

An Insight into E-waste Literacy, disposal practices and perceptions on E-waste burden among College Students (Arts and Science, Medical and Engineering Students) in Chengalpattu district - A Cross-sectional study

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ABSTRACT

Introduction & Background: Industrialization and changing lifestyles have led to the increased use of electronic gadgets by making life easier. Consumer demand continues to rise in the number of electronic products. Consumers discard electronics more frequently as a result of frequent updates and new product releases, which accelerates the growth of e-waste. Improper disposal and recycling of e-waste can cause risks to human health and the environment.

Aim and objectives: The study aims to assess the awareness regarding e-waste existence and its hazardous materials, e-waste disposal and management, awareness regarding policies, laws, or regulations in e-waste management and evaluate the factors associated with e-waste disposal.

Methods: The study focused on college students in Chengalpattu district (cross-sectional design). It was carried out over a course of 4 months. The target population consisted of 402 students from the Engineering, Medical, and Arts and Science streams out of a total of 1,206 participants. The sample size was determined using a prevalence of 64.8% (from the study done by Suguna et al) with 5% precision error. Using multistage sampling, colleges were chosen at random, and then students within the colleges were chosen using random sampling. A semi-structured questionnaire (which included 6 parts namely E-waste literacy, Attitude towards e-waste disposal, disposal practices, Electronic equipment usage, perception of e-waste burden, and willingness to participate in the e-waste program) that had been pre-tested and validated was used to collect data.

Results: Overall, 27.4% of students sell or exchange e-waste, with medical students leading at 32.08%. It is significant that 41.4% of students throw away e-waste in the trash alongside other solid waste, with engineering students representing the highest percentage at 53.23%. Medical students are the most likely to separate and deposit e-waste at collection centers (32.33%). The percentage of engineering students who stored their electronic waste for later use was 15.67%. These results indicate that while a majority of students still dispose of e-waste through inappropriate means, medical students demonstrate comparatively better.

Conclusion: This study highlights the necessity of incorporating e-waste awareness in a broader educational framework. Students across all fields should be educated about the risks to the environment and human health associated with improper disposal. It is essential to educate them on the significance of recycling and complying with relevant regulations

Keywords: E-waste, E-waste Literacy, E-waste disposal, E-waste burden, Cross-sectional study.

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INTRODUCTION :

Industrialization and changing lifestyles have led to the increased use of electronic gadgets by making life easier. Consumer demand continues to rise in the number of electronic products. Consumers discard electronics more frequently as a result of frequent updates and new product releases, which accelerates the growth of e-waste. Improper disposal and recycling of e-waste can cause risks to human health and the environment¹. One of the solid waste sources that is expanding the fastest in the world is e-waste. Despite being a valuable resource, it is hazardous waste due to its toxic components and the harmful chemicals released during improper recycling^{2,3}. Many substances are harmful to human health, and among the ten compounds of public health concern are dioxins, lead, and mercury. Inadequate e-waste recycling is endangering public health and safety¹. When e-waste is stored or recycled by open burning, lead is released into the environment^{4,5}.

Globally, around 50 million of e-waste are produced annually, with a 4-5 % increase each year. India ranks third in Asia and fifth worldwide in e-waste

production^{6,7}. However, only 20 % of e-waste is properly collected and recycled, while the disposal of the remaining 80% is undocumented. India has become a major destination for e-waste disposal from developed nations. According to ILO estimates from 2020, up to 16.5 million children worldwide were employed in the industrial sector, including waste processing as a subsector^{8,9}. Serious risks include silicosis, acid burns, circulatory failure, mercury exposure, and environmental harm, including groundwater contamination and river acidification, caused by improper e-waste practices like scavenging, open burning, acid leaching, stripping the plastic coatings, and disassembling the equipment manually. These actions endanger the environment and public health^{10,11}. Lack of awareness and lax enforcement of environmental laws exacerbate the situation in India¹². Many electronic products can be reused, refurbished, or recycled to reduce their environmental impact. However, there are severe risks associated with inappropriate recycling and disposal. These risks can be reduced through proper awareness, making e-waste management education essential.

