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Impact of E- Waste Management On Environment in Assam

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ABSTRACT

Electronic waste (e-waste) has emerged as one of the fastest-growing waste streams worldwide due to rapid technological advancement, increased consumption of electronic devices, and shorter product life cycles. Improper disposal and handling of e-waste pose serious environmental and public health concerns because of the presence of hazardous substances such as lead, mercury, cadmium, and brominated flame retardants. This study examines the current scenario of e-waste generation and management, with particular emphasis on the environmental impacts associated with inappropriate disposal practices. A survey conducted among respondents from different districts of Assam assessed public awareness, household e-waste generation, and disposal practices. The findings revealed that although a considerable proportion of respondents had heard about e-waste, detailed knowledge regarding its environmental consequences and proper management remained limited. The study highlights major challenges in e-waste management, including inadequate collection facilities, lack of recycling infrastructure, and insufficient public awareness. It further emphasizes the need for effective management strategies such as resource recovery, recycling, awareness campaigns, and policy implementation to promote sustainable e-waste management and minimize its adverse impacts on the environment and human health.

Keywords: E- Waste Management, Environment, Technological, Assam, Human Health

1. INTRODUCTION

The surge of electronic gadgets and rapid technical progress has resulted in a significant accumulation of electronic trash globally. E-waste, or electronic garbage, denotes discarded electronic gadgets and appliances that are no longer desired or required. This include devices such as computers, mobile phones, TVs, and appliances like refrigerators and washing machines. E-waste poses an escalating issue due to its composition of many compounds that may be detrimental to human health and the environment if improperly discarded. [1] E-waste has several dangerous substances, such as lead, mercury, and cadmium, which may infiltrate soil and water if inadequately handled. These substances may adversely affect human health, causing neurological damage and increasing cancer risk. Besides these health hazards, e-waste may also exacerbate environmental pollution, since its materials may emit toxic compounds into the atmosphere when incinerated or as they decompose over time. This analysis seeks to provide a thorough examination of e-waste management, including its origins, environmental and health repercussions, and the policies and techniques used for its treatment. [2]

Environmental Impacts of E-Waste: Electronic waste (e-waste) has emerged as one of the fastest-growing waste streams worldwide due to rapid technological advancements, increasing consumer demand, and the shortening lifespan of electronic products. Improper disposal of discarded electrical and electronic equipment poses severe environmental challenges because these devices contain numerous hazardous substances, including lead, mercury, cadmium, chromium, and brominated flame retardants. [3] When e-waste is dumped in open landfills or processed using unsafe methods, these toxic materials can leach into the soil and groundwater, contaminating ecosystems and entering the food chain. Such contamination threatens biodiversity and compromises the quality of natural resources essential for human survival. [4]

In addition to soil and water contamination, inappropriate treatment practices such as open burning and informal recycling contribute significantly to air pollution. The combustion of plastics and electronic components releases toxic gases, particulate matter, dioxins, and furans into the atmosphere, which can adversely affect both environmental quality and public health. Continuous exposure to these pollutants has been associated with respiratory illnesses, neurological disorders, endocrine disruption, and developmental abnormalities. [5] Workers engaged in informal e-waste recycling, particularly in developing countries, are among the most vulnerable populations due to inadequate protective measures and prolonged exposure to hazardous substances. [6]

E-waste also represents a major concern from the perspective of resource conservation and climate change. Electronic devices contain valuable materials such as gold, silver, copper, palladium, and rare earth elements that require energy-intensive mining and extraction processes. Failure to recover these resources through proper recycling accelerates resource depletion and increases the demand for virgin raw materials. [7] Furthermore, the manufacturing, transportation, and disposal of electronic products consume substantial amounts of energy, contributing to greenhouse gas emissions and exacerbating global climate change. Adopting circular economy principles through repair, reuse, refurbishment, and recycling can significantly reduce these environmental burdens.

