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E-WASTE AWARENESS AND DISPOSAL PRACTICES AMONG HIGHER EDUCATION STUDENTS IN KATHMANDU VALLEY, NEPAL

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ABSTRACT
Electronic waste (e-waste) is a rapidly growing global challenge, with significant management deficiencies in developing countries like Nepal. While studies have examined general consumer behavior, a critical gap exists in the quantitative assessment of the youth demographic most engaged with technology. This study addresses this by providing the first comprehensive quantitative analysis of e-waste awareness, disposal practices, and barriers among higher education students in Nepal. A cross-sectional survey of 400 students in Kathmandu Valley revealed a significant attitude-behavior gap: while 65.5% were aware of e-waste and 96.2% agreed proper disposal is important, 42.0% admitted to discarding electronics in regular garbage, and only 12.2% used recycling channels. A novel and counterintuitive finding was that Master's students had significantly lower awareness than Bachelor's students (p=0.022), suggesting a potential generational shift in education. The primary barriers were lack of access to recycling programs (34.0%) and inconvenience (29.0%). Crucially, 82.5% expressed willingness to participate if convenient options were available. These findings provide unprecedented empirical evidence of the disconnect between knowledge and action, highlighting the urgent need for improved infrastructure and targeted educational policies to leverage positive student attitudes for sustainable e-waste management in Nepal.

Keywords: *electronic waste, disposal behavior, environmental awareness, higher education, Nepal, recycling barriers, attitude-behavior gap*

INTRODUCTION
Electronic waste (e-waste) – discarded electrical and electronic equipment – is among the fastest-growing waste streams worldwide. Global e-waste generation reached an unprecedented 53.6 million metric tons in 2019 (equivalent to 7.3 kg per capita) (Forti et al., 2020) and was estimated at 62 million tons by 2022 (Balde et al., 2024). Less than a quarter of this e-waste is formally collected or recycled (Forti et al., 2020). E-waste

contains myriad hazardous substances (e.g., lead, mercury, cadmium, flame retardants) that can leach into soil, water, and air if improperly handled (Robinson, 2009). Improper recycling (e.g., open burning, acid baths, informal disassembly) can release toxic pollutants, posing serious environmental and human-health risks (Kharel et al., 2022).
Vulnerable populations – especially women and children – in low- and middle-income countries face the greatest health threats from e-waste due to weak regulations and recycling infrastructure (WHO, 2021).
Nepal is confronting a rapidly expanding e-waste challenge. The Global E-waste Monitor (2024) reports Nepal generates about 41.5 million kg per year (≈41.5 kt), or ~1.4 kg per capita, one of the lowest per-capita rates in South Asia (Balde et al., 2024). However, formal e-waste management is minimal: the Government of Nepal has yet to enact comprehensive e-waste legislation, and most waste is handled informally (Adhikari et al., 2022). A recent review noted that Nepal's e-waste (28 kt/year) is largely processed by unregulated collectors, leading to environmental contamination and health threats (Parajuly et al., 2018). Surveys in Nepal (e.g., Rauniyar, 2024) find that while many consumers are aware of e-waste issues, they often lack knowledge of formal recycling options and instead sell or repair obsolete devices (Rauniyar, 2024).
Higher-education students are a critical demographic for sustainable e-waste management: they are intensive technology users, and as future leaders, their attitudes may shape policy and behavior. Previous studies in Asia and elsewhere have documented mixed awareness among youth (e.g., Shajil et al., 2022; Adeel et al., 2023). However, a significant research gap persists in the Nepalese context. Existing research has primarily focused on the macro-level informal recycling sector or general consumer practices (Parajuly et al., 2018; Adhikari et al., 2022), leaving a lack of empirical, quantitative data on the awareness and practices of the educated youth—a key group for driving future change. To our knowledge, no study has yet provided a quantified, comprehensive assessment of e-waste knowledge and disposal behavior specifically among Nepali university students. This study aims to fill this gap by surveying higher-education students in Kathmandu Valley. Its novelty lies in establishing the first baseline of awareness and practice for this demographic, investigating the prevalence of the attitude-behavior gap, and identifying the specific, ranked barriers that prevent responsible disposal. The results will provide crucial evidence to inform policymakers and educators in designing effective interventions. (Parajuly et al., 2018).