OBJECTIVES

The study aims to assess the awareness regarding e-waste existence and its hazardous materials, e-waste disposal and management, awareness regarding policies, laws, or regulations in e-waste management and evaluate the factors associated with e-waste disposal.

METHODOLOGY

The study focused on college students in Chengalpattu district (cross-sectional design). It was carried out over a course of 4 months. The target population consisted of 402 students from the Engineering, Medical, and Arts and Science streams out of a total of 1,206 participants. The sample size was determined using a prevalence of 64.8% (from the study done by Suguna et al) with 5% precision error. Using multistage sampling, colleges were chosen at random, and then students within the colleges were chosen using random sampling. A semi-structured questionnaire (which included 6 parts namely E-waste literacy, Attitude towards e-waste disposal, disposal practices, Electronic equipment usage, perception of e-waste burden, and willingness to participate in the e-waste program) that had been pre-tested and validated was used to collect data. The gathered data was analyzed and statistical analysis and results were obtained using SPSS Software version 22.0

RESULTS

1. E-WASTE LITERACY

Table 1 : Distribution of e-waste literacy among college students

E-waste Literacy	Whole frequency (%)	Arts & Science frequency (%)	Engineering frequency (%)	Medicine frequency (%)
E-waste existence	378 (31.3%)	94 (23.4%)	103 (25.6%)	181 (45.02%)
Health hazards of E-waste	616 (51.07%)	164 (40.7%)	164 (40.7%)	288 (71.6%)
Environmental hazards of E-waste	376 (31.1%)	84 (20.8%)	35 (8.7%)	257 (63.9%)
E-waste recycling	442 (36.7%)	165 (41.04%)	160 (39.8%)	117 (29.10%)

facilities				
Policies/regulations/laws	445 (36.8%)	119 (29.6%)	184 (45.7%)	142 (35.3%)

Among the 1,206 college students, the level of e-waste literacy varied across academic streams. Medical students demonstrated the highest awareness (45.0%) regarding the existence of e-waste, followed by engineering (25.6%) and arts and science students (23.4%). Regarding the health hazards of e-waste, medical students responded with higher awareness (71.6%) compared to those in arts and science (40.7%) and engineering (40.7%) students. Regarding the environmental hazards of e-waste, highest awareness found in medical students (63.9%) and low among arts and science (20.8%) and engineering (8.7%) students. In contrast, regarding the availability of e-waste recycling facilities, higher awareness found among arts and science (41.0%) and engineering (39.8%) students than medical students (29.1%). Awareness on knowledge of e-waste policies, regulations, and laws is found highest among engineering students (45.7%), followed by medical (35.3%) and arts and science (29.6%) students.

2. ATTITUDE TOWARDS E-WASTE DISPOSAL:

Table 2 : Distribution of opinion of college students regarding disposal of old electronic equipments across different academic streams

Opinion on disposal of old electronic equipments	Whole frequency(%)	Arts & Science frequency(%)	Engineering frequency(%)	Medicine frequency (%)
Should be disposed of with regular waste	461 (38.2%)	178 (44.3%)	203 (50.5%)	80 (19.9%)
Should be recycled by manufacturers	745 (61.8%)	224 (55.7%)	199 (49.5%)	322 (80.1%)

Almost 61.8% of the respondents believed that obsolete electronic equipment should be recycled by manufacturers and 38.2% felt it should be disposed of with regular waste. Around 55.7% of Arts and Science students and 49.5% of Engineering students supported manufacturer-led recycling, while 44.3% and 50.5%, respectively, preferred disposal with household waste. A higher proportion of Medical students (80.1%) responded recycling by manufacturers and only 19.9% supported regular waste disposal which indicates a greater level of environmental awareness toward e-waste management among Medical students.