Another important issue associated with e-waste is environmental injustice arising from the transboundary movement of hazardous electronic waste. Large quantities of e-waste are often exported from developed nations to developing countries where environmental regulations and recycling infrastructure may be inadequate. [8] Consequently, economically disadvantaged communities bear a disproportionate share of the environmental and health impacts associated with unsafe recycling activities. Strengthening international cooperation, enforcing e-waste regulations, promoting environmentally sound recycling technologies, and increasing public awareness are therefore essential for minimizing the adverse impacts of e-waste and achieving sustainable waste management practices.

2. OBJECTIVES

- To assess the level of public awareness and practices related to e-waste management among people in Assam.
- To identify the environmental impacts of e-waste and propose suitable strategies for its effective management and disposal.

3. RESEARCH METHODOLOGY

The study adopted a descriptive research approach to investigate the awareness and management practices related to electronic waste in Assam. Relevant information on e-waste generation, environmental impacts, challenges, and management strategies was collected through an extensive review of recent literature, government reports, and published research articles. In addition, an online survey was conducted among individuals from different districts of Assam representing diverse age groups, residential backgrounds, and educational qualifications. A structured questionnaire was designed to collect data regarding respondents' awareness of e-waste, household waste generation patterns, disposal practices, and suggestions for minimizing e-waste. The collected responses were compiled, categorized, and analyzed using percentage-based analysis, and the findings were presented through figures and tables to facilitate interpretation and draw meaningful conclusions regarding the current status of e-waste management and public awareness in the study area.

4. RESULTS

Table 1: Age Group of Respondents

Age Group (Years)	Percentage
15–20	26%
21–25	65%
26–30	4%
31–35	2%
36 and above	3%
Total	100

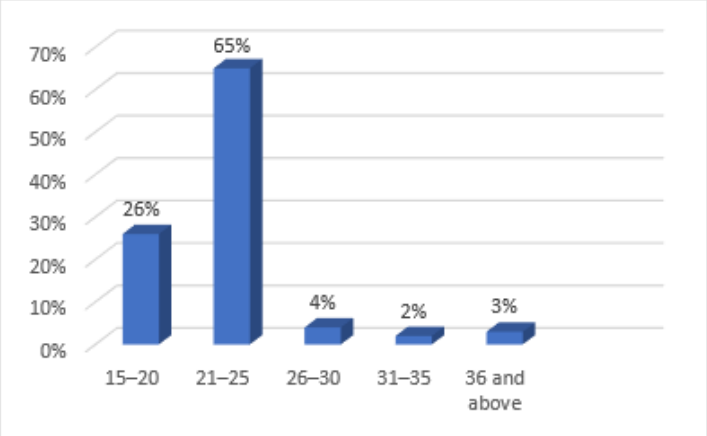

Figure 1: Age Group of Respondents

Table and figure 1 presents the age-wise distribution of the survey participants. The majority of respondents (65%) belonged to the 21–25 years' age group, indicating that young adults formed the largest segment of the survey population. This was followed by respondents aged 15–20 years (26%). Participants in the age groups of 26–30 years (4%), 31–35 years (2%), and 36 years and above (3%) constituted only a small proportion of the sample. The findings suggest that awareness and opinions regarding e-waste management were predominantly obtained from younger individuals, who are generally more exposed to electronic devices and digital technologies.

