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E-Waste Management Rules 2022: Issues and Solution for Environmental Protection

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ABSTRACT:
An important global concern is the handling of electrical and electronic waste, particularly in India, a rapidly growing electronics market. The COVID-19 pandemic has accelerated demand and growth, with India contributing over two million tonne's of its electronic waste every year. India produced 1.6 million tonne's of e-waste in the fiscal 2021–22, ranking third in the world, however, only half a million tons was gathered and treated. As India transforms to a digital economy, and electric mobility, this number is anticipated to rise dramatically as a result of the rising usage of the electronic gadgets, solar panels, and electric automobiles. E-waste must be managed carefully because it contains dangerous materials that, if improperly handled or disposed of, are damaging "to the environment and human health." In its 192nd Report on the "Functioning of the Central Pollution Control Board (CPCB), the Department of Parliamentary Standing Committee on Science, Technology, Environment, and Forests came to the conclusion that e-waste will become a significant issue in the future"[1] due to modern lifestyles, rising living standards, and increased economic growth. In order to control e-waste and safeguard the environment in India, this article examines the problems and potential solutions. It also critically evaluates the recent legal adoption and effective execution "of the E-Waste (Management) Rules, 2022, which went into effect on April 1, 2023, These regulations mark the beginning of a new Extended Producer Responsibility (EPR) system for recycling e-waste."[2]

Keywords: Electronic waste, hazardous substances**,** CPCB, Environmental Protection, EPR, Recycling.

INTRODUCTION

"E-waste is defined as discarded electrical and electronic equipment" such as solar photovoltaic modules, panels, or cells, computers, mobile phones, televisions, "and refrigerators, as well as rejects from manufacturing, refurbishing, and repair procedures."[3] "These devices contain hazardous components such as lead, mercury, cadmium, and polyvinyl chloride (PVC)," which has been a major concern around the includes items that are dumped or sent to a charity retailer like Goodwill even when they are both functioning and broken, or they have quickly become obsolete and have been replaced by newer versions as technology continues to advance at an incredible rate. Unsold merchandise at stores is regularly thrown

[1] "E-waste (Management) Rules, 2016" <https://greene.gov.in/wp-content/uploads/2018/01/EWM-Rules-2016-english-23.03.2016.pdf > **accessed** on 20 July 2023.
[2] Ibid 1
[3] "E-waste (Management) Rules, 2016" <https://greene.gov.in/wp-content/uploads/2018/01/EWM-Rules-2016-english-23.03.2016.pdf > accessed on 20 July 2023.

away. E-waste is particularly dangerous because toxic chemicals spontaneously escape from the metals inside when it is buried. The rapid turnover of electronic items has resulted in a significant "increase in e-waste generation."

Electronic waste is currently world's most rapidly expanding waste sources is electronic waste. Both emerging and developing economies face challenges from electronic waste. This study is solely focused on "India's e-waste system," India's economy is among the world's fastest growing. This is because of the quick development of technology, increased requirement of the information technology, widespread usage of electronics and electrically powered devices. On a daily basis, desktops, laptops, data storage devices, cell phones, servers, printing and Xerox machines, television sets, microwaves, refrigerators, and other household electronic equipment, including heavy air conditioners, produce "a significant amount of E-waste."[4]

The global generation of electronic "waste is expected to exceed 50 million tons by 2020." "India is one of the top five e-waste-producing countries in the world, with an estimated annual output of 2 million tons."[5] "In India, as in other developing countries, the informal sector dominates e-waste treatment, with estimates indicating that more than 90%"[6] of garbage is handled "in this sector. E-waste contains valuable metals, exotic metals, non-ferrous and ferrous metals, wood, plastic, and glass." "Unscientific e-waste processing procedures have been linked to a variety of environmental and health consequences."[7]

"The Indian government has enacted the E-Waste Management Rules, 2022, which replace the E-Waste Management Rules, 2016."[8] On the first of April 2023, these fresh laws went into force., and include a number of significant enhancements aimed at encouraging environmentally responsible e-waste disposal practices. They broaden the product scope by tracking electronic trash data in actual time, and it was missing in the previous edition. Furthermore, the new regulations have reduced the regulatory burden on organizations that handle regulated waste. These electronic devices and equipment contain dangerous and poisonous components that, if not disposed of properly and scientifically, can endanger health of people and the natural surroundings. The New "E-Waste Management Rules are intended to reduce the risk of hazardous waste disposal by making it easier to recover and reuse usable components or materials from waste electrical and electronic equipment."[9] As a result, the risk of noxious trash disposal is reduced. By expanding protections and providing real-time information, the 2022 Rules are an important step toward resolving India's e-waste problem. They make legal requirements for entities easier to understand, make registration and compliance reporting easier, and promote environmentally responsible e-waste management. They also impose harsher penalties for noncompliance in order to discourage improper

[4]Kajalben Patel, "Understanding the current E-waste management system in India" < https://www.diva-portal.org/smash/get/diva2:1648723/FULLTEXT01.pdf> accessed on 20 July 2023

[5] Ibid 3

[6] Baldé, C. P., Forti V., Gray, V., Kuehr, R., & Stegmann, P. (2017). "Global E-waste monitor 2017: Quantities, flows, and resources. Bonn/Geneva/Vienna: United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA)", Retrieved from <https://collections.unu. edu/eserv/UNU:6341/Global-E-waste_Monitor_2017__electronic_single_pages_.pdf> accessed on 20 July 2023

[7] Toxics Links. (2014) "On the edge: Potential hotspots in Delhi. New Delhi", Retrieved from <http://toxicslink. org/docs/Report-On-the-Edge.pdf> accessed on 20 July 2023

[8] Ministry of Environment, Forest and Climate Change, "The E-Waste (Management) Rules, 2016", Government of India, 23 March 2016 <https://greene.gov.in/wp-content/uploads/2018/01/EWM-Rules-2016-english-23.03.2016.pdf> accessed 3rd June2023

[9] Press Information Bureau. "Press Release: Extension of timelines for compliances under the Income-tax Act, 1961 in view of the pandemic", Government of India, Ministry of Finance, 20 May 2021 <https://pib.gov.in/PressReleasePage.aspx?PRID=1881761> accessed 3rd June 2023

disposal and encourage responsible handling. They also emphasize extended producer responsibility, which requires manufacturers to be responsible for the entire product lifecycle, including proper disposal and recycling. This comprehensive strategy will effectively address India's growing e-waste problem. These electronic devices and equipment contain dangerous and poisonous components that, if not disposed of correctly and scientifically, can harm health of general public and the natural world. Thus, the "New E-Waste Management Rules are intended to facilitate the recovery and re-use of usable components or materials from Waste Electrical and Electronic Equipment, thereby decreasing the danger of hazardous waste disposal" in the environment.

The 2022 Rules aim to address India's e-waste problem by expanding protections, providing real-time information, simplifying legal requirements, simplifying registration and compliance reporting, and promoting environmentally responsible e-waste management. They introduce stricter penalties for non-compliance and emphasize extended producer responsibility, requiring manufacturers to take responsibility for the entire product lifecycle, including proper disposal and recycling. This holistic approach effectively addresses India's growing e-waste issue.

