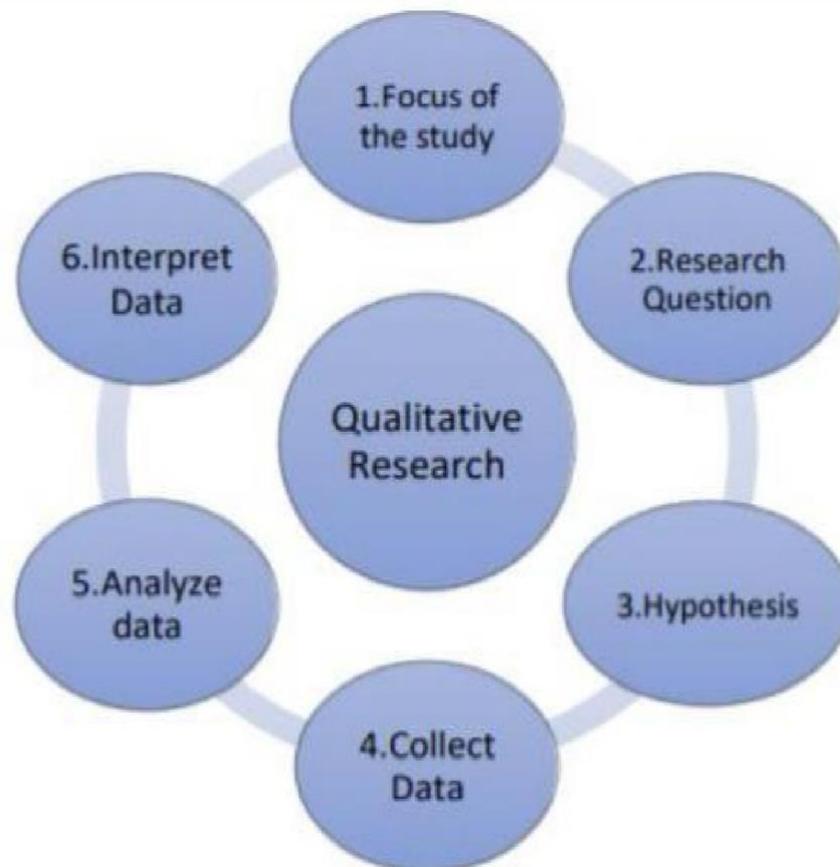
Cause and Effect Relationship

The relationship between cause and effect is important in all kinds of waste. Here the causes may be characterized as the causes for the generation and rapid obsolescence of electrical and electronic equipment.

The reasons for prompt generation and obsolesces of E-waste include rapid economic growth, urbanization, industrialization, increased consumerism etc. The Anwesha Borthaku' Pardeep Singh International Journal of Environmental Sciences Volume 3 No.1, 2012 355 Electronic waste in India: Problems and policies effects are the health and environmental risks associated with E-waste. The effects of improper disposal of E-waste are observed relatively after a long period of time. When an electronic gadget is disposed of with all its hazardous elements embedded in it, precarious health and environmental effects are not observed immediately.

Literature Review on E-Waste:

E-waste which is also called e-scrap is currently the largest growing waste stream which comprises discarded electrical or electronic devices and is the waste generated from various used household appliances. These gadgets are now not fit for their original use and are intended for recycling or disposal. Electronic devices such as mobile phones, laptops, computers, etc. can be included in e-waste. Small household appliances like toasters,

iron, heaters, etc., and large household appliances like washing machines, air conditioners, etc. are a few products that come under e-waste.

Today with the rapid increase in the use of technology and innovation, there is also an increase in the manufacturing and usage of these electronic products. Because of having large consumption, there is an issue of its disposal. McAllister (2013) in her study claims that "Around 40 million metric tons of electronic waste (e-waste) are produced globally each year, and about 13 percent of that weight is recycled mostly in developing countries" (McAllister, 2013). It is hazardous, complex, and expensive to treat e-waste in an environmentally sound manner, and there is a general lack of legislation or enforcement surrounding it. These products are made of toxic and harmful substances which cause harm to the environment and to human health. So it's important to have safe and proper disposal of these electronic items.

E-waste is not only an issue but also a great business opportunity because this e-waste not only consists of harmful and toxic substances but also several valuable materials and metals. According to Wildmer (2005) metals such as gold, iron, copper, etc. are found in many electronic products, which around 60% and other toxic pollutants are 2.70% (Widmera, et al., 2005). Recovery of these metals will reduce the demand for mining heavy metals and will reduce the greenhouse gas emissions from manufacturing virgin materials (Cifani, 2017).