MATERIALS AND METHODS

A cross-sectional survey was conducted among 400 students at various colleges and universities across the Kathmandu Valley during 2024. Participants were recruited via a convenience sampling approach; surveys were distributed in common areas (libraries, cafeterias) and classrooms to ensure a diversity of academic streams. Eligibility required completion of higher secondary education and current enrollment in a bachelor's or master's program. The questionnaire (see Supplement) was adapted from prior studies

(Sadik, 2017; Adeel et al., 2023) and included items on (i) demographic background (age, gender, academic level and field, locality), (ii) e-waste awareness (ever heard of term, understanding of meaning, information sources), (iii) disposal practices (ever discarded electronics in garbage, usual methods – sell, donate, recycle, throw away, etc.), (iv) knowledge of environmental and health impacts, (v) attitudes (importance of correct disposal), (vi) participation in e-waste programs and how they learned of them, and (vii) barriers to proper disposal and willingness to participate if convenient. Responses were mostly multiple-choice (Yes/No or categorical).

Participation in this study was entirely voluntary, and informed consent was obtained both verbally for in-person surveys and electronically for the online questionnaire. No personal identifiers were collected, and all responses were treated with strict confidentiality. The study posed minimal risk to participants, and the research protocol received approval from the Human Research Ethics Committee (HREC) of Prince of Songkla University.

Data was entered and analyzed using R (version 4.2). Descriptive statistics (frequencies, means) summarized respondent characteristics and responses (Tables 1–3). Cross-tabulations were performed for key variables, with chi-square tests of association.

Logistic regression models were used to examine predictors of binary outcomes (e.g., "Heard of e-waste" vs not). Specifically, we regressed awareness (Yes=1/No=0) on age, gender, academic level (Master's vs Bachelor's), and academic stream. Odds ratios (OR) with 95% confidence intervals (CI) were computed. All p-values were two-tailed with significance set at 0.05.

RESULTS AND DISCUSSION

Demographics

The 400 respondents averaged 22.4 years (SD=3.9); ages ranged 18-32 (Figure 1). Female students slightly outnumbered males (54.25% vs 45.75%; Figure 2, Table 1). Most (90.5%) were pursuing Bachelor's degrees, with 9.5% Master's students. The fields of study included Management (36.5%), Science & Technology (20.8%), Engineering (14.8%), Humanities/Social Sciences (15.8%), Health Sciences (7.8%), and Education (4.5%) (Figure 3, Table 1). Students came from diverse Kathmandu Valley localities (not tabulated).

Table 1. Demographic characteristics of survey respondents (N=400)

Characteristic	**Data**
Age (mean ± SD)	22.4 ± 3.9
Age range	18-32
Gender	
Male	183 (45.75%)
Female	217 (54.25%)
Academic Level	
Bachelor's	362 (90.5%)

Master's	38 (9.5%)
Academic Stream	
Management	146 (36.5%)
Science & Technology	83 (20.8%)
Engineering	59 (14.8%)
Humanities & Social Sciences	63 (15.8%)
Health Sciences	31 (7.8%)
Education	18 (4.5%)