1. ISSUES IN E-WASTE MANAGEMENT

"Inadequate data on e-waste creation rates: The 2012 laws recognized the lack of waste inventories as a restriction and charged the individual state pollution control boards (SPCBs) with compiling state-by-state e-waste inventories." "To our knowledge, no SPCB has provided an inventory in the seven years" since these regulations. Electronic product sales data, "which is a crucial input in estimating e-waste volumes, is frequently accessible at the national level, making it difficult to create inventories at the state level." "In addition to domestic creation, e-waste is illegally imported from industrialized economies." "There is limited information of the type and quantity of e-waste coming into the nation." "Designing systems for efficient E- waste collection, transportation, and processing need a reasonable understanding of waste creation, composition, and flows."

"Environmentally unsustainable informal sector practices: Despite the growth of the formal sector's dismantling and recycling industry (in terms of the number of such facilities), the volume" of trash handled there is still very small. Anecdotal evidence indicates that, because of a lack of rubbish, the bulk of "these authorized facilities are operating much below their permitted capacities." "The lack of knowledge about e-waste and the cost of bringing end-of-life equipment to authorized collection" facilities is making it less appealing for home and institutional users to recycle their waste in a legal way. "Most importantly, the informal sector makes it more tempting for customers to return their trash than the formal business, which has not yet invested in strong collection and incentive systems, thanks to the convenience of domestic collection and financial incentives (even if nominal)." Despite employing millions of people, many of whom come from marginalized groups, the informal e-waste industry's methods of handling "waste seriously endanger the environment and the health of both its workers and the broader public." Any electronic waste disposal system's long-term survival depends on our ability to resolve the moral conundrum that this raises for policy makers.

"Frictions in markets for the end-of-life products": The ability for third-party parties, "such as PROs, to build official e-waste management structures is constrained by the challenge of consistently sourcing e-waste volumes that offer economies of scale." For instance, establishing efficient recycling techniques

"for e-waste may require high upfront expenditures on capital, which may not be acceptable to private businesses" due to uncertainty regarding returns.

First off, as the recycling of electronic waste sector is still developing, "there may be market barriers due to a lack of knowledge about efficient recycling practices." "Second, the functioning of the market is impacted by poor customer understanding, which is partly caused by a lack of reliable information about e-waste treatment." The government may need to be more involved in allowing improved electronic debris markets in addition to the current electronic garbage regulations.

"Inadequate legislative design and enforcement: The 2012 legislation' mandatory take-back program for" manufacturers provided no motivation to accept responsibility, which prevented any advancement in electronic debris management techniques. The 2016 reforms fixed this by outlining increasingly narrower collection purposes and providing more legal certainty. "Nevertheless, the regulatory structure places a heavy burden on already understaffed regulatory bodies." The authorities are tasked with evaluating the manufacturers' EPR plans, authorizing them, and enforcing the terms of the EPR plans. Additionally, the regulations established stringent "standards and procedures for other organizations, including collectors, dismantlers, recyclables, and mass consumers, and mandated that the agencies enforce compliance with these standards." Electronic garbage regulations in India are no distinct from other environmental regulations in that they are subject to "regulatory capture by groups that profit from lax enforcement, a lack of transparency, and a failure to disclose information on conformity and regulatory actions" in an open manner. This presents a "significant public policy issue for the future" electronic garbage disposal throughout the nation.

2. "EFFECTS OF E-WASTE ON HUMAN HEALTH AND ENVIRONMENT"-

Hazardous substances such as mercury and lead might be found in electronic trash. "The circuit boards that use cadmium and oxide to monitor the cathode ray tube, thereby enhancing the flat screen and switches", are where these elements are most frequently found. "Cadmium has been discovered in computer batteries", which are used to produce extremely dangerous PVC wire casings. These are incredibly complicated components that are difficult to recycle, potentially jeopardizing environmental sustainability and slowing country progress.

E-waste is a significant issue that affects both the natural world and people's health in India. On a global scale, the United States ranks fifth in terms of e-waste production. It may be argued that trash is mostly popular owing to its informal term from electrical items used in daily life such as "televisions, computers, VCRs, copier stereos, and fax machines, which are common products responsible for E-waste." "It is necessary to expand the rubbish list for electronic waste." "70% of E-waste from the telecom and commercial IT" sectors originates from computer equipment that represent India. "It is critical to recognize that there is a need to maintain the rapid increase of e-waste in India in order to manage environmental sustainability." "E-waste contains several hazardous chemicals that must be managed and may be exceedingly damaging to human health as well as" environmental stability.

Because of its composition, e-waste is extremely difficult to manage. It is composed of several components, some of which include harmful compounds that can have a negative influence "on human health and the environment if not treated appropriately, i.e., if incorrect recycling and disposal" procedures are used. As a result, adequate technology for handling and disposal of hazardous substances is required.

The Basel Convention classifies e-waste as hazardous when it contains or is polluted with mercury, lead, cadmium, polychlorinated biphenyl, and other toxic metals. Hazardous e- wastes include insulation "or metal wires covered with polymers polluted with or containing lead, coal tar, cadmium, Polychlorinated Biphenyl (PCB)", and other chemicals. "Hazardous wastes include precious metal ash from printed circuit boards, glass waste from cathode-ray tubes, LCD panels, and other activated" glassware.

"Effects of some of the prime hazardous components in of e- waste are mentioned below":

"S. No.	Hazardous components	Effect of Hazardous components of e-waste
1.	Arsenic	Can cause skin irritation and reduce nerve conduction velocity. Chronic arsenic exposure can lead to lung cancer, which can be lethal.
2.	Lead	It has the potential to harm the kidneys, reproductive systems, and neural connections. It can cause blood and brain issues, and it can occasionally be deadly.
3.	Barium	Can have an effect on the cardiac muscle.
4.	Chromium	Can harm the liver and kidneys, as well as induce asthmatic bronchitis and lung cancer.
5.	Beryllium	May cause lung diseases.
6.	Mercury	It harms the foetus's growth by affecting the central nervous system, kidneys, and immune system. It is possible that this medication will harm your brain or liver.
7.	Cadmium	Severe joint and spine pain is possible. It has an effect on the kidneys and softens the bones.
8.	BFR (Brominates flame retardants)	Can affect the reproductive and immunological systems and induce hormonal imbalances.
9.	Chlorofluorocarbon (CFC)	It is possible that this will have an impact on the ozone layer. It has the potential to induce skin cancer in humans as well as genetic harm in creatures..
10.	Polychlorinated Biphenyl (PCB)	Animals may get cancer, and it can harm the immune system, reproductive system, neurological system, and endocrine system. PCBs remain in the environment and inflict significant harm.
11.	Polyvinyl Chloride (PVC)	PVC contains up to 56% chlorine and, when burned, creates hydrogen chloride gas, which in turn makes hydrochloric acid, which is hazardous to the respiratory system.
12.	Dioxin	These are very harmful to animals and can cause foetal dysfunction, lower reproduction and growth rates, and immune system disruption."

