

E-WASTE AWARENESS, PERCEPTION AND DISPOSAL PRACTICES AMONG HIGHER-EDUCATION STUDENTS IN KOLKATA: A CASE STUDY OF TWO INSTITUTIONS

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Abstract: With rapid expansion of the nature of information and communication technologies the patterns of consumption of electronic items even evolved. This led to a substantial rise in electronic waste (e-waste) generation as well. As these discarded electrical and electronic equipments often contain hazardous substances, improper handling and disposal of them pose significant environmental and health risks. Therefore, generating awareness among young users is a critical component of sustainable e-waste management. The present study, thus, attempts to examine the awareness, perception and household disposal practices related to such e-waste among students pursuing higher education in Kolkata. Adopting a case study approach, primary data were collected from 90 students (Gokhale Memorial Girls' College and Aliah University) through a structured questionnaire using systematic random sampling. The collected data were analysed using descriptive statistics (frequency distributions and percentage analysis) to assess awareness, information sources, perceptions regarding e-waste-generating products, knowledge of potentially hazardous constituents and disposal practices. Further, graphical and regression-based analysis examined the relationship between selected socio-economic and family educational variables and perception of e-waste. The findings revealed that nearly 58 per cent of respondents were only rarely familiar with the term e-waste and it is through different mediums of media (40 per cent) that they got to know about it. Mobile phones were perceived as the most important e-waste-generating electronic product and the most common disposal practice was as household waste (30 per cent). Moreover, the analysis of socio-economic relationships revealed very weak linear associations between perception and parental educational attainment ($R^2 = 0.007$) and between perception and income ($R^2 = 0.0002$). Additionally, inadequate recycling facilities and collection systems were reported as major barriers to effective e-waste management. The findings, thus, highlight the need for strengthening environmental education, institutional awareness programmes and accessible collection and recycling mechanisms for promoting responsible e-waste management among young consumers.

Keywords - E-waste, Environmental awareness, Higher education, Hazardous waste.

I. INTRODUCTION

The rapid advancement of science and technology has transformed patterns of production, consumption, and contemporary society. Electrical and electronic equipments have become an integral part of everyday living, with computers, mobile phones, and televisions being increasingly used for communication, education, entertainment, and occupational purposes. Concurrently, accelerated technological innovation, evolving consumption patterns, and shortened product life cycles have contributed to a substantial rise in electronic waste, or e-waste (Robinson, 2009). E-waste is broadly understood as discarded electrical and electronic equipment encompassing computers, monitors, printers, scanners, televisions, mobile phones, batteries, and related components, that no longer is suitable for its intended use or has reached the end of its functional life (StEP Initiative, 2014). The European Union's Waste Electrical and Electronic Equipment (WEEE) Directive (2002) similarly characterises e-waste as equipment, along with its components and consumables, discarded as waste - a definition echoed in subsequent international and national regulatory frameworks, including India's E-Waste (Management) Rules (MoEFCC, 2016).

Globally, annual e-waste generation is estimated to be 20–50 million tonnes, constituting nearly 1-3 per cent of total urban waste production of which computers, mobile phones, and televisions alone contributed nearly 5.5 million tonnes in 2010, projected to reach 9.8 million tonnes by 2015. While e-waste accounts for nearly 8 per cent of urban waste in developed nations, the situation in developing countries remains equally concerning. The environmental significance of e-waste stems largely from its hazardous constituents such as lead, cadmium, and mercury, which pose serious environmental and health risks when electronic products are improperly dismantled or disposed of prior to adequate processing. Given inadequate recycling infrastructure the issue extends beyond waste generation to consumer awareness and responsible behaviour. In India, itself e-waste concerns, compounded by inadequate recycling infrastructure intensified following the IT revolution of the 1990s, with ten states generating 70 per cent of national e-waste (Borthakur & Govind, 2017). West Bengal ranked fifth. Moreover, students, as frequent device users and future decision-makers, represent a particularly relevant demographic unit, facing direct exposure to embedded toxins. Accordingly, the study focuses on higher-education students in Kolkata and examines their awareness, information sources, perceptions, and disposal practices concerning e-waste, alongside relevant socio-economic determinants.