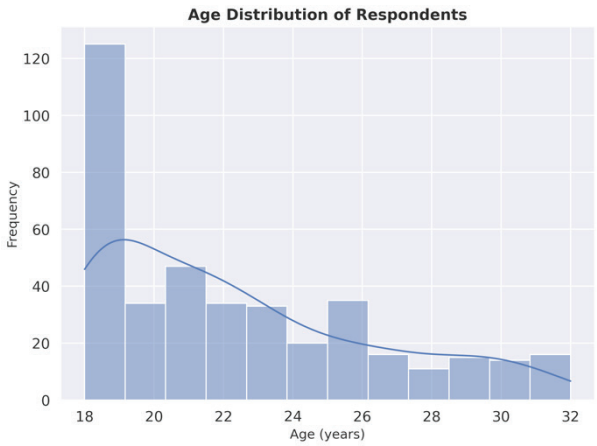

Figure 1
Age Distribution of the 400 survey respondents

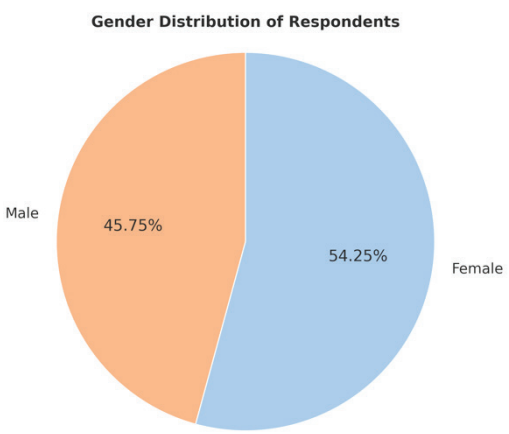

Figure 2

Gender distribution of respondents

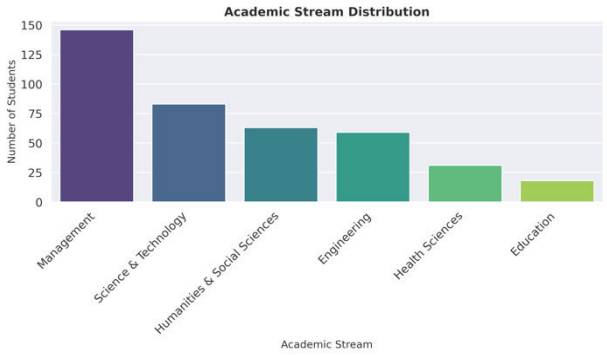

Figure 3

Academic stream distribution

E-Waste Awareness and Knowledge

Most students had encountered the term "e-waste." 65.5% reported having heard of e-waste, while 34.5% had not (Figure 4, Table 2). Similarly, 63.8% said they know what e- waste means (i.e., understand its definition), compared to 36.2% who did not (Table 2). Thus, roughly two-thirds of respondents had basic awareness. Of those who had heard the term, common sources were school/university (32%), followed by social media (25%), friends/family (20%), online search (15%), and other media (8%) (not shown). A large majority (86.2%) reported they had ever been informed about e-waste's harmful environmental effects (Yes vs No, Table 2). Likewise, 83.0% were aware of health hazards associated with e-waste (Yes vs No).

Table 2. E-waste awareness and attitudes among respondents (N=400)

Awareness/Attitude	**Frequency (%)**
Heard of e-waste	
Yes	262 (65.5%)
No	138 (34.5%)
Know what e-waste means	
Yes	255 (63.7%)
No	145 (36.2%)
Informed of environmental harm	
Yes	345 (86.2%)
No	55 (13.8%)
Aware of health hazards	
Yes	332 (83.0%)
No	68 (17.0%)
Agree correct disposal important	
Yes	385 (96.2%)
No	15 (3.8%)

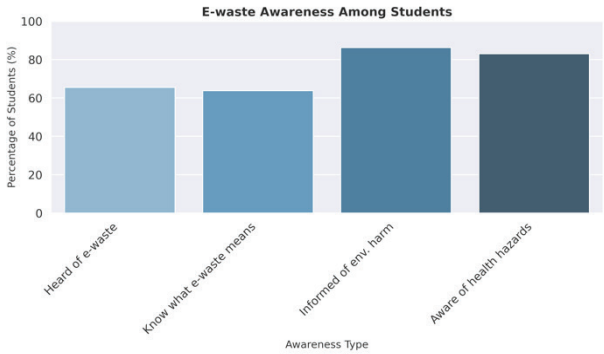

Figure 4

Percentage of students who reported having heard of the term 'e-waste'

When asked about specific impacts, 54.0% selected "all of the above" for environmental impacts (contamination, wildlife harm, greenhouse gases), indicating broad recognition of multiple risks. Similarly, 49.8% chose "all of the above" for health hazards (cancer, birth defects, respiratory problems). In terms of attitudes, 96.2% agreed that it is important to dispose of electronic devices correctly (Table 2), reflecting very positive attitudes toward proper e-waste management.

Disposal Practices and Behaviors

Despite high awareness, a substantial fraction of students had disposed of electronics improperly. Overall, 42.0% reported having ever thrown an electronic device in the garbage, while 58.0% had never done so (Table 3). When asked about their usual disposal methods, the most common response was selling unwanted devices (37.2% of students, e.g., to scrap dealers or secondhand markets) (Table 3, Figure 5, Figure 6). The next most frequent option was donating to others (22.8%). Throwing away was indicated by 20.0% of respondents, and only 12.2% reported recycling their devices. A few students kept devices at home (4.0%) or used informal collection (3.8%). Figures 5 and 6 illustrate these disposal patterns.