Prenatal exposures and health of neonates

Ewaste can cause a variety of negative birth outcomes for mothers who have been exposed to it for reuse, "low birth weight, stillbirth, and other issues", as well as long-term effects like challenges with comprehension and behavior in infants in their futures.. Mothers' excessive PFOA exposure in Guinea

has been linked to negative impacts on their newborns' development and dominance in this area. Furthermore, "as a result of Cadmium exposure, Guiyu neonates had a higher level of placental metallothionein - a small protein that indicates dangerous metal exposures - whereas the higher quantity of Cadmium in Guiyu neonates was associated to their parents' participation in e trash recycling." Exposure to ewaste after childbirth has certain severe implications for the newborn's contaminated human body. The greater lead concentration in neonates' cord blood was associated with the involvement of parents in the reusing of electronic trash.

"People living near e-waste recycling sites"-

Even if they are not involved in e-waste recycling, persons who live near e-waste recycling operations may be exposed to environmental hazards due to food, environment, and water contamination produced by e-waste food. E-waste is also present in polluted air, soil, dust, water, and food. The three basic exposure modes are respiratory, nutritional, and cutaneous interactions. According to research, people who live near e-waste recycling facilities have higher daily levels of heavy metals and are heavier on average. Potential health risks include general physiological injury, health harm, cognitive function, and mental health. The DNA damage in all e-waste generated categories (neonates, children, and adults) was greater than in the control population. "DNA breaks can increase the probability of improper replication and mutations, as well as lead to cancer, if the tumour suppressor gene is damaged."

3. "RECYCLING OF E-WASTE"-

"Recycling is critical in e-waste management." "If done correctly, it should greatly reduce the quantity of dangerous compounds in the environment"[10] while also conserving natural resource energy. However, the local government must support it as well as boost "community awareness and education." "Reusing circuit boards made from electrical waste is the most demanding process."[11] "The printed circuit boards are encased in precious metals like as silver, platinum, tin, gold, and so on, whereas traditional ways of employing basic metals such as iron, aluminum, copper", and so on are less efficient. Melting "circuit boards and open-pit acid leaching to separate burn cable sheets and precious metals for recovering copper wires"[12] is another method of processing electronic trash. Proper reusing or disposing of devices helps to decrease "greenhouse gas emissions and health hazards while also" creating additional jobs. Another approach, "cryogenic dissociation, has been tested for reusing printed circuit boards, and a few are still"[13] being researched. "The regeneration and recycling of more environmentally friendly and socially

[10]Adám, B., Göen, T., Scheepers, P.T.J., Adliene, D., Batinic, B., Budnik, L.T., Duca, R.-C., Ghosh, M., Giurgiu, D.I., Godderis, L., Goksel, O., Hansen, K.K., Kassomenos, P., Milic, N., Orru, H., Paschalidou, A., Petrovic, M., Puiso, J., Radonic, J., Sekulic, M. T., Teixeira, J.P., Zaid, H., Au, W.W., 2021. "From inequitable to sustainable e-waste processing for reduction of impact on human health and the environment" Environmental Research 194, 110728. https://doi.org/10.1016/j. envres.2021.110728.

[11] "Electronic Waste Management in India: Market Growth Trajectory and Future Potential Electronic Waste Management in India: Market Growth Trajectory and Future Potential" https://www.frost.com/frost-perspectives/electronic- waste-management-in-india-market-growth-trajectory-and-future- potential/ (accessed Feb. 06, 2022)

[12] (Ganesan et al., 1964);("(17) (PDF) "Electronic waste reprocessing or processing: An alternative practice for production and extraction of metals in Zambia" <https://www.researchgate.net/publication/> accessed on 20 July 2023

[13] Ibid 20

conscientious alternatives is part of the downcycling process. Because they contain mercury, cadmium, and lead, several sizes of coin cells and buttons with a 29v battery are reused in a few nations."[14]

Advantages "of e-waste recycling"

The reuse of "raw materials from the final electronics of life is the most effective solution to the problem" of rising ewaste. The majority of electrical equipment include metal that may be recycled and reused "in the future." "By removing and reusing the potential for reuse, natural" resources are conserved in their entirety, and water/air pollution caused by hazardous ewaste disposal is avoided. Furthermore, reusing new items minimizes greenhouse gas emissions from green products. Harmful smoke and gases are caught, restricted, and treated to limit environmental risk and consequences. More plastic created by these printers as a byproduct may be reinstalled to manufacture new 3D printed things. In Europe, recycled metals are returned to their originator firms at a lower rate. As a consequence of a specialized recycling infrastructure, Japanese manufacturers are compelled to design more ecological products. Using these methods, all of the critical computer-building materials may be securely recovered. Iron and steel are both re-useable iron metals. Because of the present surge in interest in 3D printing technology, a few 3D printers (FDM variations) are designed to generate waste that can be readily reused, hence reducing the quantity of dangerous pollutants in the atmosphere. Because different sectors are accountable for the reuse of their goods, it is the producers' job to adapt their infrastructure. As a result, Japanese manufacturers have developed recycling alternatives for unwanted metals.

4. WHAT ARE THE KEY ENVIRONMENTAL IMPACTS OF E-WASTE?

E-waste has several key environmental impacts, which include:

1. **Soil Contamination:** E-waste frequently ends up in landfills, where toxic compounds such as lead, mercury, and cadmium can leak into the soil. This has the potential to significantly impact terrestrial ecosystems.
2. **Water Pollution:** Harmful chemicals from e-waste can leach into groundwater when disposed in landfills. This has the potential to pollute drinking water supplies, resulting in serious health repercussions for local inhabitants and wildlife.
3. **Air Pollution:** When e-waste is burnt, dangerous elements such as heavy metals and pollutants such as dioxins and furans are released into the atmosphere.
4. **Threats to Wildlife:** Harmful compounds from e-waste can enter the food chain, posing serious dangers to animals. Birds and animals may mistake tiny pieces of plastic for food, resulting in the consumption of toxic chemicals.
5. **Resource Depletion:** E-waste also contributes to resource depletion as valuable metals and rare earth elements found in electronic products are not recovered or recycled.
6. **Climate Change:** Climate Change: Electronic product manufacture and disposal both contribute to greenhouse gas emissions. These emissions, if not handled properly, can contribute to global warming. Each of these consequences highlights the critical need for effective e-waste management techniques to safeguard our environment.

[14] "Recycling of E-waste elsivier - Google Search" <https://www.google.com/ searchq=Recycling+of+E-waste+elsivieroq=Recycling+of+E-waste+elsivieraqs=chrome..69i57j33i10i160.5612j0j9sourceid=chromeie=UTF-8> accessed on 20 July 2023

7. **Human Health Risk**: Exposure to the chemicals and carcinogens found in e-waste can "cause a wide range of health problems, from skin and respiratory disorders to neurological damage and cancer, either directly or indirectly through contamination of food and water supplies." The rising volume of e-waste emphasizes the importance of addressing these environmental problems and developing appropriate e-waste management systems.