II. REVIEW OF LITERATURE

The growing volume of electronic waste has drawn sustained attention from researchers concerned with environmental sustainability, public health, and waste management. Cairns (2005) highlighted the accelerating generation of waste electronic equipment driven by change in consumption patterns, emphasising the need for workable solutions across every stage of the product life cycle to safeguard consumers, public health, and the environment. Complementing this, Hawari and Hassan (2008) identified computers, televisions, stereos, copiers, fax machines, mobile phones, audio equipment, and batteries as major sources of e-waste generation, noting the presence of toxic constituents such as lead, whose environmental impact varies with local conditions and concentration. Awareness has emerged as a critical dimension of effective e-waste management. A perception study conducted among 200 students and 300 staff at the University of Kebangsaan (Babington et al., 2010) revealed a pressing need for greater awareness both within and beyond campus settings. Within the Indian context, Gupta (2015), surveying 200 students across colleges affiliated with Kurukshetra University in Ambala, found no significant variation in awareness levels across socio-economic backgrounds - suggesting that awareness gaps may be widespread rather than confined to specific social strata.

The literature also situates e-waste within a global equity framework. Saoji (2013) observed that developing nations have increasingly become dumping grounds for e-waste as a consequence of free trade, while Needhidasan et al. (2014) emphasised that the absence of adequate infrastructure for disposal and recycling poses a significant challenge for e-waste management in India. Rao (2014) further cautioned that without proper management systems, the environmental and health consequences of toxic metals and organo-compounds would become increasingly pronounced. In response, scholars have proposed multi-stakeholder solutions. Murthy (2014) advocated for corporate social responsibility (CSR) as a mechanism to share management responsibility alongside government intervention, while Wang et al. (2013) emphasised global take-back and treatment systems grounded in the 3R principle—reduce, reuse, recycle. Izatt (2012) additionally highlighted the recovery of toxic elements as essential to mitigating health and environmental threats.

Collectively, these literatures identify three interlinked dimensions of the e-waste problem: rising generation volumes, hazardous environmental and health implications, and the necessity of awareness-driven, multi-stakeholder management systems. However, limited attention has been paid to how young electronic consumers in specific urban contexts - such as Kolkata - understand, perceive, and act upon e-waste concerns, indicating a clear gap this study seeks to address.

III. STATEMENT OF THE PROBLEM

With continued digital penetration along with already prevalent high urban density, West Bengal has been identified among the major e-waste-generating states in India. Against this backdrop, students pursuing higher-education in Kolkata - the capital city of West Bengal, constitute a particularly relevant group of study, given their sustained engagement with electronic devices and potential influence on future consumption, disposal and sustainability practices. The present study, in this context, examines the level of awareness and perception of e-waste among higher-education students in Kolkata, along with the practices and underlying factors associated with its management.

IV. STUDY AREA

The study was conducted in Kolkata, West Bengal, with two higher-education institutions selected as study centres, namely Gokhale Memorial Girls' College, Bhawanipore (22°14'47"N, 88°22'24"E), and Aliah University, Park Circus (22°32'47" N, 88°22'10" E). The selection of these institutions enabled the inclusion of respondents from diverse socio-cultural backgrounds, thereby enhancing the representativeness of the sample.

V. OBJECTIVES OF THE STUDY

The present study aims

- To determine the level of awareness and familiarity regarding e-waste among higher-education students, along with the major sources through which such awareness is acquired.
- To examine students' perceptions regarding the principal electronic products contributing to e-waste generation and their associated hazardous constituents.
- To assess the common household disposal practices adopted for discarded electronic products and to identify the major perceived barriers to effective e-waste management.
- To analyse the relationship between selected socio-economic and family educational characteristics and respondents' perception of e-waste.

VI. DATABASE AND METHODOLOGY

The study adopted a descriptive, cross-sectional survey design, drawing on primary data collected from students pursuing higher education in Kolkata. A total sample of 90 respondents was selected from two institutions, comprising of 40 female students from Gokhale Memorial Girls' College and 50 students - 32 female and 18 male - from Aliah University, yielding a final composition of 72 female and 18 male respondents. Systematic random sampling was employed to select respondents from the population of students enrolled in the geography department of the selected institutions.