Hence e-waste management is an important aspect not only from an environmental point of view but also for obtaining these valuable materials. Both developed and underdeveloped countries face problems with e-waste

E-Waste in India

•   Government's Responsibility

The EPR rule in India has handed over the responsibility to the state government for monitoring the manufacturers, producers, and recyclers to ensure that standards are followed and also those they meet the targets of collection of e-waste (Anon., 2018). The state government also needs to ensure proper allocation of industrial space for having proper e-waste practices such as dismantling and recycling (Sharma, n.d.).

•   Manufacturer's Responsibility

Manufacturers will have the responsibility to collect e-waste generated during the manufacturing of any electrical and electronic equipment and channel it for recycling or disposal. They have to ensure that there is no damage caused to the environment during the collection and transportation of e-waste.

It's their responsibility to maintain records of the e-waste generated, handled, and disposed of, these records must be presented to the State Pollution Control Board (Sharrma, n.d.).2.7.3

•   Producer's Responsibility

The producers are responsible for the collection and channelization of e-waste generated from the 'end-of-life' of their products or 'end-of-life' products with the same electrical and electronic products. The channelization of e-waste includes practices such as the collection of e-waste from the service centres and transporting them to authorized dismantlers or recyclers (Sharrma, n.d.).

•   Consumer's Responsibility

Further, the law also places responsibility on the consumers to protect the environment against the harm caused by the devices upon their end-of-life under the take-back scheme. Consumers are responsible for the proper segregation and disposal of e-waste (Sharrma, n.d.).

Different products are creating issues and enhancing the level of e-waste in a market including new electronic products and their integral parts. New electronic products that can be observed in developing countries can be considered a problem for E-waste management for example India. The rapid growth of up-gradation and technological innovation that can be observed in different electronic industries has led to the enhancement of electronic equipment in the current society.
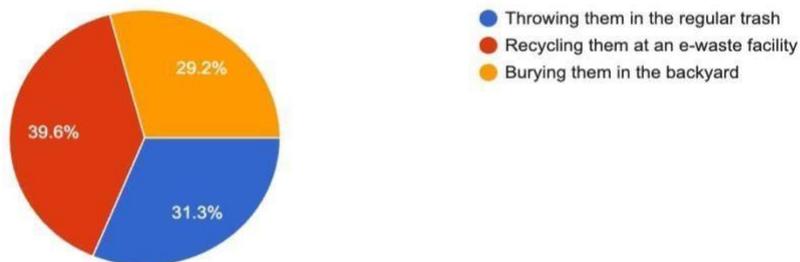
Data analysis

1. What does "e-waste" stand for?

48 responses
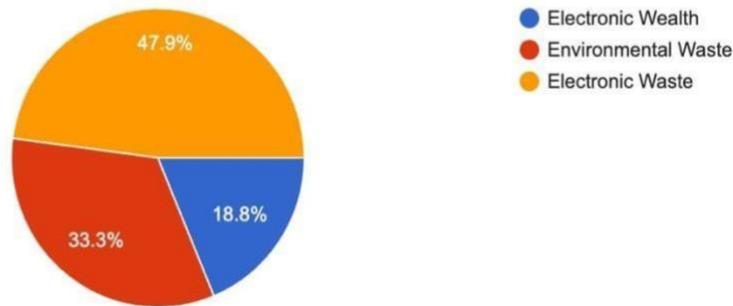
- E-waste stands for electronic waste It can be stated that:

47.6% responses said electronic waste.

33.3% responses said environmental waste.

18.8% responses says electronic wealth.

2. Which of the following is the most environmentally friendly way to dispose of old electronic devices ?

48 responses

- The most eco friendly way to dispose old electronic devices is recycling them at an ewaste facility It can be stated that:

31.3% responses said throwing them in regular trash.

39.6% responses said recycling them at e-waste facility.

29.2% responses said burying them in backyard

**3. How often do you upgrade your electronic devices?**

48 responses

- Every few months
- Once a year
- Only when necessary

- Electronic devices should be upgraded only when necessary It can be stated that:

25% said Every few months.

31.3% said once a year. 43.8% only when necessary.