5. HOW DOES E-WASTE IMPACT LAND AND WATER ECOSYSTEMS?

"E-waste has the potential to have a" large impact on both terrestrial and aquatic ecosyste

a) Land Ecosystem Impact:

1. **Soil Contamination:** When "e-waste is incorrectly disposed of in landfills, harmful toxic metals such as lead, mercury, and arsenic" can leak into the soil and pollute the environment. These noxious compounds degrade soil quality, injure plants, and disturb ecological equilibrium.
2. **Contamination of the Food Chain:** Small e-waste particles can be erroneously ingested by animals. This not only physically hurts them, but it can also introduce hazardous compounds into the food chain, possibly affecting animal and human populations.
3. **Habitat degradation:** Large e-waste dumping sites can result in habitat degradation, endangering biodiversity even more.

5.2. Impact on Water Ecosystems:

Water Ecosystem Impact:

1. **Water Pollution:** When e-waste is disposed of in landfills, toxic substances can contaminate groundwater. This can have an impact on drinking water supplies, aquatic life, and humans who utilize these water sources for consumption or bathing.
2. **Bioaccumulation & Bio-magnification:** Toxic compounds from e-waste may accumulate in aquatic life forms' bodies, a process called as bioaccumulation. Toxins grow more concentrated as they go "up the food chain, a process known" as bio-magnification, posing serious health dangers to animals higher up the food chain, including humans. Thus, appropriately managing e-waste becomes critical in conserving both land and aquatic environments.

6. "WHAT ARE THE IMPACTS OF THE EXTENDED PRODUCER" RESPONSIBILITY (EPR) POLICY ON THE INFORMAL SECTOR IN INDIA?

The success of formal EPR is inversely proportional to the size of the informal sector. This is because the informal sector accounts for 95% of e-waste activities in India. According to Gupt and Sahay (2015), the positive side of EPR implementation is that there has been a significant increase in the number of registered e-waste processing units in the first three years of EPR. In 2010, there were 23 registered processing units, which increased to around 145 in 2015. Following the establishment of EPR, several significant producers have established connections with both registered and unregistered recycling plants. As a result, they are now disposing of their garbage through traditional routes. This is one example of an improvement noticed as a result of EPR adoption. However, the authors emphasize that there are still significant issues here. According to their research, despite a rise in the number of registered units. Many of these units are still not getting the appropriate quantity of e-waste, indicating that a considerable volume of e-waste being diverted through informal routes. According to the author, manufacturers do not provide

monetary rewards. The practice of disposal to the informal sector persists. The authors also believe that a lack of consumer knowledge may be a factor in the failure of EPR in India owing to the informal sector.
Another difficulty with EPR deployment in India is that the modalities presented do not adhere to the acknowledged principles that underpin successful EPR systems throughout the world. In India, there is a lack of government and popular support for EPR. EPR fails to present a vision of how the regulation will achieve its goal. The informal sector, which is heavily unregulated, is the most difficult challenge in regulating EPR.
Under the EPR policy, India's infrastructure capacity for big e-waste management is relatively restricted. According to Gaikwad (2019), the country has "178 government-approved e-waste recycling centers with a combined capacity of approximately 400,000 metric tons per year." The supply chain between current facilities and informal e-waste manufacturers is deficient. Only ewaste from the formal industry has a more robust supply chain. As a result, India has insufficient infrastructure for handling e-waste.
EPR is not completely implemented in the overall integrity of the idea since informal sector recycling and collecting is prevalent and unregulated. EPR in India has improved, but not as much as projected. According to Rama Mohana R. Turaga's (2019) study, India's e-waste legislation of EPR went into force in 2012, with subsequent revisions in 2016. According to his research, the seven years of deployment had little influence on India's e-waste management system. As a result, EPR in India has improved, although not as planned.

7. HOW CAN "STRENGTHENING THE CONNECTION BETWEEN THE FORMAL AND INFORMAL SECTORS OF E-WASTE MANAGEMENT BE STRENGTHENED UNDER EPR"? [15]

The following "are some steps that are necessary under the EPR rule to enhance the integration of the formal and informal sectors."

a) "Auditing the current scenario and regulations

It is critical to monitor compliance and execution of existing e-waste legislation since the current regulatory infrastructure appears insufficient."[16] "The role and activities of the informal sector must be addressed" anew by examining the present legislation. The informal sector's repairs and refurbishments must be recognized. According to the study's author, "this situation is unlikely to change in the next years since the state" refuses to admit its shortcomings. "There is also a need for a new and improved regulatory structure and governance mechanism to enhance these conditions." It is "also feasible to improve integration by auditing the present scenario and" rules.

b) "Informal sectors"

"To increase the link between both sectors under EPR, the author of this paper claims to first solve the problem in the informal sector". Analyzing the current state of affairs in the informal sector is essential. The legislation must acknowledge the informal sector's existence and participation. Identifying informal recyclers as important partners is also essential. The author of the report contends that the initial step should be to establish relationships with workers in the informal sector that respect their inherent right to

[15] Gupt, Y., & Sahay, S. (2015) "Review of extended producer responsibility: A case study approach.Sage Publications", Inc.Gupta, B.K. and Singh, S., 2021. Experimental Investigation on concrete containing E-waste as course aggregate". IOP Conference Series.Earth and Environmental Science, 889(1),.

[16] Gaikwad, V. (2019) "Improving E-Waste Management in India. [Online]", Available at: <https://www.aii.unimelb.edu.au/publications/very-short-policy-brief/improving-e-waste-managementin-india/> accessed 3rd June 2023

a living, foster trust, and foster a shared understanding of the problems and potential solutions. A multi-level strategy is needed to integrate the informal sector into the official recycling industry because it is complicated and involves many stakeholders. As a result, the MoEFCC should evaluate current legislation to recognize the relevance of the informal sector. "Informal actors must be progressively brought on board through awareness programs established by the government, with the use of innovative technologies."[17]

"Informal workers have to be supported with training on legal framework and working conditions such as safety, risks, noncompliance, and organizing work procedures under the umbrella of formal association."[18]

c) "Role of government and stakeholder in integration"

"The role of government" is critical, since it must develop a forum that stimulates dialogue among many parties. Workers in the informal sector, "PROs, NGOs, various recyclers and manufacturers, and other third parties" are all potential stakeholders. According to the "author of this thesis, establishing cross-sector collaborations with clearly defined roles for each stakeholder will improve the relationship between the formal and informal sectors."[19]

Several alternatives must be considered and determined before forming a partnership. Working out the correct agreements and norms, according to Turaga, Bhaskar, and Sinha (2019), is essential to a relationship between both sectors. Interface groups should act as mediators, communicating the requirements "of informal collectors and aligning them with PROs". "Transparency is critical for forming effective collaborations with producers and PROs."