Primary data were collected through a structured questionnaire designed to examine respondents' familiarity with e-waste, duration of such familiarity, sources of information, perceptions regarding e-waste-generating electronic products, awareness of hazardous constituents, and household disposal practices, alongside questions pertaining to family educational background, economic status, and the occupational characteristics of the family breadwinner. The collected data were analysed primarily through descriptive statistical techniques, including frequency distributions and percentage analysis, while perceptions regarding hazardous constituents and selected relationships with socio-economic characteristics were further examined using graphical representation.

VII. RESULTS AND DISCUSSION

a) Socio-demographic profile of respondents

The sample comprised 90 students, of whom 72 were female and 18 were male. Female respondents therefore constituted 80 per cent of the sample. This predominance can be attributed to Gokhale Memorial Girls' College. The respondents, nevertheless, represented differences with regard to their native place, socio-economic status and cultural background.

In terms of social category approximately 52 per cent of respondents belonged to the general category, 37 per cent to OBC groups, 9 per cent to SC groups and 2 per cent to ST groups. Approximately 97 per cent of respondents were classified as above the poverty line. Regarding occupational structure, 50 per cent of the family breadwinners were engaged in the tertiary sector, followed by the primary (27 per cent) and secondary (23 per cent) sectors.

b) Familiarity with the concept of e-waste

Awareness of the term 'e-waste' was present among most respondents, though depth of familiarity varied. While 35.56 per cent reported common familiarity, 57.78 per cent had rare familiarity, and 6.67 per cent had no familiarity at all, as represented in figure 1 (Fig.1). Duration of awareness, as portrayed in figure 2 (Fig. 2) was similarly limited, with 57 per cent being familiar with the term for under two years, while 30 per cent reported being accustomed for two to four years, and only 13 per cent had the knowhow of the term for over four years - indicating that awareness, where present, was largely recent.

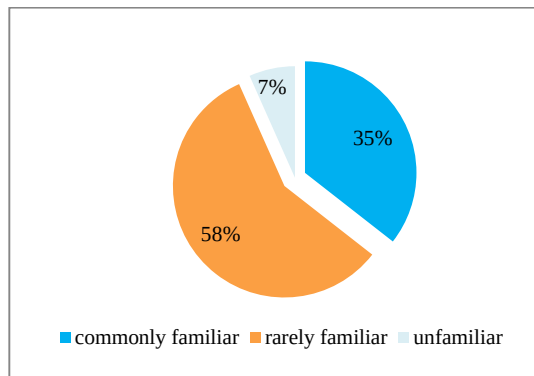


Fig. 1 Level of familiarity by share of respondents

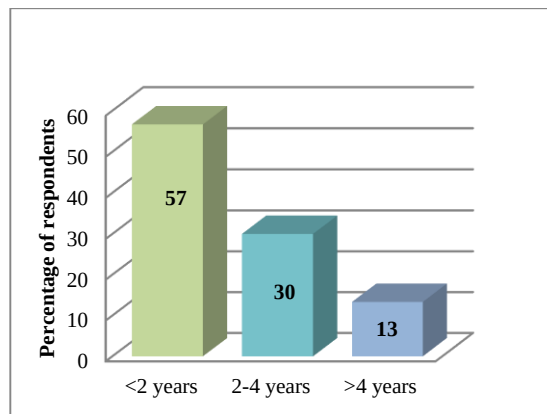


Fig. 2 Duration of knowhow by share of respondents

c) Sources of information

In figure 3 (Fig.3) it is clearly seen that media emerged as the most important source of information about e-waste (40 per cent) indicating its important role in generating awareness among young people, followed by educational institutions (26 per cent), peers (22 per cent), and parents (12 per cent). The limited contribution of family members, however, suggests that e-waste has not yet become a prominent household-level concern.

