Informal e waste management: an Indian perspective

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Abstract :

In the present world, India is among the top five e-waste producing countries. The estimated annual production is 2 million tons. E-waste management in India is dominated by the informal sectors. It is estimated that more than 90 per cent of the waste is processed in this sector. Unfortunately, unscientific practices are observed in the processing of e-waste. The poor e management processes generate several environmental and health problems. Electronic waste management is fast becoming a health concern for the informal sector that recycles e-waste in India.

Materials and Methods:

All the information has been collected from Government of India records, Gazettes, Newspaper interviews and reliable websites.

Results:

It is observed, about 76% of e-waste workers in India suffer from respiratory ailments like breathing difficulties, coughing and choking due to improper personal safeguards and unsafe working conditions. Moreover, India is facing the problem of e-waste management due to lack of awareness among people about the dangerous effects of e-waste on the environment and humans through informal e-waste collection and processing. The current practices of e-waste management in India face many challenges like the ineffective regulations, unsafe conditions of informal recycling, poor awareness etc.

Conclusions:

Electronic waste is a rapidly developing environmental problem for the developed and developing countries. There are expensive technological solutions for processing it, However, India is now trying her best to find out the prospective solution to overcome the e-waste management problems for the betterment of health and working environment of concerned Indian informal sectors.

Keywords: E-waste segregation; Health impacts; Job opportunities; Occupational hazards; Waste segregators

1. Introduction :

Globally, the proliferation of electronic devices has resulted in a staggering amount of e-waste being generated each year. According to the Global E-waste Monitor 2020, approximately 53.6 million metric tons of e-waste were generated in 2019, with only 17.4% being documented as formally collected and recycled. The remaining e-waste often ends up in landfills or is illegally traded to the developing or to the third world countries, leading to adverse environmental and human health consequences (Solving the E-waste Problem (StEP): - [UNU-StEP],2017).

In developed countries, there is generally more awareness and infrastructure for e-waste management. Many have established recycling programs, strict regulations, and dedicated facilities for the proper disposal of electronic devices. However, even in these regions, challenges persist due to the constant evolution of technology, resulting in a faster turnover of electronic devices and potential gaps in regulatory frameworks (Global E-waste Statistics Partnership,2021).

On the other hand, third-world countries face more significant challenges in managing e-waste. These nations often lack the necessary infrastructure, resources, and regulatory frameworks to address the growing issue effectively. In India, for example, a significant portion of e-waste is handled by the informal sector, consisting of small-scale recyclers and waste pickers. While these workers play a crucial role in salvaging valuable materials, they often work in hazardous conditions without proper safety measures (Basel Convention on the Control of Transboundary Movements of Hazardous Wastes).

India is one of the largest producers of e-waste globally, and its e-waste management scenario reflects the complexity of the issue. The country generated approximately 3.2 million metric tons of e-waste in 2019, and this figure is expected to rise with increasing technology penetration. The formal e-waste recycling industry in India faces challenges such as inadequate infrastructure, limited awareness among consumers, and the prevalence of informal recycling practices (E-Waste Coalition,2020)

The Informal sector's involvement in e-waste management in India is a double-edged sword. On one hand, it provides livelihoods for many marginalized individuals, contributing to their economic well-being. On the other hand, the lack of proper training and safety measures in the informal sector

poses serious health and environmental risks. Workers are exposed to harmful chemicals and substances during the dismantling and processing of electronic devices, leading to long-term health issues (E-Waste Coalition,2020; Environmental Protection Agency,2023)

In recent years, there have been efforts to address the e-waste problem in India. The government has introduced policies and regulations to promote responsible e-waste management. The E-Waste (Management) Rules, 2016, aim to regulate the generation, collection, disposal, and recycling of e-waste. However, effective implementation and enforcement remain significant challenges. The awareness among consumers about proper e-waste disposal and recycling is also a crucial aspect that needs attention (It's a Waste World,2019).

In addition to India, many other third-world countries grapple with e-waste management challenges. Limited financial resources, inadequate infrastructure, and a lack of awareness contribute to the problem. Some nations may lack specific regulations or struggle with their enforcement, allowing illegal and environmentally harmful practices to persist. One notable example is the informal e-waste processing activities in Agbogbloshie, Ghana. This area has become a global symbol of electronic waste dumping and primitive recycling methods. Open burning of electronic components releases toxic fumes into the air and contaminates the soil and water, posing serious health risks to both the local population and the environment (Solid Waste Management, 2022).

Addressing the global e-waste crisis requires a concerted effort from governments, businesses, and individuals. Developed countries can play a vital role by supporting capacity building and infrastructure development in third-world nations. This may involve providing financial assistance, sharing technological expertise, and collaborating on research and development of sustainable e-waste management practices. Furthermore, manufacturers should take responsibility for the entire life cycle of their products, from design to disposal. Implementing extended producer responsibility (EPR) programs can encourage companies to design products with easier recyclability, use eco-friendly materials, and take back and recycle their products at the end of their life.