"The process of increasing the link between the formal and informal is difficult since, according to Krüger (2010), very little is known about the diversity of networking inside informal recyclers", as well as "their allocation of duties and funding mechanisms between its"[20] many players. However, the informal sectors are highly diversified and involve a wide range of players. As a result, a multi-level strategy is necessary to chart a course for their inclusion in the formal recycling market.

d) Waste inventory and data collection

There have never been serious efforts to solve the concerns of garbage inventorization and data creation. A rigorous and reasonable method frequently incorporates electronic product inventorization and life cycle assessment. According to "Turaga, Bhaskar, and Sinha (2019), the waste flow volumes of the informal sector and the population that is directly or indirectly involved in e-waste are solely focused on a lack of knowledge, which impedes the development of a sound legal structure and an efficient mechanism for implementation." "The government should generate more credible estimates of individuals and personnel active in e-waste management in India in collaboration with grassroots groups." "It is necessary to estimate the people and techniques involved in various operations such as collection, separation, and recycling."[21]

e) Utilization of Technology

"Recycling electronic waste entails separating materials, particles, or chemical components." "This is done in order to be marketed as raw material for the manufacture of new electrical gadgets." "It must first be deconstructed, sorted, ground, and separated." They are being burned and treated chemically. All of these procedures necessitate the use of different producers and tactics. Many "developed countries, such as the

[17] Krüger, C. (2010) "E-Waste Recycling In India – Bridging The Gap Between The Informal And Formal Sector"
[18] Ibid 29
[19] Turaga, R. M., Bhaskar, K., & Sinha, S. (2019). "E-Waste Management in India: Issues and Strategies. [Online]" Available at <https://journals.sagepub.com/doi/full/10.1177/0256090919880655> accessed 3rd June 2023
[20] Krüger, C. (2010) "E-Waste Recycling In India – Bridging The Gap Between The Informal And Formal Sector",
[21] Turaga, R. M., Bhaskar, K., & Sinha, S. (2019) "E-Waste Management in India: Issues and Strategies" Available at: <https://journals.sagepub.com/doi/full/10.1177/0256090919880655> accessed 3rd June 2023

United States, Sweden, Canada, and Germany, adopt modern technologies, and the government plays an important role in developing, promoting, maintaining, and regulating cost-effective technologies to address e-waste management."[22] The merging "of the official and informal sectors will allow the government to give early financial assistance before achieving self-sufficiency."[23]

In addition, the respondent claims that the current approaches employed "in India for e-waste treatment are antiquated and inefficient." According to "Mohd and Kaushal (2018)", the informal sector in India uses primitive and archaic procedures such as acid leaching and open-air burning. Adopting manual technology would also assist to increase integration. Interviewees highlight current approaches such as the DFE method, which is used to decrease environmental effect by ensuring that all production operations "are done in a sustainable" manner.

"Prasad and Vithanage (2019)" innovative technologies that are currently available for disposal and decollation requirements for electronic parts including capacitors, battery packs, resistors, and circuit boards with printed circuits are described in their book. These authors examine the extraction of valuable metals utilizing cutting-edge technology like thermal plasma and pyrometallurgy. Another economical and ecologically acceptable biological strategy for recovering priceless techniques is microbiological therapy. By implementing these technologies, handling of electronic waste will improve.

"Adoption and initiatives"

"A few interviewees also mentioned the circular economy." "The study's author also discovered that adopting a circular economy can be helpful to long-term economic development and the development of new sectors and jobs."[24] "A circular economy helps to decouple economic growth from the consumption of natural resources by minimizing waste at every level of the value chain."[25]

Electronic items must be subject to "economic instruments such as advanced recycling fees (ARF) or advanced disposal fees (ADF)." It would be feasible to employ this technology to relieve producers of physical collecting requirements, and the income produced might "be used to create end-of-life electronics items." "Many wealthy nations have already embraced these tools. Additionally, the Deposit Refund Scheme (DRS) should be implemented" as part of the EPR strategy to ensure optimal integration between the two sectors. An alternative economic strategy used by producers is called DRS, and it entails adding a deposit to the price of electrical and electronic goods. "When the equipment reaches the end of its useful life, the deposit is subsequently returned to the client along with a portion of interest." Using such a method will. This ensures the distribution of electrical equipment to authorized dismantlers and their assortment. The use of such economic tools will guarantee proper electronic trash administration in accordance with the EPR regulation.

"A PRO is an organization that, through various recyclers and dismantlers all over the country, assists manufacturers in meeting EPR targets and objectives." "A PRO is also accountable for establishing an engaged e-waste collection framework and bringing issues concerning e-waste recycling to light."[26]

[22] Turaga, R. M., Bhaskar, K., & Sinha, S. (2019). "E-Waste Management in India: Issues and Strategies" Available at: >https://journals.sagepub.com/doi/full/10.1177/0256090919880655> accessed 3rd June 2023

[23] Ibid 20

[24] "Environmental Benefits of E-Waste Recycling - CJD E-Cycling" <https://www. cjdecycling.com/e-waste-recycling/> accessed 3rd June 2023

[25] Condra, M. (2020) "Future Of E-Waste In The Circular Economy", Available at: <https://www.human-i-t.org/blogs/the-future-of-e-waste-in-the-circular-economy> accessed 3rd June 2023

[26] "BENEFITS OF E-WASTE RECYCLING - GCL Geri Kazanım ve Rafineri A.S", <http://gclcevre.com/en/benefits-of-e-waste-recycling> accessed 3rd June 2023

"Selection of such an organization under the EPR rule would aid in enhancing the cooperation of official and informal sectors."[27]

As a result, it is possible to conclude that ERP's effects "on the informal sector were not as positive as anticipated". "The main reason for its failure was that EPR failed to understand the importance of India's vast informal sector in e-waste collection and recycling, and there was insufficient support from the government, stakeholders, and consumers." Furthermore, "it is possible to claim that the government should examine all current legislation and procedures in order to enable the successful implementation of EPR". "It is critical to audit the present scenario and rules, recognizing the presence and contribution of the informal sector, and implement specific incentives and tools that will assist to" enhance the merger of formal and informal sectors.

8. WHAT IS THE ROLE "OF EXTENDED PRODUCER RESPONSIBILITY (EPR) IN E WASTE RECYCLING"?

Extended Producer duty (EPR) is important in e-waste recycling since it assigns duty for end-of-life management to product makers or producers. Some of its functions include:

1. **Internalizing Costs:** EPR attempts to make manufacturers shoulder the cost of product management when they become garbage, forcing them to address end-of-life disposal throughout the product design process.
2. **Incentive for Eco-design:** By requiring producers to shoulder the expenses of waste management, EPR stimulates the design of goods that are less destructive to the environment, more recyclable, and "easier to deconstruct at the end of their useful life."
3. **Shifting Waste Management Burden:** EPR relieves local governments of certain waste management obligations, moving the load upstream to manufacturers.
4. **Implementing various types of Responsibility:** "The Producers can be held accountable in four ways: economic responsibility", physical duty, liability responsibility, and informational responsibility.
5. **Creating Formal e-waste Collection Systems:** EPR implementation can lead to formal and structured e-waste collection systems, improving overall e-waste management and recycling.
6. **Informal Sector Integration:** EPR, particularly through Producer Responsibility Organizations (PROs), "can help to integrate the informal sector into official waste management systems." Finally, EPR is critical in enhancing the e-waste recycling infrastructure and supporting sustainable product design.