**4. Where can you typically find e-waste recycling programs?**

48 responses

- Grocery stores
- Gas stations
- Specialized e-waste recycling facilities
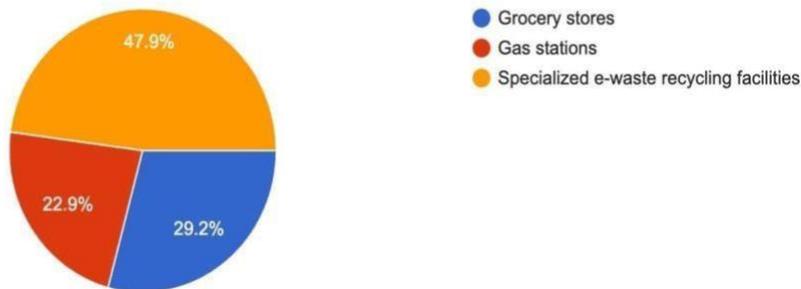
- E-waste recycling programs are located at specialized e-waste recycling facilities It can be stated that:

29.2% said Grocery stores.

22.9% said Gas stations.   47.9% said Specialized e-waste recycling facilities.

5. Whose responsibility is it to ensure proper disposal of electronic waste?

48 responses

- Only the government
- Only corporations
- Individuals and society
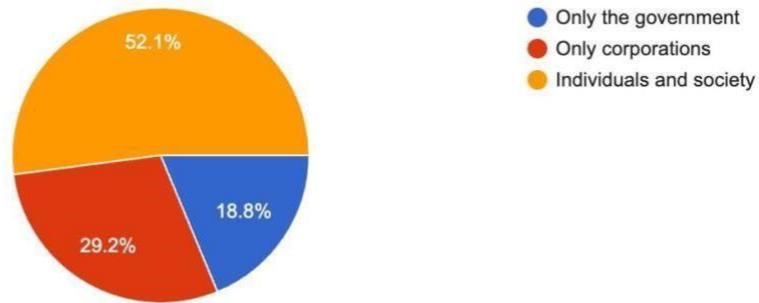
-      The responsibility to ensure proper disposal of e-waste is of individuals and society It can be stated that:
18.8% said Only the Government.
29.2% said Only corporations. 52.1%
said Individuals and society.

6. Should governments enforce regulations on e-waste management?

48 responses

- Yes, always
- No, never
- Depends on the situation
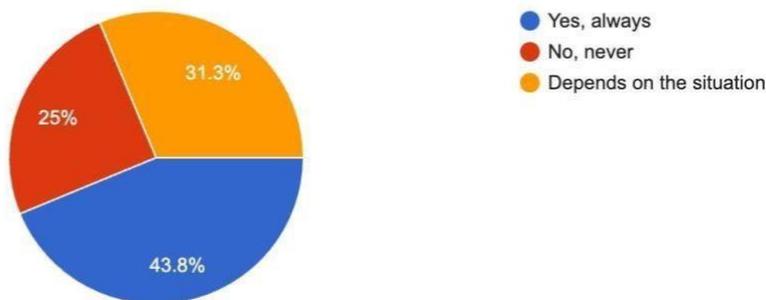
-      The government should enforce regulations on e-waste management It can be stated that:
43.8% said Yes, always. 25% said No, never.
31.3% said Depends on the situation

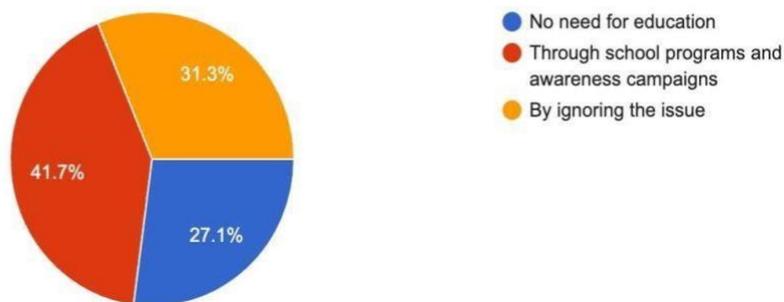7. What is a sustainable option for old electronic devices?