Table 2: Area from Where They Belong

Area	Percentage
Rural	46%
Urban	54%
Total	100

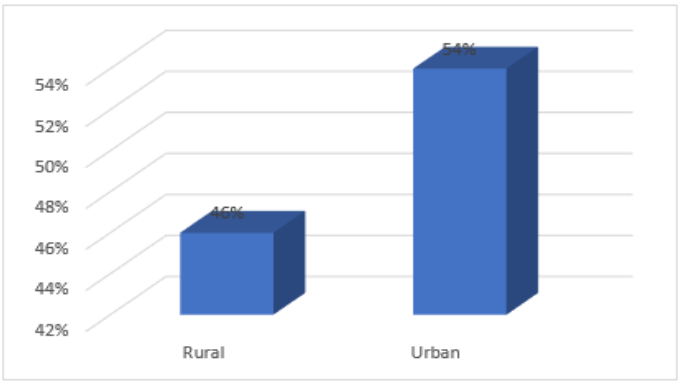

Figure 2: Area from Where They Belong

Table and figure 2 illustrates the residential background of the respondents. It was observed that 54% of the participants belonged to urban areas, while 46% were from rural areas. The relatively balanced representation from both urban and rural regions provides a broader perspective on the awareness and practices related to e-waste management across Assam. The slightly higher participation from urban areas may reflect increased access to electronic devices and greater exposure to information regarding environmental issues.

Table 3: District-wise Distribution of Respondents

District	Responses
Sonitpur	9%
Golaghat	23%
Dibrugarh	7%
Nagaon	5%
Jorhat	27%
Sivasagar	3%
Tinsukia	6%
Lakhimpur	4%
Majuli	6%
Dima Hasao	7%
Dibrugarh*	3%
Total	100

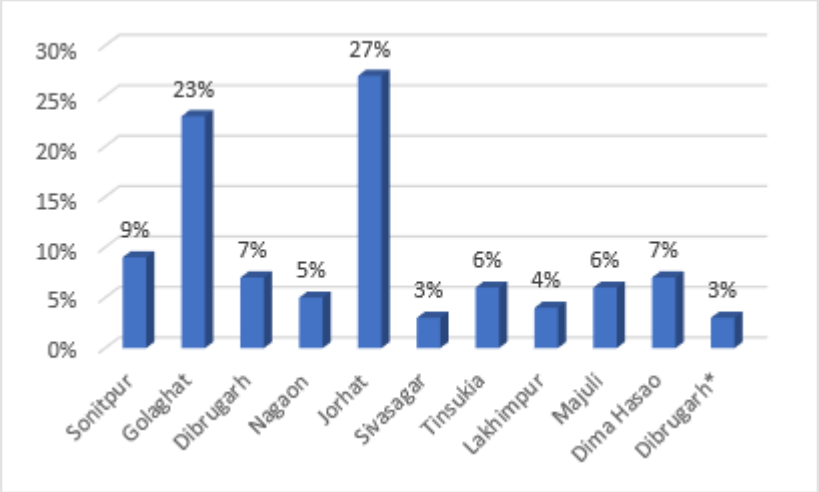

Figure 3: District-wise Distribution of Respondents

Table and figure 3 depicts the district-wise participation of respondents in the survey. Among all districts, Jorhat recorded the highest participation (27%), followed by Golaghat (23%), indicating that the majority of responses were concentrated in these districts. Moderate participation was observed from Sonitpur (9%), Dibrugarh (7%), Majuli (7%), and Tinsukia (6%), whereas Nagaon (5%), Lakhimpur (4%), Sivasagar (3%), and other districts contributed comparatively fewer responses. This distribution demonstrates that the survey covered respondents from multiple districts of Assam, thereby enhancing the representativeness of the findings.

Table 4: Educational Qualifications of Respondents

Educational Qualification	Percentage
Matriculation	15%
Higher Secondary	35%
Undergraduate	37%
Postgraduate	13%
Total	100