Table 3. E-waste disposal practices and participation (N=400)

Practice/Participation	**Frequency (%)**
Thrown e-device in garbage	
Yes	168 (42.0%)
No	232 (58.0%)
Usual disposal method	
Sell them	149 (37.2%)
Donate them	91 (22.8%)
Throw them away	80 (20.0%)
Recycle them	49 (12.2%)
Keep them at home	0 (0.0%)
Other (informal collector)	15 (3.8%)

Taken part in e-waste program	
Yes	81 (20.2%)
No	319 (79.8%)
Obstacles to proper disposal	
Lack of access to recycling programs	136 (34.0%)
Inconvenience	116 (29.0%)
Lack of knowledge	78 (19.5%)
Cost	46 (11.5%)
Too little e-waste	0 (0.0%)
Willing to participate if convenient	
Yes	330 (82.5%)
No	13 (3.2%)
Not sure	57 (14.2%)

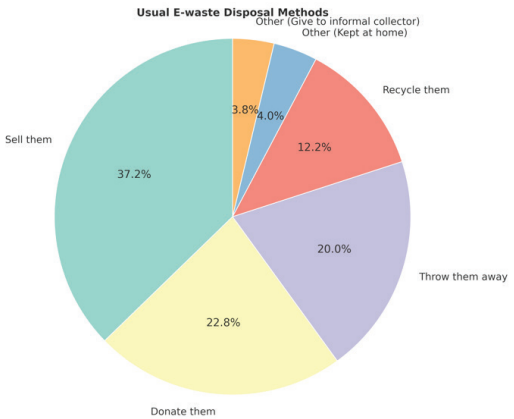

Figure 5

Usual E-waste disposal methods (percentage)

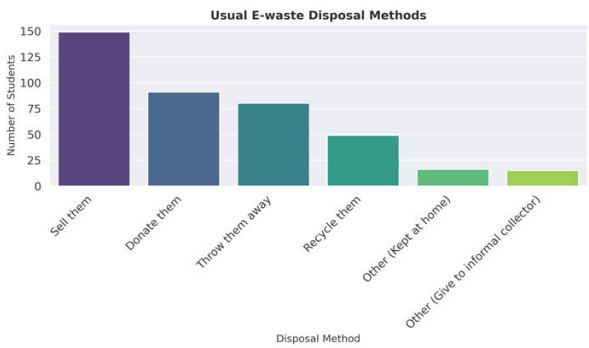

Figure 6

Usual E-waste disposal methods (barchart)

Only 20.2% of students had ever participated in a formal e-waste recycling/disposal program (Yes vs No, Table 3). Among those 81 participants, how they learned of these programs was evenly split: online search (29.6%), social media (22.2%), friends/ family or school (both 19.8%), and local notices (4.9%). Thus, digital channels (social media, internet) and personal networks were key sources of information.

Barriers to proper disposal were also reported (Table 3, Figure 7). The most cited obstacle was lack of access to recycling programs (34.0% of respondents), followed by inconvenience (29.0%), lack of knowledge (19.5%), and cost (11.5%). Only 3.0% reported "too little e-waste" as an excuse. In short, students noted practical and informational hurdles to recycling, consistent with findings elsewhere (Adeel et al., 2023).

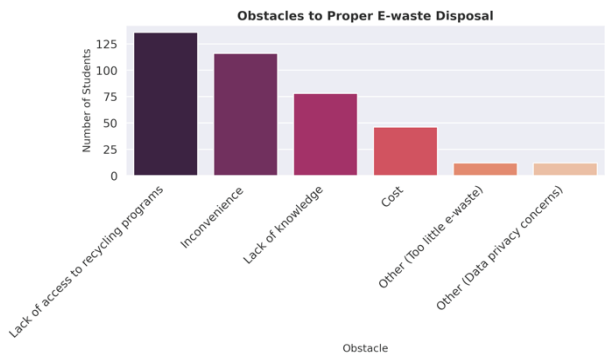

Figure 7

Obstacles to proper E-waste disposal

Notably, willingness to act was high: 82.5% said they would willingly participate in an e- waste recycling program if one were conveniently accessible (yes vs no/not sure) (Figure 8). Only 3.2% outright said "No," and 14.2% were "Not sure." This gap between willingness and current participation suggests that improving accessibility could greatly boost proper e-waste disposal.