48 responses

- Throwing them away
- Donating or selling them
- Keeping them indefinitely

27.1%

39.6%

33.3%
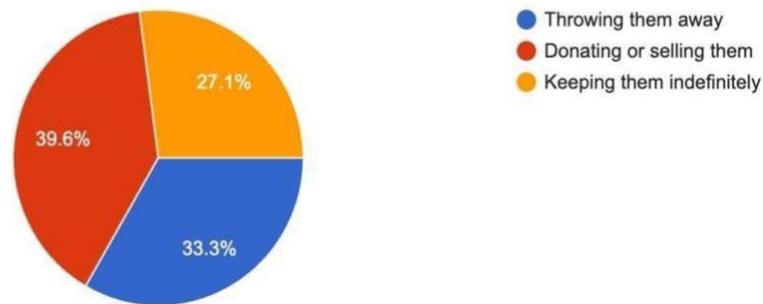
-      Sustainable option for old electronic device is to donate or sell it It can be stated that:

33.3% said Throwing them away.

39.6% said Donating or selling them. 27.1%
said Keeping them indefinitely.

8. How can society better educate people about e-waste?

48 responses

- No need for education
- Through school programs and awareness campaigns
- By ignoring the issue

31.3%

41.7%

27.1%

-      Society can educate people on e-waste through school programs and awareness campaigns
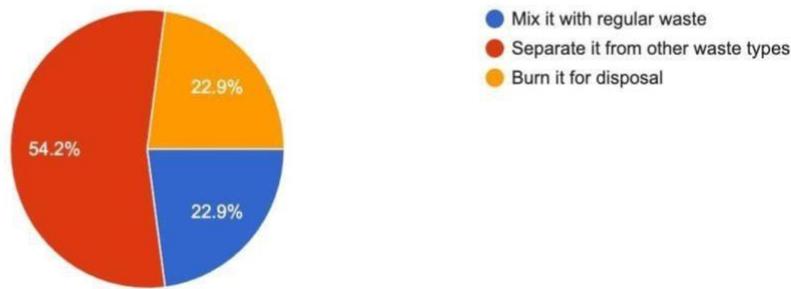
It can be stated that:

27.1% said No need for education.

41.7% said Through school programs and awareness campaigns. 31.3%
said By ignoring the issue.

9. How should e-waste be collected for effective management?

48 responses

Legend:
- Mix it with regular waste
- Separate it from other waste types
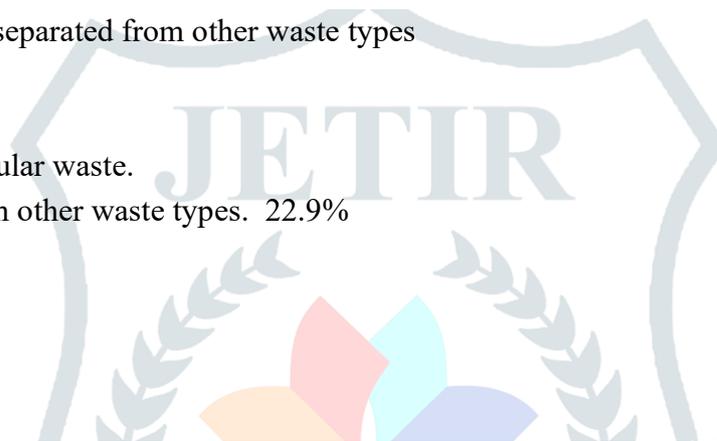- Burn it for disposal

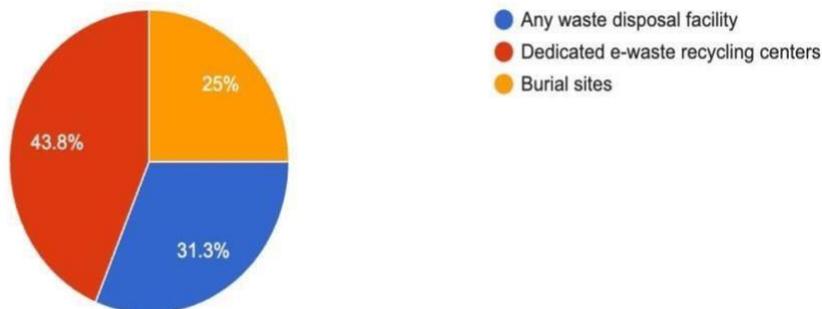- E-waste should be separated from other waste types

It can be stated that:

22.9% said Mix it with regular waste.

54.2% said Separate it from other waste types. 22.9% said Burn it for disposal.