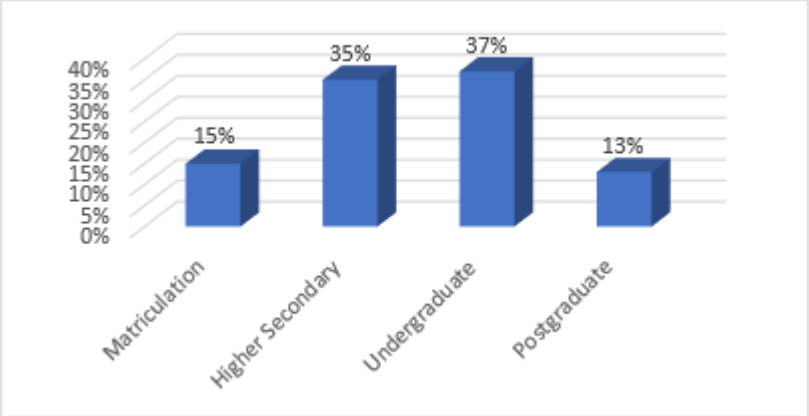

Figure 4: Educational Qualifications of Respondents

Table and figure 4 summarizes the educational background of the survey participants. The largest proportion of respondents were undergraduates (37%), followed closely by those with higher secondary education (35%). Respondents with matriculation-level education accounted for 15%, while postgraduates represented 13% of the total sample. These results indicate that the survey primarily captured the perspectives of educated individuals, particularly students and young adults pursuing higher education, who may possess relatively greater awareness of environmental concerns and e-waste management practices.

Table 5: Awareness of E-Waste among Respondents

Response	Percentage
Yes	86%
No	14%
Total	100

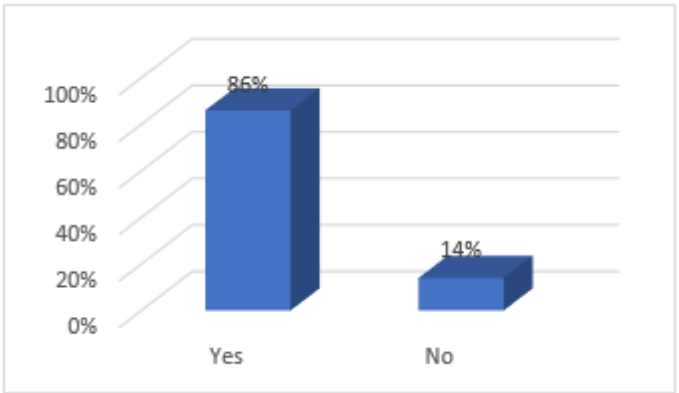

Figure 5: Awareness of E-Waste among Respondents

Table and figure 5 presents the level of awareness regarding e-waste among the survey respondents. The findings indicate that a majority of the participants (86%) had heard about e-waste, demonstrating a relatively high level of basic awareness among the surveyed population. However, 14% of the respondents reported that they had no knowledge of e-waste, highlighting the existence of an awareness gap within society. Although the results suggest that the concept of e-waste is familiar to most individuals, awareness does not necessarily translate into adequate understanding of its environmental impacts and proper disposal methods. Therefore, continuous educational initiatives and awareness campaigns are essential to improve public knowledge and encourage responsible e-waste management practices.

Table 6: Sources of Awareness about E-Waste

Source of Information	Percentage
Social Media	48%
Educational Institutions	23%
Television	18%
Newspapers	11%
Total	100