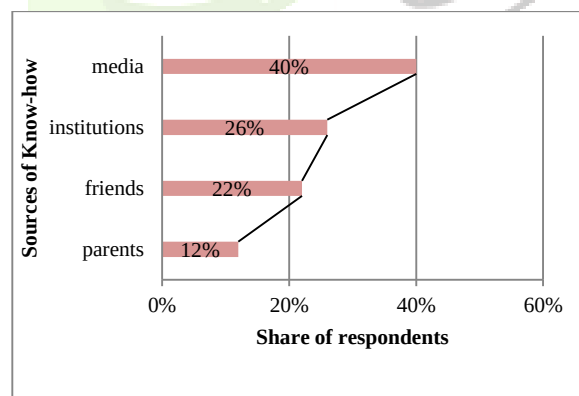


Fig. 3 Sources of know-how by share of respondents

d) Perception of major e-waste-generating electronic products

Mobile phones were identified by 53.3 per cent of respondents as major generators of e-waste, followed by televisions (approximately 37.8 per cent), laptops/computers (31 per cent), refrigerators (36.7 per cent) and irons (27.8 per cent), as outlined in Fig.4. This reflected both widespread use and rapid replacement cycles, particularly for mobile devices.

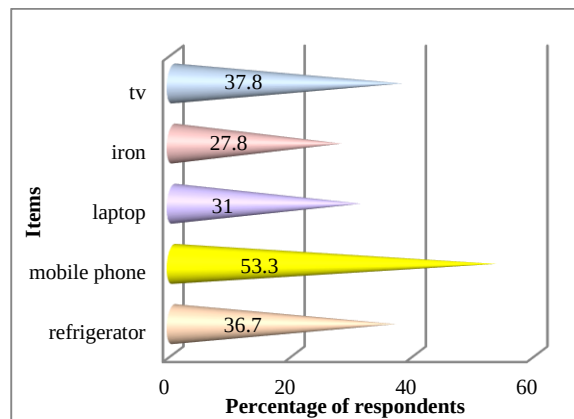


Fig. 4 Perception about major electrical gadgets as potential e-waste generators by share of respondents

e) Perceived causes of e-waste generation

As seen in Fig. 5, respondents attributed growth of IT hubs as the foremost cause (53.33 per cent), followed by dumping linked to free trade (30 per cent) and retailer-driven exchange schemes (16.67 per cent), reflecting that students primarily associate e-waste with technological and IT-sector expansion.

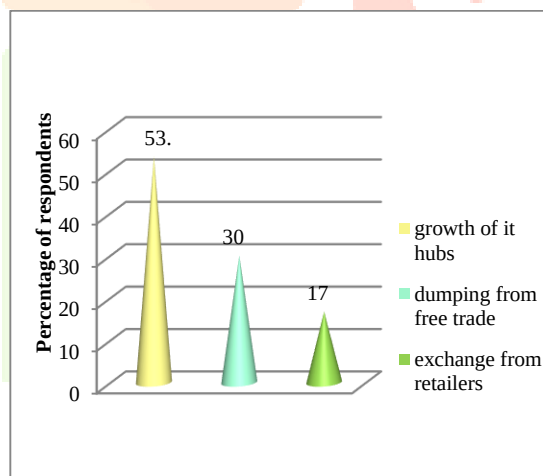


Fig. 5 Possible causes for e-waste generation by share of respondents

f) Perception of hazardous constituents

Among listed constituents, cadmium (82 per cent) and mercury (80 per cent) were most frequently recognised to be present in electronic products (Fig. 6), followed by lead (60 per cent), copper (54 per cent), zinc (50 per cent), selenium (46.7 per cent) and chromium (43 per cent). When asked specifically to identify hazardous substances, cadmium (60 per cent) and mercury (55.6 per cent) topped the list, followed by lithium (37.8 per cent) chromium (35.6 per cent) and others.