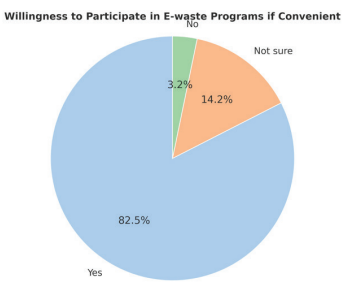

Figure 8

Willingness to participate in E-waste program if convenient

Inferential Analysis

We tested for associations between awareness and demographic factors. By chi-square test, there was no significant gender difference in having heard of e-waste ($\chi^2(1)=0.095$, $p=0.758$), nor by field of study ($\chi^2(5)=2.687$, $p=0.748$). However, there was a significant association with level of study: Master's students were less likely to have heard of e-waste than Bachelor's students ($\chi^2(1)=5.254$, $p=0.022$; Table 4). This result was confirmed in logistic regression.

Table 4 presents the chi-square tests for the outcome awareness of the term "e-waste." Age and gender were not significant predictors. Being a Master's student (versus Bachelor's) was associated with significantly lower odds of awareness (OR=0.46, 95% CI 0.23–0.91, $p=0.025$). None of the academic disciplines (engineering, management, etc.) showed significant effects (all $p>0.05$). Thus, the strongest predictor of awareness in our model was level of study, possibly reflecting recent undergraduate curricula that emphasize environmental topics.

Table 4. Chi-square tests of association for e-waste awareness

Analysis	Statistic	p-value
Chi-square Tests		
Awareness by Gender	$\chi^2(1) = 0.095$	0.758
Awareness by Academic Level (Bachelor's vs Master's)	$\chi^2(1) = 5.254$	0.022
Awareness by Academic Stream	$\chi^2(5) = 2.687$	0.748

For the outcome having ever thrown a device in the garbage, logistic regression indicated a non-significant trend: engineering and health-science students showed higher odds (OR≈2.9 and 2.8, respectively) of disposal in garbage, but these did not reach statistical significance ($p\approx0.07$–0.11). In general, no strong demographic predictors of improper disposal emerged in our models, suggesting that this behavior is widespread across groups. Figure 9 shows the percentage of students aware of e-waste by academic stream, while Figure 10 displays the percentage who have thrown e-devices in garbage by academic stream. Figure 11 presents the odds ratios from the logistic regression model predicting awareness, showing that Master's level is the only significant predictor (with lower odds of awareness).

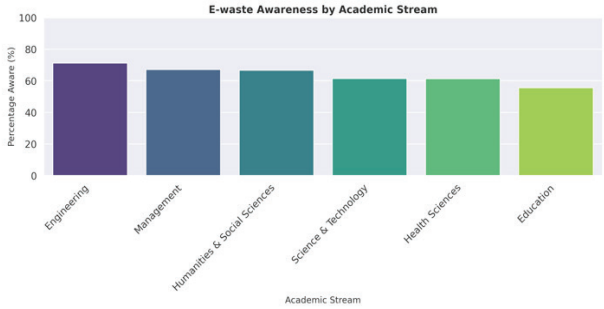

Figure 9

Bar chart showing awareness of e-waste across different academic streams

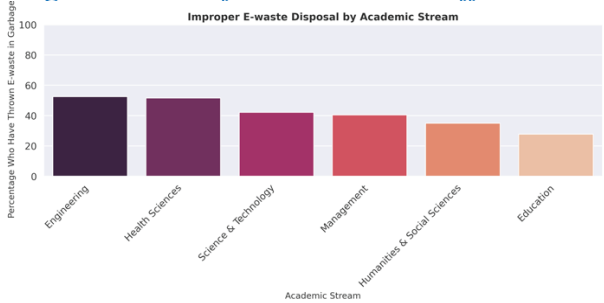

Figure 10

Improper e-waste disposal by academic streams

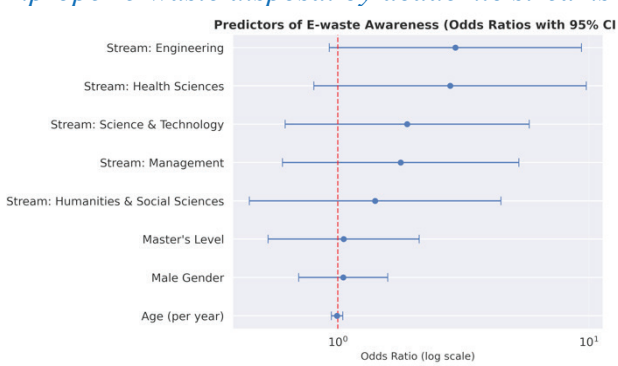

Figure 11

Predictors of E-waste awareness (odds ratios with 95% CI)

DISCUSSION

The awareness levels are comparable to or slightly higher than those reported in other studies of educated youth in Asia. For instance, our finding of 65.5% awareness is somewhat lower than the 76% of consumers with good e-waste knowledge reported by Shajil et al. (2022) in Tamil Nadu, a difference that may reflect varying national educational policies or media coverage levels. Similar to the qualitative findings of Adeel et al. (2023) in Pakistan, which noted low overall awareness except among engineering majors, our study found that academic stream was not a significant predictor, though engineering and health-science students showed a non-significant trend towards higher improper disposal rates.