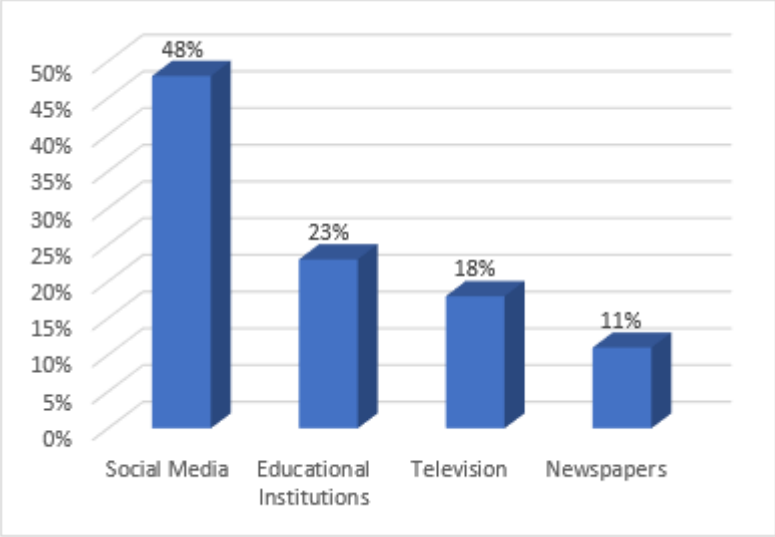

Figure 6: Sources of Awareness about E-Waste

Table and figure 6 illustrates the various sources through which respondents became aware of e-waste. The findings reveal that social media was the most influential source of information, accounting for 48% of the responses, indicating the growing role of digital platforms in disseminating environmental knowledge. This was followed by educational institutions (23%), which highlights the importance of

formal education in creating awareness among students and young adults. Television contributed 18%, while newspapers accounted for 11% of the responses. These results suggest that both traditional and digital media play significant roles in enhancing public understanding of e-waste issues. Therefore, awareness campaigns should utilize multiple communication channels, particularly social media and educational programmes, to effectively promote responsible e-waste management practices.

Table 7: Household Waste Generation and E-Waste Production

Parameter	Category	Percentage
Types	Biodegradable Waste	41%
	Non-biodegradable Waste	34%
	E-waste	25%
E-Waste Generated in Households	Batteries	43%
	Mobile Phones	29%
	Electronic Appliances	28%

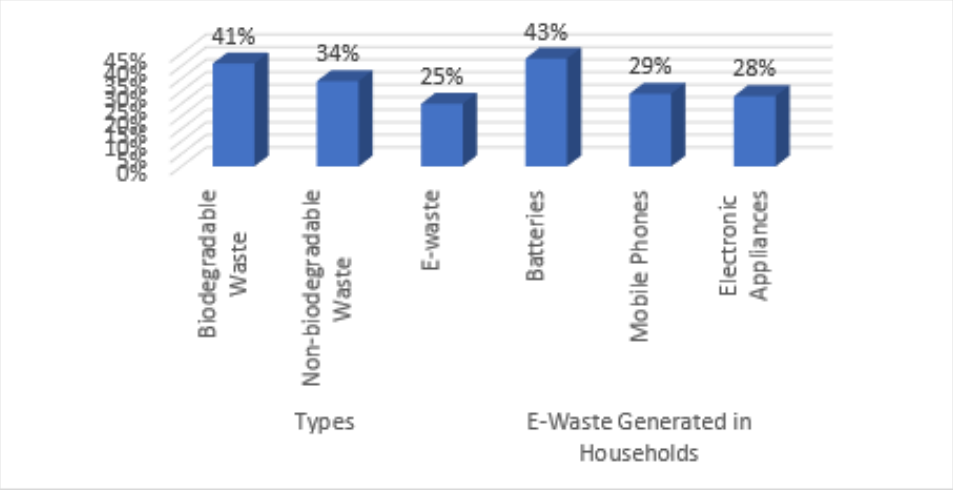

Figure 7: Household Waste Generation and E-Waste Production

Table and figure 7 presents the types of waste generated in households and the major categories of e-waste produced by the respondents. The results indicate that biodegradable waste constituted the largest share of household waste (41%), followed by non-biodegradable waste (34%), while e-waste accounted for 25% of the total waste generated. With respect to electronic waste, used batteries emerged as the most commonly generated e-waste item (43%), followed by mobile phones (29%) and electronic appliances (28%). These findings highlight that households contribute a notable amount of e-waste, particularly battery waste, which contains hazardous substances capable of causing environmental

contamination if disposed of improperly. Therefore, promoting source segregation, establishing dedicated collection systems, and encouraging safe recycling practices are essential for effective household e-waste management.

