Role of E-Waste Management in Achieving Sustainability: A Case Study of Delhi

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Abstract - Technology is developing at a rapid pace, leading to the production of new electronic waste and the improper disposal of existing waste which pose environmental and health risks. This study seeks to explore the level of awareness people in Delhi, India have about e-waste, as well as their perceptions and actions towards it. A questionnaire survey was conducted from different demographies to know their awareness of e-waste, their disposal method, their awareness of adverse health and environmental effects, and their willingness to participate in e-waste management. The studies also show that while a considerable number of the respondents are concerned about e-waste and its proper disposal, the overall knowledge and understanding of the recycling procedures and governing legislation remains low. Furthermore, the study reveals that social media significantly influences people's perceptions and actions regarding e-waste management. Therefore, the study calls for heightened education, better facilities, and strong policy implementation to address e-waste problems. The results of this study are critical in guiding policymakers and other stakeholders to develop an effective e-waste management approach that will support the country in achieving the Sustainable Development Goals.

*Keywords - E-waste, Sustainability, E-waste management, Environmental health, Delhi*

INTRODUCTION

In the Asia-Pacific countries, India is a prominent electronics consumer country. India is establishing itself as the global leader in "Electronic System Design and Manufacturing" (ESDM). India's proportion of the worldwide electronic system manufacturing sector has increased from 1.3% in 2012 to 3.6% in 2019 (Bagwan, 2024). Electronic waste has developed as one of the rapidly growing waste streams worldwide. Around 2 million tonnes of e-waste will be generated by 2025 (Chatterjee, 2011). E-waste poses significant environmental and health challenges (Joon et al., 2017; Saoji, 2012). Advancements in material science and

technology have resulted in consumer products with numerous features that are difficult to recycle using existing technologies. As a result, instead of recycling, these materials often end up in landfills or incinerator facilities (Sahajwalla et. al., 2023). The circular economy is a regenerative system that continuously reuses materials, restores nature and prevents waste generation. Practices such as maintenance, reuse, refurbishment, remanufacture, recycling, and composting ensure the continuous flow of products and materials in a circular economy. From the statistics of 2017, after the USA, China, Japan, Germany, India stands fifth in the list of e-waste producing nations (Bagwan, 2024) while the Recycling rate in India is only 1% of the total E-waste generated annually (Kumar et al., 2022). This study highlights the crucial necessity for effective e-waste management in Delhi to promote sustainability, reduce environmental impact, and support community well-being. The paper is organised into several sections: Section 2 highlights the current scenario of e-waste in India, Section 3 discusses the methodology, Section 4 explains the results and findings in detail, Section 5 emphasises the study's conclusion, and Section 6 points out the study's prospects.

E-waste Scenario in India

Electrical EEE has become an essential component of contemporary living. Due to its broad range of advantages and wide availability, it has enhanced the overall standard of living for people around the world, particularly in the aftermath of the COVID-19 global outbreak when individuals were compelled to utilise remote equipment (Kumar et al., 2022). E-waste encompasses a wide variety of electrical devices, such as common household kitchen appliances, computers, laptops, smartphones, and so on (Devi et al., 2014; Mundada et al., 2004). These wastes are also generated from transportation, security systems, energy provision, and healthcare facilities (Parajuly et al., 2019). Fig. 1 shows the state-wise E-Waste Generation whereas Fig. 2 demonstrates the city-wise E-Waste Generation in India (Tonnes/Year).

Fig 1: E-waste production of Indian States (Tonnes/Year)
Source: Adapted from Chatterjee, 2011
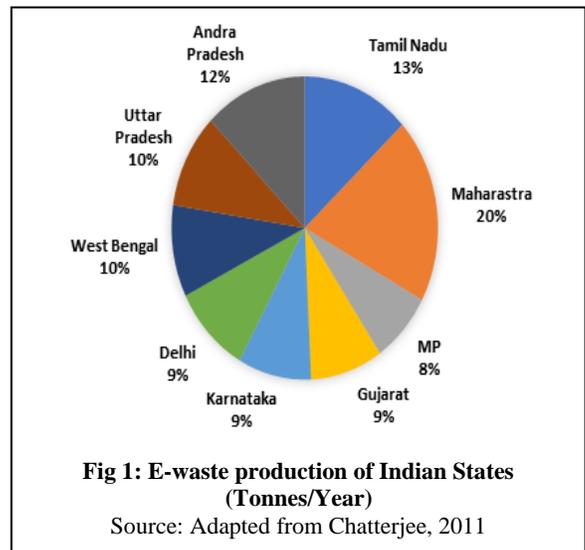
The Ministry of Electronics and Information Technology (MeitY), Government of India has initiated an awareness campaign to raise people's awareness of the environmental and health hazards linked with e-waste discarding and recycling in unauthorized centers. Since 2011, India has been the individual republic in South Asia to have its own unique rules for managing electronic trash. The Global E-waste Monitor Report 2024 released by the United Nations Institute for Training and Research (UNITAR), showed that India is the third largest electronic waste generator in the world after the USA and China.