9. WHAT IS THE PRESENT SCENARIO TOWARD E- WASTE MANAGEMENT IN INDIA?

India has evolved as a significant IT powerhouse in recent years, and the consumer electronics sector has risen at an exponential rate. "The Indian PC sector is increasing at a compound annual growth rate of 25%, according to the Manufacturers Association of Information Technology (MAIT)". According to one study, 2.2 million laptops were rendered out-dated in 2007 "and 14 million mobile" devices were updated. "The e-waste generated was estimated to be 3,32,979, tons out of which 144,000 tons was recyclable and actually e-waste recycled was 19,000, tons"[28]

[27] Ibid 35

[28] "Six Benefits of Recycling E-Waste - Recycle Technologies", <https://recycletechnolo gies.com/benefits-of-recycling-e-waste/> accessed 3rd June 2023

There were "12000 tons of computers and 7000 tons of televisions among the e-waste handled". "It was also projected that around 50,000 tons of e-waste"[29] were imported, in addition to the 3,32,000 tons created locally.

Because of economic discrepancies, "developed countries find it economical to ship e-waste to poor countries for reuse/recycling." For example, "the cost of recycling a computer in the United States is $ 20, but in India it is $2." "As a result, the import of e-waste into India has a good possibility of increasing. Ten states "account for 70% of all e-waste created in the country, whereas 65 cities account for more than 60% of total e-waste generated in India."[30]

I"n "India, the Ministry of Environment and Forests (MoEF) is in charge of environmental laws and enforcement. CPCB, SPCBs, Gtz, and industry organisations such as MAIT are the key bodies involved in e-waste management in India."[31]

"These entities operate under the supervision of the MoEF. In 2007, the CPCB (Central Pollution Control Board) established a task group to evaluate the many elements of e-waste covered by various environmental legislations in India and to produce guidelines for ecologically sound e-waste"[32] handling. The CPCB issued recommendations for ecologically sound e-waste treatment in early 2008, "which apply to all individuals that handle e-waste." "These rules are India's first policy framework addressing the prevention, management, treatment, recycling, and disposal of e-waste."[33]

'The regulations established give guidance for manufacturers, consumers, generators, collectors, recyclers, transporters, dismantlers, and enforcement agencies,"[34] as well as processes "for dealing with e-waste in an" ecologically responsible manner. They include international regulations and norms such as the limitation on hazardous chemicals (RoHS) in EEE, in addition to the deployment of ecologically sound technology.

10. "HOW WE CAN ACHIEVE SUSTAINABLE E- WASTE MANAGEMENT"?

"We can accomplish sustainable Ewaste management" by reducing ewaste. When we limit the usage of electronic materials and equipment, we reduce ewaste and help to save "our natural resources and energy, which we normally extract from the planet to" make e goods. Rather than "recycling or mining, repurposing polymers and precious metals from outdated cell phones would save energy." Waste reduction can be accomplished by reevaluating "used products, recycling electronics and batteries in ewaste recycling bins located around campus, reusing large electronics, donating used electronics to social programs, purchasing environmentally friendly electronics, and extending the life of your electronics."

11. WHAT ARE THE ENVIRONMENTAL PROTECTION MEASURES FOR SUSTAINABLE E-WASTE PRACTICES?

Several measures can be taken for environmental protection in the context of sustainable e-waste practices:

[29] Ibid 36
[30] "Effective electronic waste management and recycling process involving formal and non formal sectors by S. Chatterjee and Krishna Kumar, Department of IT", CGO complex, New Delhi
[31] "E-Waste - Sources, Composition, Effects, Treatment and Disposal System", <https://electricalfundablog.com/e-waste-electronic-waste-sources-composition/> accessed 3rd June 2023
[32] Ibid 38
[33] Ibid 37
[34] "E-waste assessment in Kolkatta Metropolitan Area – A report by IMRB international April2010 to West Bengal Pollution control Board GTZ and ICC Kolkata"

1. **Green Manufacturing Promotion:** Electronics manufacturers should be encouraged to produce products that are environmentally benign, easy to repair, upgrade, and recycle, hence lowering their environmental imprint.
2. **Strict Regulations**: Governments must rigorously enforce e-waste management regulations, penalize unlawful dumping or exporting of e-waste, and ensure the safe and responsible treatment of e-waste.
3. **Establishment of Recycling Centers:** More specialized recycling facilities "should be established for the safe handling, recycling, and disposal of e-waste", with high standards of worker safety and environmental protection.
4. **Public Awareness Campaigns:** Effective campaigns and education programs can raise public awareness about e-waste issues and teach people how to dispose of their old electronics responsibly.
5. **E-Waste Collection Programs:** Holding regular e-waste collection campaigns will encourage individuals to appropriately dispose of their old gadgets, avoiding them from ending up in normal landfills.
6. **Industry Collaboration**: Encouraging collaboration across the electronics industry can help share best practices, innovations and advancements in environmentally friendly e-waste management. Collectively, these measures can help protect the environment from "the harmful effects of e-waste and promote a more" sustainable approach to e-waste management.

12. HOW DO "THE E-WASTE MANAGEMENT RULES" 2022 ADDRESS THE ENVIRONMENTAL CONCERNS?

The "Indian government's E-Waste Management Rules 2022" attempt to address environmental problems linked with e-waste in numerous ways:

1. **Broadened Scope:** The 2022 guidelines broaden the scope of e-waste to encourage effective and ecologically sound disposal and recycling.
2. **Real-time Data:** The new standards provide real-time data on e-waste, enabling for better e-waste tracking and management.
3. **Simplified Regulatory Requirements:** To align with other waste management regulations, compliance reporting for registered firms has been simplified.
4. **Hazardous Waste Disposal:** The guidelines aim to avoid incorrect hazardous waste disposal by encouraging the recovery and reuse of usable components and materials from trash.
5. **"Extended Producer Responsibility (EPR)":** A new EPR system for electronic trash recycling will be implemented, making manufacturers more liable for their devices' end-of-life.
6. **Public Awareness:** Producers are required to conduct periodic public awareness campaigns. All of these policies attempt to encourage ecologically sound e-waste handling techniques in India.