Table 8: Timing of Visiting Handcart Pilot for Waste Disposal

Frequency of Visiting Handcart Pilot	Percentage
Daily	13%
Weekly	50%
Monthly	29%
Rarely	8%
Total	100

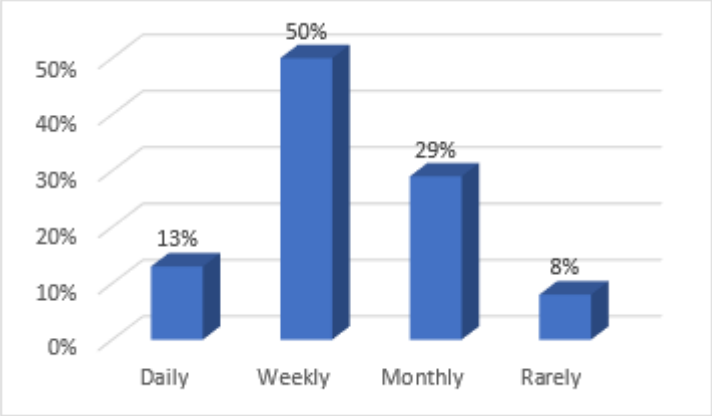

Figure 8: Timing of Visiting Handcart Pilot for Waste Disposal

Table and figure 8 illustrates the frequency with which respondents utilized handcart pilot services for waste disposal. The findings reveal that 50% of the respondents reported visiting the handcart pilot on a weekly basis, indicating that weekly collection was the most common practice. Approximately 29% disposed of their waste monthly, while 13% used the service daily. A smaller proportion of respondents (8%) reported that they rarely visited the handcart pilot. These results suggest that periodic waste collection systems are more prevalent among households. However, the limited frequency of disposal among some respondents highlights the need for more accessible and efficient waste collection services to ensure the safe management of household and electronic waste.

Table 9: Ways of Minimizing E-Waste

Method for Minimizing E-Waste	Percentage

Reduce	12%
Reuse	53%
Recycle	35%
Total	100

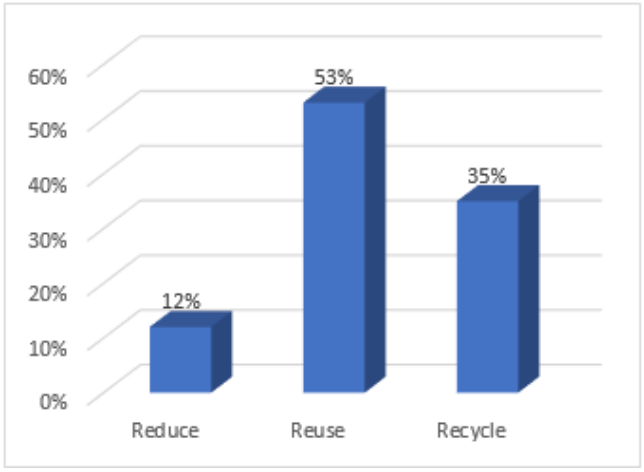

Figure 9: Ways of Minimizing E-Waste

Table and figure 9 presents the respondents' opinions regarding effective methods for minimizing e-waste generation. The findings indicate that reuse was considered the most effective approach by 53% of the respondents, suggesting that extending the lifespan of electronic products through repair and repeated use can significantly reduce waste generation. This was followed by recycling (35%), reflecting public recognition of the importance of recovering valuable materials from discarded electronic devices. Only 12% of respondents preferred reduction strategies, such as limiting the purchase of new electronic products. These results emphasize that promoting the principles of reuse and recycling can play a crucial role in achieving sustainable e-waste management and reducing the environmental burden associated with electronic waste.