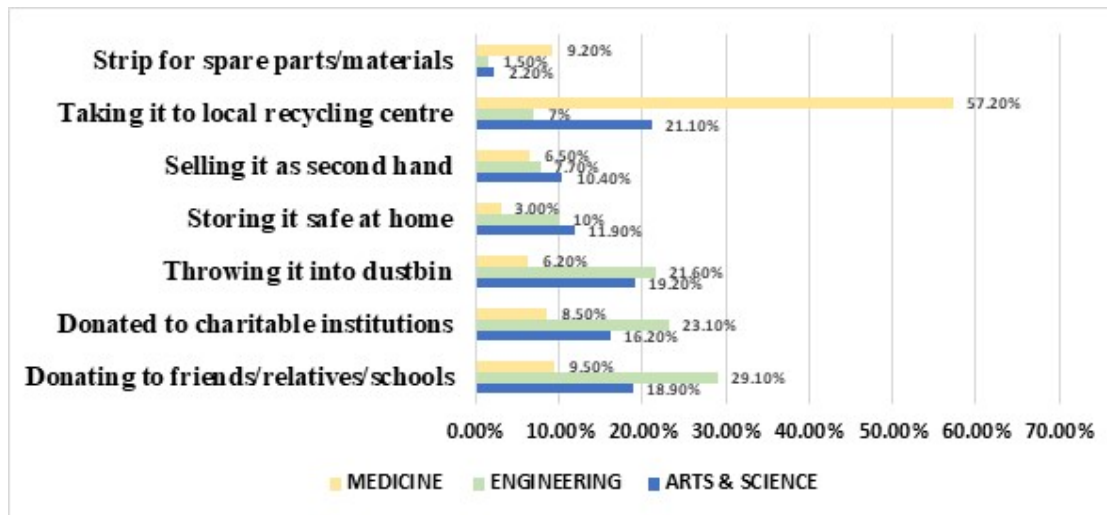


Figure 1 : Perception of students regarding the best ways to dispose e-waste

Around 28.4 % of the students preferred recycling of overall students. Around 57.2% of medical students, 7% of engineering students, and 21.1 % of arts and science students prefer recycling. Their methods of disposing of e-waste differ significantly and 28.4% of the overall students preferred recycling.

DISPOSAL OF E-WASTE:

Table 3 : E-waste disposal practices followed by college students

Disposal of e-waste Practices by college students	WHOLE frequency (%)	ARTS & SCIENCE frequency (%)	ENGINEERING frequency (%)	MEDICINE frequency (%)
Sell in second hand/ Exchange	331 (27.4 %)	114 (28.35 %)	88 (21.89 %)	129 (32.08 %)
Dispose of other Solid wastes into a dustbin	499 (41.4 %)	175 (43.53 %)	214 (53.23 %)	110 (27.36 %)
Segregate & deposit at Collection centers	229 (19 %)	62 (15.42 %)	37 (9.20 %)	130 (32.33 %)
Store it for later	147 (12.2 %)	51 (12.68 %)	63 (15.67 %)	33 (8.20 %)

Overall, 27.4% of students sell or exchange e-waste, with medical students leading at 32.08%. It is significant that 41.4% of students throw away e-waste in the trash alongside other solid waste, with engineering students representing the highest percentage at 53.23%. Medical students are the most likely to separate and deposit e-waste at collection centers (32.33%). The percentage of engineering students who stored their electronic waste for later use was 15.67%. These results indicate that while a majority of students still dispose of e-waste through inappropriate means, medical students demonstrate comparatively better.

3. ELECTRONIC EQUIPMENT - USAGE

The frequent reason for buying the new electronic equipment was upgrading for fashion or the latest trends (37.8%). It indicates that the preference of the consumers and modern lifestyle trends which influence e-waste generation. The next common cause was Technical problems (33.7%). Around 28.4% responses accounted due to physical damage (accidental damage / unrepairable defects).