10. Where should e-waste be taken for recycling?

48 responses

Legend:
- Any waste disposal facility
- Dedicated e-waste recycling centers
- Burial sites

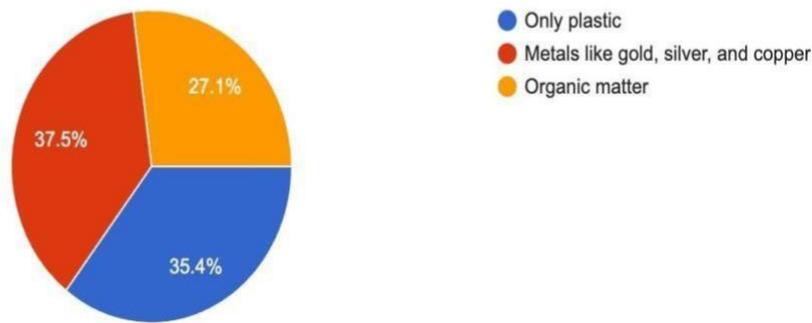- E-waste should be recycled at e-waste recycling centers It can be stated that:

31.3% said Any waste disposal facility.

43.8% said Dedicated e-waste recycling centers. 25% said Burial sites.

11. What valuable materials can be recovered during the e-waste recycling process?

48 responses

- Only plastic
- Metals like gold, silver, and copper
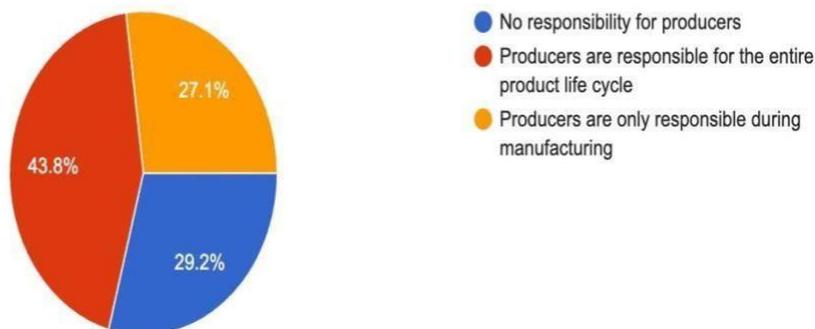- Organic matter

- Recycling e-waste generates valuable materials like gold silver and copper It can be stated that:
35.4% said Only plastic.
37.5% said Metals like gold, silver, and copper. 27.1%
said Organic Matter.

12. What does EPR entail in the context of e-waste management?

48 responses

- No responsibility for producers
- Producers are responsible for the entire product life cycle
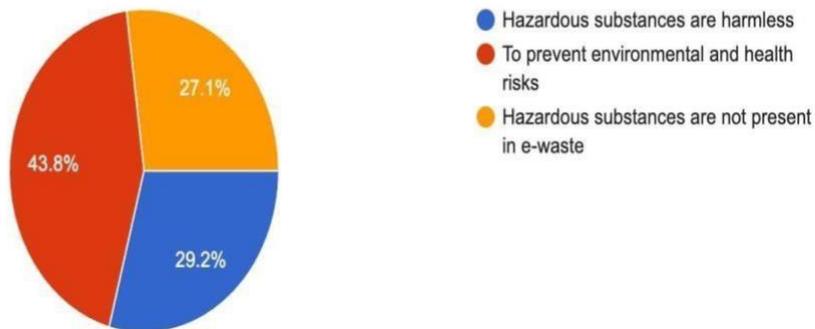- Producers are only responsible during manufacturing

- EPR entails that producers are responsible for the entire product life cycle It can be stated that:
29.2% said No responsibility for producers.
43.8% said Producers are responsible for the entire product life cycle. 27.1%
said Producers are only responsible during manufacturing.

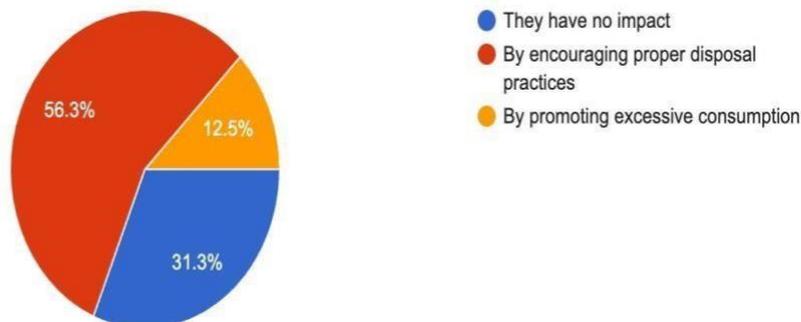13. Why is it crucial to manage e-waste separately due to hazardous substances?