India directly contributes 7 Mt of e-waste, which is 10 per cent of the total e-waste generated across the global community. It accounts for 62% of all the e-waste produced worldwide and 37% of the total e-waste exported globally (Blade et al., 2015). By 2016, expect it to account for 11 percent of all e-waste in Asia (Blade et al.,2017). India annually generates one and a half to two million metric tonnes of electronic garbage, with large quantities of this garbage imported from other countries (Manish et al.,2019).
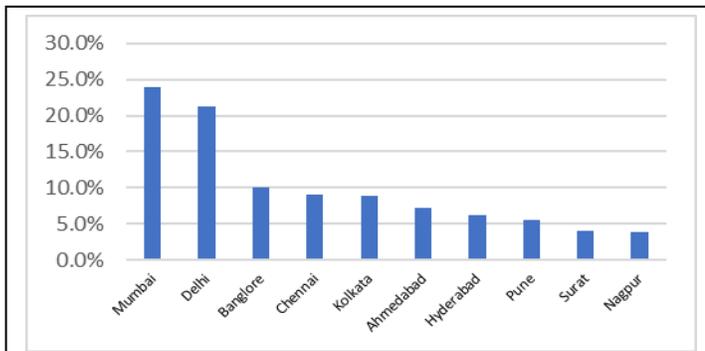
Fig 2: E-waste Production in Indian Cities (Tonnes/Year)
Source: Adapted from Chatterjee, 2011

The formal e-waste recycling industry is currently being developed in India's major cities. On the other hand, informal recycling has been around for longer than formal recycling, with more than 1 million poor people involved in manual recycling operations. Many of these individuals lack formal education and are unaware of the potential risks associated with the treatment programs. The "Central Pollution Control Board" (CPCB) in India monitors the authorized e-waste management and recycling institutions. It comprises licensed and accredited recycling hubs across the country that are safe and efficient in managing e-waste without posing any threat to the environment. The informal e-waste recycling industry is unauthorized by government agencies and does not consider any rules or regulations. The company employs people from poor areas who are illiterates, both males, females, and children, as handlers of electronic waste. They make their living through environmentally unsustainable and dangerous methods and techniques that compromise their health and the health of others, besides polluting the environment (Dutta and Goel, 2021).

2.1 Sustainable Development Goals and E-waste Management in India

The Sustainable Development Goals (SDGs) are being viewed as a roadmap to ensure a brighter future for people. According to the UN Global E-waste Monitor 2020 study, India produced 3.2 million tonnes (Mt) of e-waste. This placed it in third place in the world for e-waste production (E-waste Monitor, 2024). Almost 95% of India's e-waste is recycled by the informal sector. In addition to being substantially unproductive, this is especially dangerous for women and young children- the primary collectors of this kind of waste. E-waste is typically treated by burning it, disposing of it in dumps, and mixing the chemicals in water, to name a few of the blatant ways of treatment of this type. These actions have dire consequences for both humans and the environment in the long run. To add to that, these methods lead to a loss of some valuable metals when underutilised. Though the robust connections between the goals of sustainable development ensure a 'no one falls behind' attitude for the larger community, it does lead to a chaotic race towards the achievement of these goals. In worst-case scenarios, this race can have detrimental effects on the communities and lands alike.