Public awareness campaigns are crucial in changing consumer behaviour and promoting responsible e-waste disposal. Governments and non-governmental organizations should work

together to educate the public about the environmental and health impacts of improper e-waste disposal. This can be achieved through school programs, community outreach, and media campaigns.

(1) 2. MATERIALS AND METHODS

All the information has been collected from extensive review of Research papers, Government of India records, Gazettes, Newspaper interviews and reliable websites.

3. PRESENT SCENARIO OF E- WASTE MANAGEMENT IN INDIA

E-waste, which includes abandoned electronic devices such as laptops, smartphones, and appliances, has become a significant issue in the modern world. Global e-waste creation was estimated to be 53.6 million metric tons in 2019 and anticipates a total of 74 million by 2050. E-waste has the ability to pollute the air, poison land and water, and release greenhouse gasses, all of which pose serious dangers to human health and the environment. Due to its reliance on electronics and fast growing digitization, India ranks third in the world in terms of e-waste output, behind China and the USA. More than 17 million TVs, 148 million cellphones, 14 million refrigerators, 19 million audio gadgets, and 6.5 million washing machines are sold in the nation each year. The production of e-waste increased, rising from 700,000 tonnes in 2017–18 to 1.6 million tonnes in 2021–2022. The trend is expected to continue, projecting additional 14 million tonnes of e-waste by 2050 (Financial Express lifestyle, (2019)).

Maharashtra is the state with the most generation of e-waste in India, followed by Mumbai among the major cities. The main industries in these states that contribute significantly to the generation of e-waste are manufacturing, industrial, commercial, institutional, household, and research & development. Undoubtedly, e-waste collectors from all sources constitute the secondary source of e-waste, function as significant stakeholders, and make a significant contribution since e-waste is collected by societal stakeholders' door to door. The recovery and recycling of materials and components from e-waste is urgently needed nowadays since it offers plenty of secondary recyclable metals and other materials for manufacture as well as strong support for the refurbishment of components.

The nation treats e-waste with the participation of both formal and informal stakeholders. Currently, 90 to 95 percent of

all e-waste produced in the nation in an environmentally harmful manner is processed by informal recyclers, who outnumber legal recyclers in this regard. More than a thousand ingredients are used in the manufacturing of the EEEs. The harmful and toxic nature of heavy metals such as mercury, lead, cadmium, and chromium (VI) found in e-waste components prompted e-waste stakeholders to set up a dedicated treatment facility for them.

In addition to potentially dangerous materials, it contains priceless, recoverable, and recyclable metals. The proportion of metals in the composition varies; in the equipment, barium, nickel, gold, titanium, cobalt, palladium, manganese, silver, and platinum are present in traces; cadmium and mercury are present in minor amounts; and steel, aluminum, copper, tin, and nickel are present in bulk. Report of the Rajya Sabha (Vats, Mahesh & Singh, S;(2014)).

(2) 4.REGULATIONS BY GOVERNING BODIES

The difficulties in managing e-waste have been acknowledged by the Indian government. In order to improve collection, recycling, and ecologically responsible e-waste management, the 2018 E-Waste Management Rules were updated. These regulations establish goals for the recycling and collecting of e-waste, particularly for new producers. When the new e-waste policy went into effect in April 2023, its reach was greatly increased. As the market for renewable energy sources grew, it acknowledged the need for responsible disposal by include more products like solar panels.

The policy covered more than 100 different types of equipment under Extended Producer Responsibility (EPR) with the goal of reducing harmful chemicals in electronic devices. Although the measures sought to promote responsible management of electronic waste, curtail harmful practices, and guarantee manufacturers' adherence in handling the end-of-life phases of their products, it is important to remember that policies will persist in changing in tandem with technological and societal advancements, necessitating continuous refinement and enhancement (Vats, Mahesh & Singh, S.(2014))

(3) 5. CONTRIBUTIONS OF DEVELOPED COUNTRIES TO THE ADDDED INFLUX OF E WASTE BULK IN INDIA

E-waste is being shipped into India and other developing nations from developed countries on the pretext of using second-hand electrical and electronic equipment (EEEs) for charitable purposes, recycling, and equipment refurbishing. Being a type of

e-waste that is hidden, the statistics needed to quantify it are not available. In 2007, e-waste was quantified using computers, mobile phones, and televisions. The results showed that 3,82,979 tonnes of e-waste were generated in India, and 50,000 tonnes were illegally imported from the USA and EU in proportions of 80 to 20 to the total quantity imported [Khattar, (2007)].