Table 10: Public Suggestions for Improving E-Waste Management

Public Suggestions	**Percentage**
Awareness Campaigns and Education Programmes	55%
Proper Disposal and Collection Facilities	30%
Recycling and Reuse of E-Waste	15%
Total	100

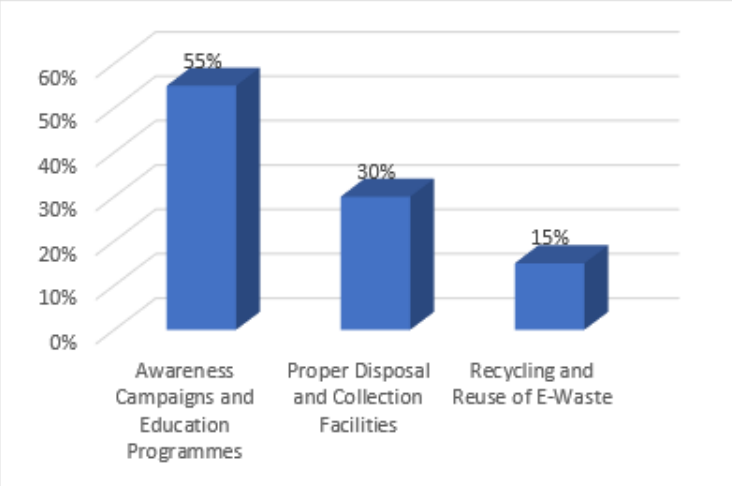

Figure 10: Public Suggestions for Improving E-Waste Management

Table and figure 10 presents the suggestions provided by respondents for improving e-waste management practices. The majority of the participants (55%) emphasized the importance of conducting awareness campaigns and educational programmes to enhance public understanding of the environmental and health impacts of e-waste and to promote responsible disposal practices. About 30% of the respondents suggested the establishment of proper collection and disposal facilities, indicating the need for improved infrastructure and accessible waste management services. Meanwhile, 15% recommended encouraging recycling and reuse activities to recover valuable materials and reduce the volume of electronic waste generated. These findings highlight that a combination of public awareness initiatives, strengthened waste management infrastructure, and sustainable recycling practices is essential for effective e-waste management in Assam.

5. DISCUSSION

The results of the present study revealed that although respondents exhibited a basic awareness of e-waste, their knowledge regarding environmentally sound disposal methods and recycling practices remained inadequate. The findings further indicated that households generate a noticeable amount of electronic waste, yet the absence of dedicated collection facilities and formal recycling infrastructure limits effective management. Similar trends have been observed in other developing regions, where rapid technological advancement and increasing consumption of electronic devices have outpaced the establishment of sustainable waste management systems. Previous studies have reported that insufficient public participation and weak implementation of e-waste policies significantly hinder effective waste management practices. [8] Developing countries continue to face major challenges associated with informal recycling sectors, resulting in environmental contamination and occupational health risks. It has also been emphasized that awareness programmes and stakeholder involvement are essential for improving collection efficiency and promoting responsible consumer behavior. [9] Moreover, the continuously rising generation of e-waste worldwide necessitates stronger regulatory frameworks and enhanced resource recovery initiatives to support circular economy objectives. [10] Recent evidence further suggests that integrating sustainable production practices, extended producer responsibility, and

consumer education can substantially reduce the environmental burden associated with electronic waste. [11] Therefore, a holistic approach involving policy enforcement, infrastructure development, technological innovation, and public engagement is necessary to address the growing e-waste challenge in Assam and ensure sustainable environmental management.

6. CONCLUSION

E-waste management has become a critical environmental challenge requiring immediate and coordinated action from governments, industries, and the public. The present study demonstrates that improper disposal of electronic waste contributes to environmental pollution, resource depletion, ecosystem degradation, and potential health risks. The survey findings indicate that while awareness of e-waste exists among many respondents, there remains a significant gap in understanding appropriate disposal methods and the long-term consequences of unsafe practices. The absence of adequate collection systems and recycling facilities further aggravates the problem, particularly in regions such as Assam. Therefore, strengthening regulatory frameworks, expanding formal recycling infrastructure, encouraging the principles of reduce, reuse, and recycle, and implementing targeted public awareness programmes are essential for achieving environmentally sound e-waste management. Adopting these measures will facilitate resource conservation, reduce environmental risks, and support the transition towards a sustainable and circular economy.

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