4. PERCEPTION OF E-WASTE BURDEN

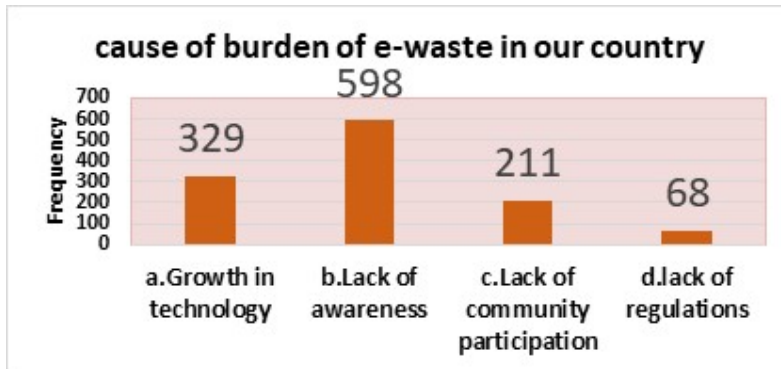


Figure 2. Perception of college students regarding the major causes contributing to the e-waste burden in the country.

The majority of respondents (49.6%) identified **lack of awareness** as the principal cause of increasing e-waste accumulation. This was followed by **growth in technology**, cited by 27.3% of students, indicating that frequent product innovations and upgrades significantly contribute to e-waste generation. **Lack of community participation** was reported by 17.5% of students as a contributing factor, while only 5.6% attributed the burden to **lack of regulations**. Overall, these findings highlight that **limited public awareness and rapid technological change as the key drivers behind the growing e-waste burden in India.**

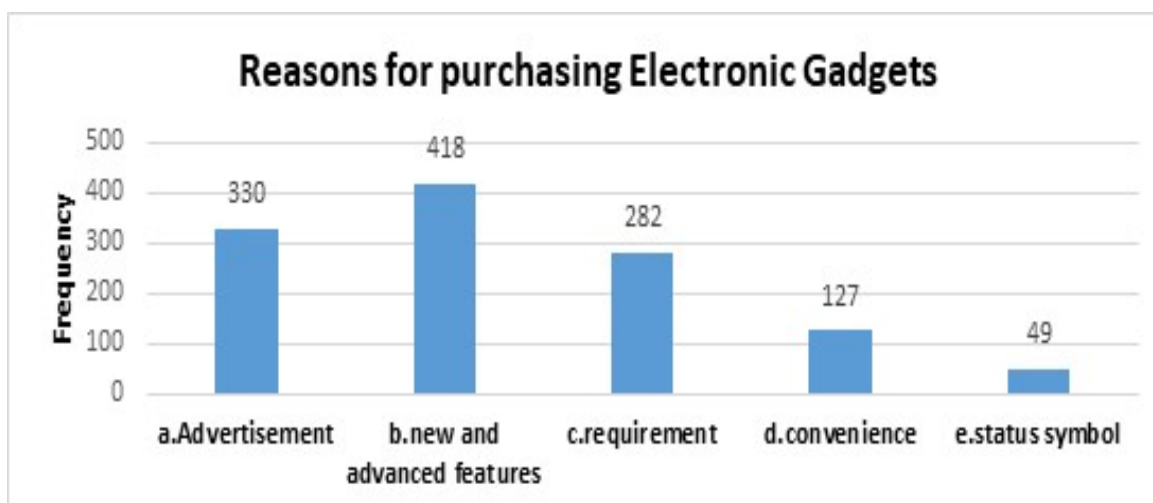


Figure 3 . Perception of college students regarding the reasons for purchasing Electronic gadgets

Majority of the students (418 students) prefer purchasing electronic gadgets due to new and advanced features. Around 330 students followed by purchase due to advertisement.