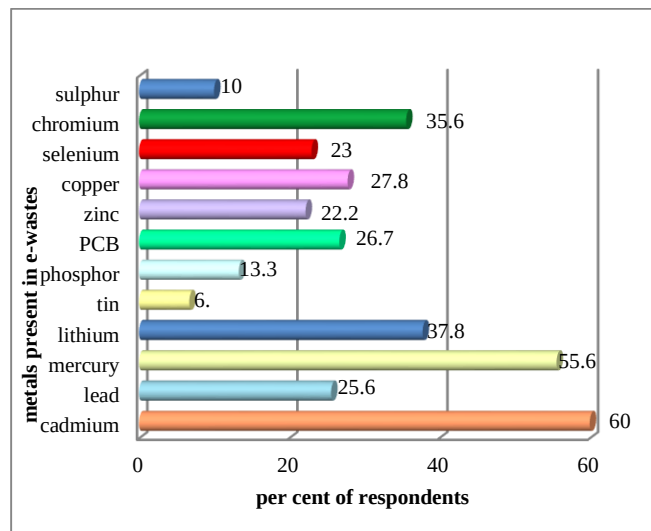


Fig.6 Perceived hazardousness of metals in e-waste by share of respondents'

The study further compared respondents' perceptions with UN reference rankings (Table 1). Though, mercury occupied the first position in the comparative ranking, differences were observed between the perceived and referenced ranking of cadmium, chromium and lead suggesting uneven understanding of comparative hazard levels despite general awareness of these constituents.

Table 1: Ranking of hazardous metals in electrical and electronic items

Hazardous metals	Rank (U.N)	Average rank from perception
Mercury	1	1(5.75)
Cadmium	2	4(4.625)
Chromium	3	2(4.75)
Lead	4	3 (4.875)

Source: U.N. Report, Institute of Advanced Studies of Sustainability (2015); Primary survey 2019

g) Educational and economic background of the family

An examination of family educational attainment reveals a discernible urban–rural divide among respondents. Approximately 76 per cent of urban family members had received education at the higher-secondary level or above with 46.1per cent of the urban respondents' family members attaining graduation-level education and 26.6 per cent being educated up to the higher secondary level, reflecting a comparatively stronger educational base within urban households. In contrast, family members of rural respondents were concentrated at considerably lower levels of educational attainment, with 20.3 per cent educated only up to the upper-primary level, 14.5 per cent up to the primary level and 15.9 per cent were illiterate. Only about 19 per cent of rural family members had attained education at the higher-secondary level or beyond, compared to roughly 76 per cent among their urban counterparts. This marked disparity suggests that the educational environment within the household - often regarded as a primary source of early learning and awareness differed substantially between the two groups, potentially shaping the extent to which environmental awareness, including that of e-waste, was cultivated at home. Despite these observed differences in educational background, regression analysis did not establish a strong statistical relationship between parental education and respondents' perception of hazardous e-waste constituents. The relationship (Fig.7) between the average number of years of parental education and perception scores was negligible ($R^2 = 0.0072$), with the near-flat regression line indicating no meaningful linear association.

However, this educational disparity did not correspond to a comparable difference in economic status, as the overwhelming majority of respondents (97 per cent) were classified as being above the poverty line. With respect to occupational structure, family breadwinners were predominantly engaged in the tertiary sector (50per cent), followed by the primary (27per cent) and secondary (23per cent) sectors, indicating a workforce profile weighted towards service-oriented occupations. Similarly, an equally weak relationship

(Fig.8) between family income and perception scores ($R^2 = 0.0002$), is demonstrated reinforcing that economic status does not substantially explain variation in awareness levels either.

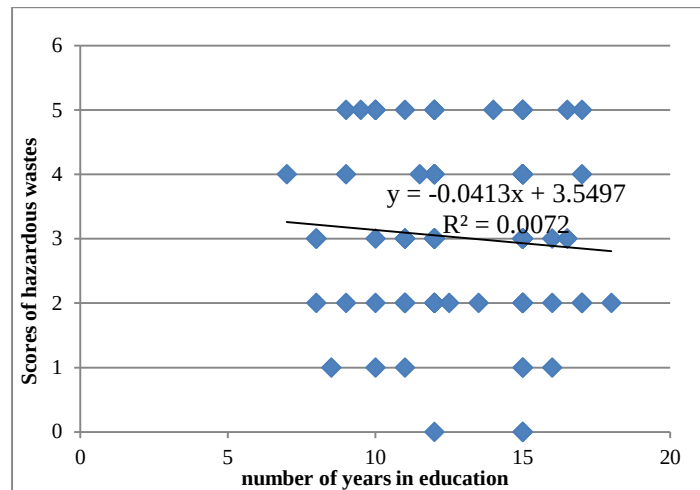


Fig. 7 Relationship between average parental level of education and perception about hazardous e-wastes