13. SOLUTIONS FOR EFFECTIVE E-WASTE MANAGEMENT

"India has the world's second biggest population and ranks fourth in terms of e-waste" consumption and management. To find a solution, it is vital to first grasp local and regional circumstances as well as the societal consequences of EPR management difficulties. The following "are the answers to these e-waste management issues":

a) "General Solutions- Effective regulation and incentive provision" are required. Workers will be allowed to employ legal measures "to manage e-waste and for central collection" as a result of this. Additionally, workers in these sectors must have safe and uniform working conditions.

b) Awareness of Consumers- Consumers are the key to effective handling of electronic debris "As a result, it is vital to educate them on safe e-waste disposal and" treatment. The "lack of understanding about e-waste, as well as the price of returning end-of-life equipment to official collection centers, are diminishing household and institutional users' desire to return their trash to the formal sector." As a result, the manufacturers' liability extends "to the post-consumer stage of the product life cycle."

c) "Use of Technical methods and Technology - Manufactures and product development processes must adhere to Design for Environment (DFE), which is a design strategy used to limit the impact of a product, process, or service on human health and the environment", with its implications assessed throughout its life cycle. Consumers must practice "the three Rs: Reduce, Reuse, and Recycle". It is necessary to adhere to "the circular economy paradigm. E-waste management in India," as in other affluent countries, must be prioritized. The usage of zero-landfill technologies is required. The majority of e-waste manufacturers are informal, and the official industry struggles with a lack of raw materials. This issue was resolved when the MoEF informed the government that necessary e-waste must be disposed of in accordance with the rules. He also states that it is the producer's responsibility to dispose of these wastes; the government was also advised that departments handling and engaged in e-waste management activities such as collection, segregation, dismantling, and recycling of e-waste must be registered with the Central Pollution Control Board (CPCB).

d) Government and public- government support, city administration, and people may all contribute to improved e-waste management. Citizens play a vital part in the management of e-waste. Many little devices and abandoned rubbish are discovered, and many individuals publicly burn that waste. It is the obligation of the general population to separate and dispose of e-waste from regular rubbish. This certainly need public knowledge. People in India are unaware of the hazardous impacts of e-waste on human health and the environment, thus education is critical. As a result, public support would ensure appropriate e-waste disposal and collection, therefore strengthening India's e-waste system.

According to the ASSOCHAM study (2017), in order to decrease e-waste concerns, the government may engage with companies to eliminate many regulated and standard processes. The government may also promote and assist young businesses by providing technical assistance and advanced tactics. In order to have a well-established collecting network, there must also be synergy between the official and informal sectors. Informal parties can collect e-waste and official parties can process it. The government may play an important role in integrating these industries. It is time for the government to take efforts to securely recycle and dispose of e-waste for the benefit of its residents and the environment. E-waste disposal is thus a significant concern for governments in many developing nations, including India. This system has improved in recent years, but there are still many areas that require improvement in this sector. As a result, it is possible to conclude that E-waste is the world's fastest growing waste stream, and for a developing country like India, where consumption of electronic products is high, the above literature review discusses e-waste in general, e-waste management in India, challenges and issues in this field, and also discusses various solutions or measures suggested by different authors to maintain a proper e-waste management system in India. As a result, it is clear that there is an urgent need to implement a few steps to enhance e-waste management in India while also protecting human life and the environment.

"Adoption of schemes, models, and techniques- Adopting a model such as a circular economy will aid in the sustainability of economic development and waste management." "A circular economy encourages reuse and recycling and would aid in the creation of new enterprises, industries, and" employment. "A

circular economy, by minimizing waste at every level of the value chain, helps to decouple economic growth from the consumption of natural resources."

Adopting "E-waste Recycling Credits (ERCs), which are a point-based reward" scheme. The "ERC program would offer incentives to illegal and unauthorized firms to legalize their" activities, as well as supply chain linkages to recognized recycling centers.

"There are two different sorts of incentive programs that can be used on electronic devices that are sold in the market": "advanced recycling fee (ARF) and advanced disposal fee (ADF)." "This comprises a charge that the buyer of particular goods pays at the moment of sale." "The expenses of gathering, restoration, and discharge are used to estimate ARF and ADF." "Fees may be computed based on weight or the number of units of the sold good." "The use of the revenues will determine how well ADF/ARF works." The levy should go toward encouraging post-consumer product recycling that is environmentally responsible.

"When buying electrical and electronic products, the maker may use a method known as a deposit Refund Scheme (DRS) in which they demand an additional payment as a deposit." The deposit and some interest are returned to the customer when the machinery hits "the end of its useful life." "This guarantees the gathering of electronic equipment and its distribution to authorized dismantlers." "When the equipment reaches the end of its life cycle, the deposit is returned to the customer along with some interest." "This guarantees the gathering of electronic equipment and its distribution" to authorized dismantlers.

"When the equipment reaches the end of its useful life, the deposit is then given back to the consumer along with a portion of interest". "This makes sure that electrical equipment is gathered and sent to licensed wreckers."

"A PRO is an agency that works with various recyclers and dismantlers around the" country to help manufacturers meet EPR requirements. A PRO also assists in the establishment of targeted e-waste collecting "systems and promoting awareness of e-waste recycling." "Adopting PRO will enable effective e-waste collection while also formalizing all informal sector" processes.

"Adopting such schemes will aid in the resolution of EPR difficulties and the merging of formal and informal sectors under EPR."

14. WHAT ARE SOME TECHNOLOGICAL SOLUTIONS FOR E-WASTE MANAGEMENT?

Technological solutions can help to improve e-waste management significantly. Here are a couple such examples:

a. **E-Waste Recycling Technologies:** Advanced technologies such as hydrometallurgical and biotechnological approaches can allow for safer and more effective precious metal recovery from e-waste.
b. **"Internet of Things (IoT)":** "Internet of Things" may help trace an electronic device's complete lifespan, from creation to disposal, guaranteeing improved accountability and faster equipment return or recycling.
c. **Advanced Sorting Systems:** New sorting technologies, such as machine learning algorithms and robotic sorting, can recognize and categorize various forms of e-waste, increasing recycling efficiency and eliminating human interaction with hazardous trash.
d. **Eco-design:** Creating electronic goods with end-of-life disposal in mind, such as employing less hazardous components or making electronic devices easier to disassemble for recycling, may considerably minimize environmental effect.

e. **Waste-to-Energy Technologies:** While some forms of e-waste may be processed to extract energy, this must be done with caution to minimize hazardous emissions.
f. **Block-chain Technology:** By making all phases of the process public and verifiable, block-chain technology may allow secure, transparent tracking of e-waste, promoting responsible management and disposal. Implementing these technical solutions necessitates a supportive governmental environment and investment, but they have the potential to significantly improve e-waste management**.**
g. **Block-chain Technology:** Block-chain can enable secure, transparent e-waste tracking, promoting proper e-waste management and disposal by making all steps of the process visible and verifiable. Implementing these technical solutions necessitates a supportive governmental environment and investment, but they have the potential to significantly improve e-waste management.