Only 1,44,143 tonnes of the 3,82,979 tonnes of total e-waste have been reported back; the remaining 238836 tonnes, or more than 62%, have either been kept in dwellings or sent to unofficial recyclers or local collectors [Khattar, (2007)]. Nevertheless, out of 1,44,143 tonnes of e-waste, only 19000 tonnes (13%) had been recycled [Khattar,(2007)].

(4) 6. CHALLENGES FACED

While the Indian government is taking action to promote responsible e-waste management, there are still many obstacles to overcome before efficient e-waste management can be considered a reality in India. Among them are:
6.1. **Public Awareness:** One of the main problems is that people are not aware of how e-waste affects the environment. Many people unintentionally add to the issue by tossing away old devices or selling them to scrap dealers, which causes an accumulation of electronics in landfills.
6.2**. Illegal Dumping:** There are serious environmental dangers associated with the illegal disposal of e-waste, which is particularly common in underdeveloped nations. Particularly prevalent in the unorganized sector is this technique.
6.3. Insufficient Infrastructure: Appropriate e-waste disposal and recycling are hampered by the absence of specialist infrastructure, such as recycling facilities. Building this kind of infrastructure takes time and requires cooperation between public and private sectors.

6.4. Data Availability: Inadequate data makes it difficult to track and assess the success of e-waste management programs. Future course of action decisions are based on data analysis and stakeholder response, necessitating close collaboration.
6.5.Public Participation: It can be difficult to include the general public, especially when many of them anticipate receiving payment for their electronic waste.

(5) **6.6. Dominance of the Informal Sector:** More than 90% of e-waste is collected through the informal sector, where recycling methods are frequently hazardous to the environment and unsafe, increasing pollution and landfill waste. In addition

to using risky methods of disposing of e-waste, such as open burning to recover specific metals like copper, aluminum, iron, and steel from equipment peripherals and acid leaching to recover copper and precious metals from PCBs (Printed Circuit Boards), mother boards, and other hazardous materials, the informal recyclers show little regard for the guidelines set forth by the Central Pollution Control Board (CPCB). In addition to these components, 36 more compounds are employed in the production process.

Addressing these challenges is crucial for the advancement of sustainable e-waste management in India.

(6) 7. HEALTH IMPACT ON THE SEGREGATORS AND COLLECTORS

E-waste segregation activities, such as dismantling and burning of electronic components, release harmful airborne pollutants. Studies have linked exposure to e-waste emissions with respiratory problems such as asthma, bronchitis, and chronic obstructive pulmonary disease (COPD) among waste segregators (Chen et al., (2016)). Inhaling particulate matter and toxic fumes from burning electronic components contributes to the deterioration of lung function and increases the risk of respiratory ailments.

Waste segregators often handle e-waste materials directly, exposing their skin to hazardous substances. Contact with chemicals like lead and cadmium can lead to dermatological problems such as rashes, burns, and skin irritation (Yang et al., (2017)). Prolonged exposure to these toxins without adequate protective measures exacerbates the risk of developing chronic skin disorders among waste segregators.

Heavy metals present in e-waste, including lead and mercury, have neurotoxic properties that can adversely affect the nervous system. Studies have highlighted the association between e-waste exposure and neurological disorders such as cognitive impairment, developmental delays, and neurobehavioral deficits (Basu et al., (2019)). Waste segregators, particularly children and pregnant women, are at heightened risk of neurodevelopmental abnormalities due to their susceptibility to toxic exposures.

Exposure to e-waste contaminants has implications for reproductive health among waste segregators. Studies have reported elevated levels of reproductive disorders, including infertility, miscarriages, and birth defects, in communities

residing near e-waste recycling sites (Hu et al., (2019)). Occupational exposure to toxicants like lead and phthalates during e-waste segregation may disrupt endocrine function, leading to reproductive dysfunction and adverse pregnancy outcomes.

Chronic exposure to e-waste pollutants has been linked to cardiovascular diseases (CVDs) among waste segregators. Heavy metals such as lead and cadmium contribute to endothelial dysfunction, inflammation, and oxidative stress, predisposing individuals to hypertension, atherosclerosis, and coronary artery disease (Wang et al., (2018)). The synergistic effects of multiple toxicants present in e-waste further elevate the risk of CVDs among vulnerable populations.

Addressing the health and physiological impacts of e-waste segregation requires a multi-faceted approach encompassing regulatory interventions, occupational health programs, and community awareness initiatives. Implementing stringent regulations to minimize exposure to hazardous substances, promoting safer e-waste handling practices, and providing waste segregators with personal protective equipment (PPE) are essential steps towards safeguarding their health and well-being.

Furthermore, empowering waste segregators through education and training programs on occupational health hazards and alternative livelihood options can mitigate their dependence on hazardous e-waste segregation activities. Collaborative efforts involving government agencies, industry stakeholders, and civil society organizations are imperative to create a sustainable e-waste management framework that prioritizes human health and environmental protection.