METHODOLOGY

Study area: This study was carried out in Delhi, the capital of India, known for its urbanization and diverse population. As a major consumer of electronic goods, Delhi generates significant e-waste, making it an ideal location for examining public awareness and disposal practices. The city's mix of socio-economic backgrounds and the presence of formal and informal e-waste sectors offer a unique context to explore the potentials and obstacles in e-waste management. Data were collected from Nehru Place in Delhi, which is Asia's biggest electronics market. Nehru place market is the focus of this study because it plays such an important part in the electronics market.

Data: Samples were conducted using a structured questionnaire to collect primary data on respondents' demographic characteristics, awareness, and perceptions of e-waste management. Purposive sampling was used to collect data from 156 respondents to capture a representative sample, providing insights that are relevant not only to the city but also to other urban areas in India facing similar e-waste management challenges.

The questionnaire comprised several questions covering various aspects of e-waste awareness, disposal practices, and attitudes towards e-waste management. The demographic variables included gender, age, educational qualification, occupation, and annual income. The survey was distributed both online and offline to ensure a diverse sample, targeting individuals across different age groups, educational backgrounds, and income levels. Responses were analyzed using descriptive statistics to summarize the data and to identify significant associations between demographic factors and awareness or behaviors related to e-waste management. The analysis aimed to highlight patterns in public perception and identify demographic segments that may require targeted awareness campaigns.

RESULTS & ANALYSIS

The research insights into on public awareness and behavior regarding e-waste management in India. The survey revealed that while a significant portion of respondents are aware of e-waste as a concept, there are considerable gaps in understanding the proper disposal methods and the health and environmental risks linked with improper e-waste management.

3.1 Awareness and Disposal Practices

The study shows that E-waste needs to be properly disposed of even though many people are aware of it. A significant number of people (22.4% slightly aware and 9.6% not aware) don't know much about e-waste (41.7% of respondents are moderately aware). 31.4% of people know how to dispose of e-waste properly, but 26.3% do it sometimes, and 25.6% never do it. This could be because recycling sites are hard to get to or people need to be motivated, having less knowledge or infrastructure to dispose of it properly. 16.7 % of people often or always dispose of their e-waste responsibly. It is crucial to combine awareness efforts with useful tips to help people go from knowing about e-waste disposal to doing something about it.

3.2 Health and Environmental Concerns:

Findings show that a lot of people are unaware of the health risks and environmental impacts of e-waste. Only 17.9% of those who answered are still not aware of the health hazards, which shows that they don't fully understand the health concerns. It's clearer that people care about the environment, though; 28.8% are very aware of it and 26.9% are somewhat aware. 13.5 per cent are still not aware of the concerns. Environmental campaigns seem to have reached more people than health efforts. Focused teaching that shows how health and environmental issues are linked is important for improving both. This will encourage people to use safer ways to get rid of electronic waste for their overall health.

3.3 Role of Legislation and Social Media:

Survey results show a big difference between how influential social media is and how much people know about e-waste legislation. Although 31.4% of those who participated believed that social media is beneficial for educating people about and encouraging responsible e-waste dumping, 45.5% do not know of any e-waste laws in India. Overall, this shows that social media does a good job of raising awareness, but it might not educate users enough about specific legal frameworks for e-waste management in India. That might be because social media tends to focus on bigger environmental problems rather than specific legal information. Specifically targeted social media campaigns should focus on e-waste laws, using interesting material and influential people to make legal information more relatable. Therefore, social media can make people more aware of and knowledgeable about e-waste rules, which can lead to more responsible disposal methods.

TABLE 1: PEOPLE'S PERCEPTION REGARDING E-WASTE MANAGEMENT PRACTICES

Questions	Results of Awareness in Percentage				
	Not aware at all	*Slightly*	*Moderately*	*Very aware*	*Extremely*
Awareness about E-waste	9.6	22.4	41.7	19.2	7.1
Awareness of recycling processes	26.3	35.3	24.4	8.3	5.8
Awareness of Environmental Impact	13.5	19.2	26.9	28.8	11.5
Awareness of E-waste legislation	45.5	17.9	25.6	7.1	3.8