The most intriguing finding was that Master's students demonstrated significantly lower awareness than Bachelor's students. This counterintuitive result contradicts the assumption that higher academic attainment correlates with greater environmental knowledge. We theorize that this may reflect a curricular modernization effect; recent undergraduate programs in Nepal may have integrated contemporary topics like e-waste and sustainability more effectively into their core curricula, whereas Master's programs, often more specialized, might not reiterate these foundational environmental concepts. Alternatively, it could be a cohort effect where younger students are more exposed to environmental messaging through social media and recent public campaigns.

Despite reasonable awareness, actual disposal practices were suboptimal. Over 40% of students admitted to having thrown devices into household garbage, and only 12% reported recycling. Instead, most students either sold used devices or donated them to others. Selling to scrap dealers was the most common (37%), a pattern noted in similar Nepalese contexts (Rauniyar, 2024) and in Tamil Nadu (Shajil et al., 2022). That finding suggests a persistent reliance on informal markets. Only one-fifth had ever participated in any organized e-waste program. Nevertheless, most students expressed willingness to do so if convenient, indicating a readiness to improve their behavior if systemic barriers are removed.

The principal barriers identified – lack of convenient recycling facilities and general inconvenience – echo those found elsewhere. Prior qualitative work in Pakistan similarly noted "non-availability of disposal facilities" and "nostalgic attachment" as hurdles (Adeel et al., 2023); in Nepal, Parajuly et al. (2018) also emphasized the absence of formal channels and regulatory support. Addressing these obstacles (for example, establishing campus collection points, introducing take-back schemes) could leverage the positive attitudes uncovered here.

Our findings align with broader evidence on e-waste in South Asia. The World Health Organization notes that countries like Nepal, without established e-waste regulations, face growing hazards from electronic junk (WHO, 2021). The fact that nearly all students agreed on the importance of proper disposal suggests fertile ground for educational

interventions. It also contrasts with the relatively low formal recycling rates nationally (less than one-fourth of e-waste is recycled globally (Forti et al., 2020), and Nepal has virtually no official recycling program). Thus, university curricula and public-awareness campaigns should emphasize e-waste risks and recycling pathways, in line with recommendations from global reviews (Balde et al., 2024).

Limitations

This study surveyed students from Kathmandu Valley and used convenience sampling, which may limit generalizability to all Nepalese youth. Self-reported behaviors can be affected by social desirability. Nonetheless, the large sample (n=400) and the consistency of findings with prior qualitative studies in the region (Parajuly et al., 2018; Rauniyar, 2024) lend credibility. Future research could extend to rural areas and track changes after awareness programs.

CONCLUSION

This study provides the first quantitative assessment of e-waste awareness and disposal practices among higher education students in Kathmandu Valley, Nepal. Our findings reveal that while awareness levels are moderate (65.5% had heard of e-waste) and attitudes are positive (96.2% agree proper disposal is important); actual disposal practices remain suboptimal, with 42.0% having discarded electronics in regular garbage and only 12.2% using recycling channels. The most common disposal method was selling to secondhand dealers (37.2%), indicating a strong reliance on informal markets.

The key barriers to proper e-waste management identified were lack of access to recycling programs (34.0%), inconvenience (29.0%), and lack of knowledge (19.5%). Importantly, 82.5% of students expressed willingness to participate in recycling programs if conveniently available, suggesting significant potential for improvement if structural barriers are addressed.

These results underscore the need for policy and practice improvements. Higher- education institutions in Kathmandu could implement campus e-waste collection drives and integrate e-waste topics into courses. Policymakers should expedite draft legislation (e.g., extended producer responsibility) and support community-based recycling initiatives, as recommended in the literature (Parajuly et al., 2018). Engaging socially- conscious students can create a multiplier effect for sustainable e-waste management in Nepal.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

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None

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