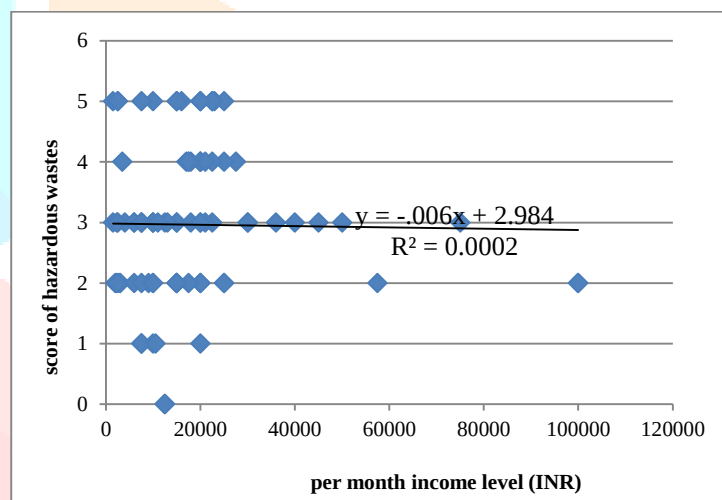


Fig.8 Relationship between average income of the family and perception of hazardous wastes

Taken together, these findings suggest that while family educational and occupational background may shape the broader household environment in which awareness is nurtured, neither parental education nor income emerges as a statistically robust predictor of individual perception regarding hazardous e-waste constituents.

h) Disposal practices

These findings (Fig. 9) reveal a marked gap between environmental awareness and the adoption of appropriate disposal behaviour. The most common practice was disposal with household (hh) waste, as reported by 30 per cent of respondents. Storage of discarded electronic items at home was reported by 28 per cent. Approximately 21 per cent reported selling such products to second-hand dealers, while the others revealed selling to scrap dealers (13 per cent) and street disposal (8 per cent) as common practice of disposing.

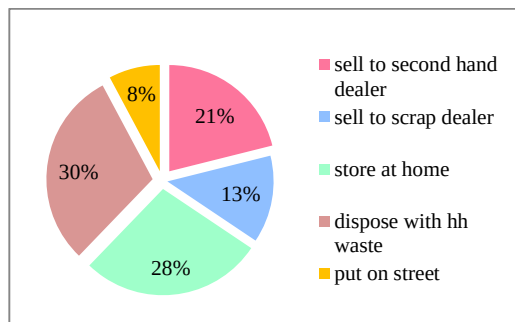


Fig. 9 Common disposal practices by share of respondents

i) Perceived barriers to e-waste management

Inadequate recycling infrastructure was identified as the primary barrier (31 per cent), followed by the absence of a defined collection system (25 per cent), lack of policy (22 per cent), and expensive nature of managing e-waste (13 per cent) with 9 per cent of respondents expressing no opinion in Fig.10. These findings suggest that institutional and infrastructural gaps were perceived to be more significant obstacles than cost considerations alone.