15. HOW CAN WE ENHANCE THE FUTURE OF E-WASTE MANAGEMENT?

A mix of technology innovation, policymaking, and behavioral improvements can enhance the future of e-waste management:

a. **Technological Innovation:** Advances in recycling technology can significantly improve e-waste processing efficiency. Furthermore, the development of more environmentally friendly electronic items can help to lessen the environmental effect of e-waste.
b. **Policy Development:** Governments must amend and implement tighter e-waste management regulations. They should enact rules that encourage electronic product reduction, reuse, and recycling.
c. **17.3 Behavioural Changes:** Educating the public on the significance of appropriate e-waste disposal might influence social behaviour. People will be more inclined to engage in recycling programs and make ecologically responsible actions if they understand the consequences of inappropriate disposal.
d. **Global Cooperation:** E-waste is a global problem that requires global collaboration to solve. Countries must collaborate to develop international standards and “legislation, as well as to prevent the unlawful export of e-waste”.
e. **Industry Engagement:** Electronic enterprises must assume greater responsibility, such as implementing 'take-back' programs, planning for lifetime and durability, and guaranteeing safe and ethical recycling methods. By concentrating on these areas, the future of e-waste management may be significantly improved, minimizing its environmental effect and contributing to a more sustainable.

16. HOW CAN E-WASTE BE PROPERLY DISPOSED OF AND RECYCLED?

E-waste disposal and recycling frequently necessitate comprehensive solutions. Here are some suggested practices:

a. **E-Waste Collection Centres:** Dedicated collection centers may greatly simplify the disposal and recycling procedure. These facilities are generally well-equipped to manage and recycle e-waste.
b. **Specialized E-Waste Recyclers:** These organizations have the necessary infrastructure and technology in place to properly break down and recycle e-waste. They can recover valuable materials for reuse and securely dispose of hazardous substances.
c. **Take-Back Programs:** Many electronic manufacturers and merchants have programs where customers may return out-dated or unwanted equipment. These businesses can then properly recycle the components.
d. **Community Recycling Events:** Local communities can hold events where residents can bring their discarded electronic goods for proper disposal.

e. **E-Waste Legislation Compliance:** It's important to follow e-waste rules and regulations, these often specify how different electronic items must be recycled, ensuring the process is safe and effective.
f. **Homeowner Disposal Method:** However, sometimes small e-waste items can be safely disposed on the household level. For instance, batteries from cell-phones and other small devices can often be taken to dedicated recycling points at supermarkets or other stores. Through these methods, e-waste can be safely and effectively managed, mitigating environmental impact and improving sustainability.

17. BENEFITS OF EFFECTIVE E-WASTE MANAGEMENT

Electronic recycling waste has become necessary for safe e-waste management in India "to conserve energy and resources and save space that landfills cover." Hence to better understand "e-waste management in India, we have to look on benefits of e-waste management in India they are":-

a. Sustainable Management Helps Increase Affordability

In numerous situations, people prefer to dispose of an electronic device for the purpose of buying the latest technology and not because the current one has stopped working. "If they donate their old gadgets to charity or resell them in a second-hand shop, it is possible for people who cannot afford to buy new electronic devices easily buy them". One should always consider that an electronic gadget that is no longer useful to them could be helpful to someone else! Innumerable "charities exist across the country that collects e-waste from people and then deliver them to different parts of the world for reuse". "E-waste management in India opens up opportunities for people who cannot afford such new devices to" use and own them.

b. Save Landfill Space

By utilizing "e-waste management services in India, one may reduce the space necessary for landfills - places that are required to cover waste products". "Keeping e-waste out of landfills saves space" and disturbs fewer microbes and plants. These locations may be suitable for housing or agriculture.

c. Save Natural Resources

The vast bulk of natural resources are non-renewable. The valuable components may be readily separated and recovered by applying "e-waste management in India". This allows for the creation of new products utilizing the same components. This helps to reduce pollution while also conserving resources and energy.

d. Increase in Employment

"In order to implement sustainable e-waste management in India, only qualified specialists should handle electronic garbage". "Differentiating between reusable and non-reusable materials is a difficult process that needs an adept eye and extensive product knowledge". "There are" several work opportunities in the recycling industry. Many specialists have earned professional degrees in electronic trash recycling. Raising awareness about electronics recycling leads to more individuals recycling, this leads to more job opportunities.

e. "Removes Data Appropriately"

"Maintaining data safe is becoming an increasingly" critical concern all around the world. Most individuals believe that they no longer exist on their computer since they have removed data from it. However, this is not always the case. To remove mobile phone and computer data, you'll need specialized software and a well-thought-out method. Before disposing of electronic equipment, it is critical to ensure that all data has been properly erased. People who disregard recycling rules or data security standards may face legal consequences. In India, e-waste management should preferably take place through certified recyclers.

CONCLUSION

"Electronic waste or e-waste is one of the fastest-growing environmental problems in the world. India." with its booming technology industry and increasing use of electronic devices, is also facing a significant e-waste problem. "The hazardous and dangerous materials used to make electronic devices are bad for both the natural world and the" well-being of humans. "Therefore, it's crucial to dispose of these technological devices safely and correctly". Electronic trash "is a fantastic business potential because it contains a number of valuable minerals and metals. Market demand for these metals is extremely high." "Therefore, effective electronic debris administration is crucial for any nation".

"India is a developing nation with a fast expanding economy." "The use of electronic items has expanded dramatically as the IT industry and technical breakthroughs have grown." As a result, electronic trash "is one of India's fastest-growing waste sources". "In India, the institutional, manufacturing, home, government, and commercial sectors"[35] generate the majority of e-waste. Collection, separation, and disassembly of items for useable parts, components, and modules with resale value are steps involved in e-waste management. "India is a growing country with a rapidly increasing economy." "As the IT sector and technological" discoveries have developed, so has the usage of electronic products. As a result, "electronic waste is one of the fastest-growing waste sources in India." In India, the "institutional, manufacturing, residential, government, and commercial sectors create the majority of e-waste". "E-waste management involves the collection", isolation, and disassembly of goods in search of usable parts, components, and modules with resale value. "This rule of ERP was drafted such that it can be used in both sectors." "India is a developing country with a fast expanding economy". "The use of electronic items" has grown in tandem with the advancement of the IT industry and technical advancements. As a result, electronic trash "is one of India's fastest rising waste sources". "In India, the institutional, manufacturing, residential, government, and commercial sectors" generate the majority of e-waste. E-waste management entails collecting, isolating, and disassembling items in search of reusable parts, components, and modules.

As a result, it is possible to infer "that there is still a long way to go before successful EPR deployment in India." "It is necessary to recognize "the informal sector, which dominates the e-waste market. In India", a proper framework and programmes must be established that take into account both sectors "of e-waste". "It is necessary to identify and" address social and economic issues. Other developed nations' modern technology, methodologies, procedures, and instruments must be implemented. As a result, there is an urgent need in India to integrate the official and informal sectors by examining EPR regulations and policies, and sustainable "e-waste management is critical to protecting "the environment and human health". "E-waste recycling is a" possible solution to India's e-waste dilemma. "E-waste recycling firms in India play a" critical role in attaining long-term e-waste management. It is our obligation to appropriately dispose "of e-waste and to support the work of e-waste recycling firms in India" to create a greener future.

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