Source- Created by Authors, 2024

3.4 Willingness to Participate in E-waste Programs:

More than half of the people who answered the survey were somewhat or very willing to take part in e-waste management projects. According to this, an increasing number of people are realizing how important it is for each person to contribute to sustainable practices. People are slightly less willing to pay for better services for managing e-waste, though. Only 32.7% are somewhat willing to do so, while 27.6% are very willing to do so. People are willing to take part but do not want to pay be due to financial concerns or the belief that managing e-waste should be the duty of everyone and should be paid for by the administration or organizations. It is significant to stress the long-term assistance and price savings of proper e-waste handling to get more people involved and more money to make. You could get more people to invest in better services by offering incentives or showing examples of successful community-led projects. This would help close the gap between participation and financial support for long-term solutions to e-waste problems.\

3.5 Importance of Sustainable Development Goals

The outcomes underscore the important influence of the Sustainable Development Goals (SDGs) on individual   s' opinions on environmental and societal problems. It's clear that the SDGs are important to many people—73.1% of those who answered think they are very important or extremely important. People all over the world agree that the SDGs are important for leading efforts for sustainable development at the global and local levels. When it comes to managing e-waste, though, people don't always act in ways that show how important this is. Respondents agree that the SDGs are essential, but more regular practice is still needed. Only 31.4% of respondents regularly dispose of electronic waste responsibly, and a significant 45.5% need to learn about e-waste laws. There is a void between what individuals know regarding the SDGs and what they accomplish, which demonstrates that it is challenging to turn knowledge into action. Similarly, the statistics demonstrate a demand for education and enhanced awareness of these problems. To complete the SDG's existence, 43.6% of respondents responded that making people more knowledgeable of problems like e-waste is essential. We unquestionably require additional targeted educational activities to close the gap between awareness and action.

The study's most significant result highlights the Indian public's perception and behavior towards e-waste. These two findings indicate that, despite a moderate level of awareness, the percentage of communities practicing responsible e-waste disposal could be much higher. This underscores the need for improved awareness creation efforts and related infrastructure support. The dominance of social media also highlights the fact that it could prove useful in these educational crusades, particularly due to its popularity among the younger generations who are sophisticated users of technology. Moreover, the lack of knowledge about current laws implies that policymakers should prioritize raising awareness about the legal requirements and ensuring the development and promotion of effective compliance mechanisms. The surveys indicate a high

level of willingness to participate in e-waste programs, underscoring the need to strengthen easily appealing programs that facilitate participation in e-waste disposal. If tackled in these areas, India has the potential to greatly combat and minimize the e-waste issue for the populace's safety and the well-being of the environment.

CONCLUSION

This paper discusses the current level of population awareness and subsequent e-waste disposal in India. A large percentage of the respondents acknowledged the existence of e-waste, but few practised proper disposal of the equipment. These conclusions further emphasize the intent of focused education to help close the gap while also calling for the enhancement of current infrastructures regarding e-waste legislation and information sharing. Furthermore, findings suggest that there is only moderate concern about environmental and health hazards linked with incorrect e-waste disposal; however, lack of knowledge about the correct procedures to dispose of the e-waste and lack of access to proper channels also contributed to relatively less responsible behaviour in this regard. In this sense, social media stands out as a strong tool to raise awareness and promote positive change in practices, primarily among youth. This positive attitude towards the option of involvement in e-waste management programs indicates that if provided with the necessary tools, bearings, and motivation, it is possible to extend the operation of proper e-waste handling in India. Efforts like these are critical not only for preventing processes that harm the environment and the health of people who live close to e-waste recycling sites but also for contributing to the attainment of the UN Sustainable Development Goals by the year 2030.

FUTURE SCOPE OF THE STUDY

The commitment of India to attaining the SDGs 2030, more specifically Goals Three, Six, Eight, Eleven, Twelve, and Fourteen, shall be partially predicated upon how efficiently India deals with its e-waste in the coming few years. To improve the e-waste management situation in India, raising awareness, particularly among the less informed public, should be the primary focus. Schools and community-based centres could educate children on the proper disposal of e-waste, thereby fostering a culture of responsible e-waste management. Patients could also adopt sustainable practices, such as offering discounts for old devices in exchange for new ones. Enhancing policies and increasing recycling opportunities are key areas, but the government, business world, and NGOs still need to work together to formulate and implement such solutions. Why do people not recycle? This is a theme that can be expanded further, to make recycling effortless through the use of technology. Thus, sustained and innovative strategies are required to not only address India's e-waste issue but also chip away at the various environmental and health-related issues plaguing the nation.

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