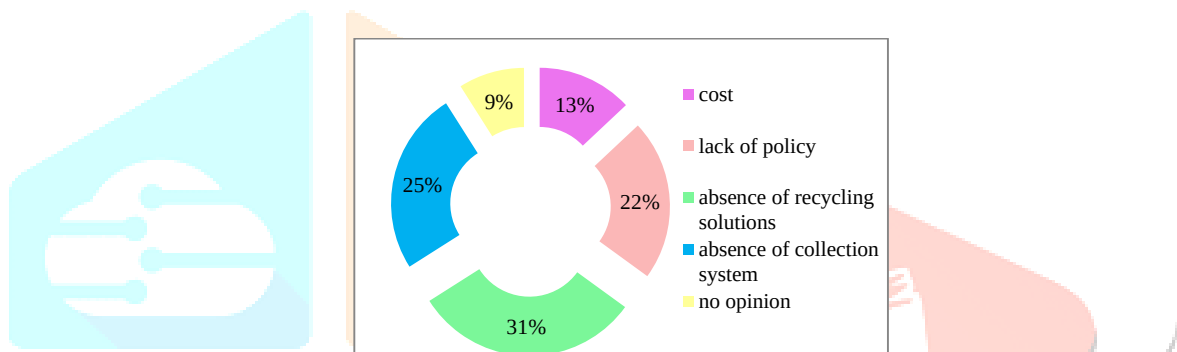


Fig. 10 Perception on barriers to e-wastes management by share of respondents

The findings indicate that while awareness of e-waste existed among most respondents, this familiarity remained largely superficial, suggesting that the concept has entered young consumers consciousness without becoming a deeply understood environmental issue. It is found that the influence of media in shaping environmental perception and awareness among youth has been overwhelming and the limited household-level engagement suggests e-waste is yet to become a routine domestic concern. The prominence of mobile phones among perceived e-waste-generating products is even consistent with their widespread use and rapid technological replacement. Young consumers are particularly familiar with mobile phones, and their perception of mobile phones as an important source of e-waste indicates an understanding of the relationship between consumption, technological change and waste generation. However, discrepancies between respondents' perceptions on recognition of hazardous constituents in electronic products and their technical rankings, suggest that awareness does not necessarily equate to accurate understanding of relative risk. Most notably, disposal practices still continue to favour informal and household-based methods revealing a persistent gap between knowledge and behaviour, attributable largely to inadequate recycling and collection infrastructure rather than individual attitude alone.

Further, examination of socio-economic factors produced an additional important finding. Although differences were observed in family educational backgrounds and socio-economic characteristics, the reported relationships between perception scores and parental educational ($R^2 \approx 0.0072$) and family income ($R^2 \approx 0.0002$), established by regression analysis, were weak. While rural respondents reported comparatively lower family educational attainment than urban respondents, neither educational background nor economic status explained meaningful variation in perception scores. Therefore, awareness should not be assumed to be determined solely by economic status or parental education. Media exposure, institutional education, peer interaction and access to information may also contribute substantially to awareness.

VIII. RECOMMENDATIONS

Based on the findings, few measures are recommended to strengthen e-waste management among young consumers. To raise greater awareness among them, educational institutions should organise periodic awareness workshops stressing the principles of reduce, reuse and recycle and integrate basic principles of e-waste management into environmental and value-based curriculum. Colleges and universities may further establish designated collection points for obsolete equipment while encouraging students to prioritise repair, reuse, and responsible upgrading over premature replacement. Complementing these institutional efforts, active corporate participation through take-back mechanisms and recycling initiatives as part of social responsibility in coherence with the existing regulatory frameworks is pivotal for comprehensive management.

IX. LIMITATIONS OF THE STUDY

The findings of this study warrant cautious interpretation in view of certain limitations. The sample, restricted to 90 students from two institutions in Kolkata, precludes generalisation to the broader population of higher-education students across the city or state. Furthermore, since respondents were drawn exclusively from Geography departments, their environmental awareness may not be representative of students from other disciplines. The reliance on self-reported data also raises the possibility of divergence between stated perceptions and actual behaviour. However, the study offers valuable exploratory evidence on e-waste awareness among young educated consumers.

X. CONCLUSION

The growing use of electronic equipment has rendered e-waste to be a pressing environmental concern. This study while examining awareness, perception, and disposal practices among 90 higher-education students across two institutions in Kolkata revealed that while most respondents possessed some familiarity with e-waste, this knowledge was largely recent and limited in depth, with media serving as the principal information source, followed by educational institutions and peers. Mobile phones, televisions, and laptops were widely perceived as major e-waste generators, and respondents demonstrated notable awareness of hazardous constituents - particularly cadmium, mercury, and lead - though discrepancies with referenced hazard rankings suggest awareness does not translate into comprehensive technical understanding. Disposal practices remain concerning, with household disposal and home storage prevailing over formal recycling channels, a gap which respondents themselves attributed to inadequate infrastructure. Notably, socio-economic status and parental education showed negligible association with perception scores, reiterating e-waste awareness as a multidimensional issue. Hence, addressing this challenge requires integrating environmental education with accessible institutional systems, supported by coordinated action among different stakeholders (educational institutions, government, producers and consumers).

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