48 responses

- Hazardous substances are harmless
- To prevent environmental and health risks
- Hazardous substances are not present in e-waste

- E-waste should be managed separately to prevent environmental and health risks It can be stated that:
29.2% said Hazardous substances are harmless.

43.8% said To prevent environmental and health risks. 27.1%
said Hazardous substances are not present in e-waste.

14. How can public awareness programs contribute to e-waste management?

48 responses

- They have no impact
- By encouraging proper disposal practices
- By promoting excessive consumption

- Public awareness programs can encourage proper disposal practices It can be stated that:
31.3% said They have no impact.

56.3% said By encouraging proper disposal practices. 12.5%
said By promoting excessive consumption.

15. Why is it important for businesses to comply with e-waste disposal regulations?
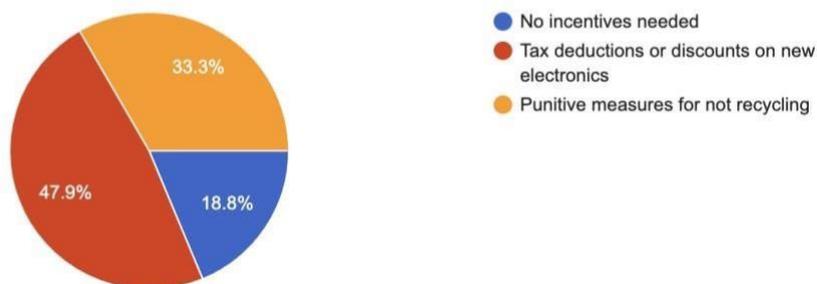
48 responses
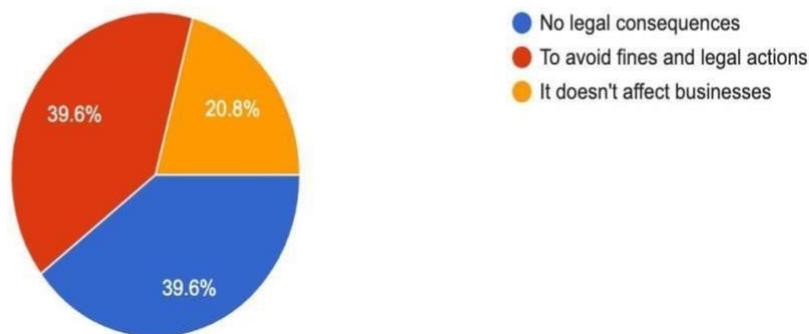
- Businesses should comply with e-waste disposal regulations to avoid legal consequences It can be stated that:

39.6% said No legal consequences.

39.6% said To avoid fines and legal actions. 20.8% said It doesn't affect businesses.

16. What incentives could encourage individuals to recycle their e-waste?

48 responses

- Incentives that could encourage individuals to recycle their e-waste is tax deductions or discounts on new electronics It can be stated that:

47.9% said Tax deductions or discounts on new electronics

33.3% said Punitive measures for not recycling

18.8% said No incentives needed

It can be stated that awareness programs that are   provided to the public should have proper implementation of an education system that will enhance the cost-effective knowledge about the technology and the requirement to provide better services.

Findings

1.   A holistic approach can be observed in the Indian management of e-waste that will enhance the challenges and resolve them by implementing suitable mechanisms.

2. Implementation of appropriate large sectors that are required to be maintained that is required to be enhanced by developing countries can be observed in public and environmental issues maintain environmental sustainability and human health.

3. There are informal sectors that have integrated with different third parties to deal with ewaste management.

4. It can be stated that open burning and land fields that can be observed in the competitive market can be considered a serious issue for India that is required to be resolved by implementing appropriate steps Implementation of an appropriate approach in India can help to reduce the e-waste approach that can be observed in both formal and informal sectors that are creating an issue for the environment and It can be stated that the average maintenance of proper ethical consideration while proceeding with this research work.

5. Some different legal ethics and professions are required to be maintained to implement any kind of information from the internet and other websites.

6. It can be stated that while creating this project there is proper maintenance of the legal consideration for the project since there is no violation of any information from the researchers and existing data that could create an issue for anyone.

Suggestions

1. Awareness Campaigns: Launch nationwide campaigns to educate the public about the hazards of e-waste and the importance of responsible disposal.