8. GENERATION OF EMPLOYMENT

Efficient e-waste management not only mitigates environmental pollution but also creates opportunities for employment across various sectors. The e-waste management industry encompasses collection, segregation, dismantling, recycling, and disposal processes, each stage offering employment prospects. (Chatterjee, A., & Bhattacharjee, S. ,2018; Ramachandra, T. V., & Sudarshan, P. B, 2007).

8.1. **Collection and Sorting:** The initial step involves collecting e-waste from households, businesses, and institutions. This task creates job opportunities for workers involved in collection drives, transportation, and sorting facilities. Informal

sector workers often engage in manual sorting, separating different types of electronic components based on their material composition.

8.2. **Dismantling and Recycling:** Dismantling units play a crucial role in the e-waste management chain. Skilled technicians dismantle electronic devices to extract valuable components like metals, plastics, and circuit boards. This process requires specialized knowledge and training, providing employment for technicians and engineers.

8.3. **Refurbishment and Repair:** Reusable electronic components and devices undergo refurbishment and repair processes. Skilled technicians refurbish old electronics, extending their lifespan and reducing the need for new manufacturing. This sector creates job opportunities for technicians and engineers proficient in electronics repair.

8.4. **Recycling Facilities:** Recycling facilities recover valuable metals such as gold, silver, copper, and palladium from electronic waste. These facilities employ workers for operating machinery, conducting quality control checks, and ensuring compliance with environmental regulations.

8.5. **Research and Innovation:** Research and development in e-waste management technologies drive innovation in the sector. Employment opportunities arise for scientists, engineers, and researchers involved in developing sustainable recycling methods, eco-friendly materials, and efficient waste management technologies.

Effective e-waste management requires supportive policies, regulations, and advocacy efforts. Professionals in policy formulation, environmental law, and advocacy organizations contribute to creating a conducive environment for sustainable e-waste management practices (Singh, N., & Srivastava, S, 2020 ; Kaza et al., 2018)

9. RESULTS

It is observed, about 76% of e-waste workers in India suffer from respiratory ailments like breathing difficulties, coughing and choking due to improper personal safeguards and unsafe working conditions. Exposure to hazardous substances during e-waste handling activities poses significant risks to the respiratory system, skin health, neurological development, reproductive health, and cardiovascular function of waste segregators (Chen et al., 2016; Yang et al., 2017; Basu et al., 2019; Hu et al., 2019; Wang et al., (2018). These adverse health

effects are particularly pronounced among marginalized communities engaged in informal e-waste segregation activities.

10. Discussion:

Efforts to mitigate these risks require a comprehensive approach, including regulatory measures, occupational health interventions, and community empowerment initiatives. Stringent regulations are needed to minimize exposure to toxic substances in e-waste, while promoting safer handling practices and providing waste segregators with adequate personal protective equipment (PPE). Furthermore, educational programs on occupational health hazards and alternative livelihood options can empower waste segregators and reduce their dependence on hazardous e-waste segregation activities.

Collaborative efforts involving government agencies, industry stakeholders, and civil society organizations are crucial to address the complex health challenges associated with e-waste segregation. By prioritizing human health and environmental protection in e-waste management policies and practices, we can create a safer and more sustainable future for waste segregators and communities affected by e-waste pollution.

11. Conclusion:

In conclusion, the current scenario of e-waste management globally reveals a complex and multifaceted issue. While developed countries have made strides in establishing effective systems, the challenge is more pronounced in developing and under developing nations like India and those in Africa.

The e-waste management sector also fosters entrepreneurship and small-scale enterprises. Initiatives promoting awareness, education, and training in e-waste management create a skilled workforce equipped to tackle the challenges associated with electronic waste. Furthermore, the informal sector, comprising waste pickers and recyclers, plays a significant role in e-waste management, contributing to livelihoods for marginalized communities (Dutta, D., & Roy, S.,(2021)).

However, it's crucial to address the health and safety concerns of workers involved in e-waste management. Exposure to hazardous substances during dismantling and recycling processes poses risks to workers' health. Therefore, proper training, implementation of safety protocols, and access to personal protective equipment are essential to safeguarding

workers' well-being (Kumar, A., & Samadder, S. R., (2020)).

Thus, e-waste management in India presents a significant opportunity for employment generation while addressing environmental and health challenges.

Improving e-waste management requires a holistic approach that includes regulatory frameworks, infrastructure development, awareness campaigns, and international cooperation. Only through collective efforts can the world address the growing menace of electronic waste and pave the way for a more sustainable future. By fostering a sustainable e-waste management ecosystem, India can harness the potential of this sector to create jobs, promote innovation, and contribute to a cleaner environment (Thakur, D., Rana, S., & Kumar, A, (2020)).

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