2. Collection Centers: Establish more collection centers in urban and rural areas for convenient e-waste drop-off, incentivizing participation with buy-back or reward programs.

3. Recycling Infrastructure: Invest in recycling facilities equipped to handle various types of e-waste, promoting eco-friendly disposal methods to minimize environmental impact.

4. Legislation Enforcement: Strengthen enforcement of existing e-waste management laws and regulations to hold manufacturers accountable for responsible disposal and recycling.

5. Public -Private Partnerships: Foster collaborations between government bodies, private sector companies, and NGOs to develop comprehensive e-waste management solutions, leveraging resources and expertise for effective implementation.

Conclusion

E-waste management is a great challenge for governments of many developing countries such as India. This is becoming a huge public health issue and is exponentially increasing by the day. In order to separately collect, effectively treat, and dispose of e-waste, as well as divert it from conventional landfills and open burning, it is essential to integrate the informal sector with the formal sector. The competent authorities in developing and transition countries need to establish mechanisms for handling and treatment of e-waste in a safe and sustainable manner. Increasing information campaigns, capacity building, and awareness is critical to promote environment friendly e-waste management programs. Increasing efforts are urgently required on improvement of the current practices such as collection schemes and management practices to reduce the illegal trade of e-waste. Reducing the amount of hazardous substances in e-products will also have a positive effect in dealing with the specific ewaste streams since it will support the prevention process. Mobile phone manufacturer Nokia is one of the very few companies that seem to have made serious effort in this direction since 2008. The companies were made responsible for creating channels for proper collection and disposal of e-waste in accordance with a Central Pollution Control Board (CPCB) approved EPR Authorization plan in India. Recently, the import license of some of the big companies were suspended for violation of Ewaste rules. Such measures have a great impact on effective implementation of e-waste management in India. Any task undertaken must have its share of incentives which attract stakeholders. In the field of e-waste management, the government must announce incentives, which could be in the form of tax concessions or rebates, to ensure compliance across the electronics industry. Additionally, the e-waste collection targets need to be regularly reviewed and renewed to ensure compliance across India on collection of e-waste.

Questionnaire

Questions asked:

1. What does "e-waste" stand for? *

○ Electronic Waste

○ Environmental Waste

○ Electronic Wealth

2. Which of the following is the most *
environmentally friendly way to dispose
of old electronic devices ?

○ Burying them in the backyard

○ Recycling them at an e-waste facility

○ Throwing them in the regular trash

3. How often do you upgrade your *
electronic devices?

○ Every few months

○ Once a year

○ Only when necessary

4. Where can you typically find e-waste *
recycling programs?

○ Gas stations

○ Grocery stores

○ Specialized e-waste recycling facilities

5. Whose responsibility is it to ensure *
proper disposal of electronic waste?

○ Only corporations

○ Only the government

○ Individuals and society

6. Should governments enforce regulations on e-waste management? *

○ Depends on the situation

○ No, never

○ Yes, always

7. What is a sustainable option for old electronic devices? *

○ Donating or selling them

○ Throwing them away

○ Keeping them indefinitely

8. How can society better educate people about e-waste? *

○ Through school programs and awareness campaigns

○ No need for education

○ By ignoring the issue

9. How should e-waste be collected for effective management? *

○ Separate it from other waste types

○ Burn it for disposal

○ Mix it with regular waste

10. Where should e-waste be taken for recycling? *

○ Any waste disposal facility

○ Burial sites

○ Dedicated e-waste recycling centers

11. What valuable materials can be recovered during the e-waste recycling process? *

○ Organic matter

○ Only plastic

○ Metals like gold, silver, and copper

12. What does EPR entail in the context of e-waste management? *

○ No responsibility for producers

○ Producers are only responsible during manufacturing

○ Producers are responsible for the entire product life cycle

13. Why is it crucial to manage e-waste separately due to hazardous substances? *

○ Hazardous substances are not present in e-waste

○ Hazardous substances are harmless

○ To prevent environmental and health risks

14. How can public awareness programs contribute to e-waste management? *

○ By encouraging proper disposal practices

○ They have no impact

○ By promoting excessive consumption

15. Why is it important for businesses to comply with e-waste disposal regulations? *

○ No legal consequences

○ It doesn't affect businesses

○ To avoid fines and legal actions

16. What incentives could encourage individuals to recycle their e-waste? *

○ Tax deductions or discounts on new electronics

○ No incentives needed

○ Punitive measures for not recycling

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