5. WILLINGNESS TO PARTICIPATE IN E-WASTE RECYCLING PROGRAM :

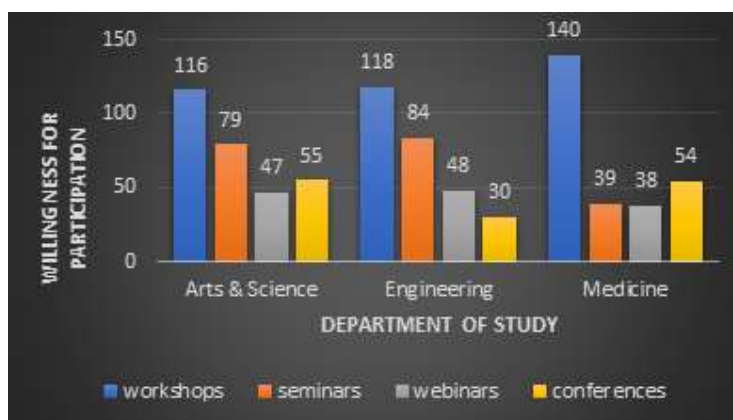


Figure 4 : Willingness for Participation in Academic Activities among Different Departments

Table 4 : Willingness of Students to participate in an e-waste program

Willingness to participate in an e-waste program	WHOLE frequency (%)	ARTS & SCIENCE frequency (%)	ENGINEERING frequency (%)	MEDICINE frequency (%)
Interested	848 (70.3 %)	297 (73.9 %)	280(69.7 %)	271 (67.4 %)
Not interested	358 (29.7 %)	105 (26.1 %)	122 (30.3 %)	131 (32.6 %)

Out of 1206 students, 848 students shared their willingness to participate in the e-waste program. The preference of all the academic streams is workshops.

Out of 1206 students, 547 were male and 659 were female. It is found that there is association gender and e-waste disposal practices (p value <0.001). There is association between field of study and e-waste disposal practices (p value <0.001).

DISCUSSION

This study's results are consistent with earlier investigations into e-waste awareness, disposal practices, and perceptions. They underscore both commonalities and discrepancies in understanding among various demographics.

A study by Suguna et al. (2021) in Puducherry found that 64.8% of households were aware of e-waste hazards, a figure that is significantly higher than the 31.3% awareness level among college students in this study. The reduced awareness observed in this study could be linked to the absence of targeted educational programs in colleges, as opposed to public awareness initiatives

aimed at households. Similar to the findings of Suguna et al., medical students demonstrated higher levels of awareness, which supports the notion that exposure to health-related education is vital for e-waste literacy. According to a global study conducted by Widmer et al. (2005), only 20% of e-waste is properly collected and recycled worldwide. This aligns with our study's findings that a significant percentage of students, especially engineering students, dispose of e-waste together with regular waste (41.4% and 53.23%, respectively). The results indicate that even though global awareness of e-waste issues is on the rise, disposal practices are still insufficient, especially among younger demographics.

This is also in agreement with the findings of Ongondo et al. (2011), who discovered that university students typically exhibit ineffective e-waste disposal practices, as many opt to keep old devices instead of recycling them. Concerning the motives for replacing electronic devices, our research revealed that 37.8% of students disposed of electronics because of fashion trends. This phenomenon was also noted by Grant et al. (2013), who pointed out that frequent tech upgrades and consumerism significantly contribute to e-waste generation. It is indicated by this trend that, in addition to awareness campaigns, behavioral interventions that encourage sustainable consumption should be put into action as well.

The considerable discrepancy in awareness levels among different fields indicates that incorporating education on e-waste management into non-medical curricula might help close the knowledge gap. Furthermore, it is encouraging that 70.3% of students indicated a willingness to take part in e-waste recycling programs. This is in agreement with the findings of Wath et al. (2011), who proposed that structured awareness programs can lead to significant enhancements in e-waste disposal behaviors among youth. The belief that e-waste can be thrown away with regular waste (held by 38.2% of students in this study) underscores the necessity for clearer guidelines and stricter enforcement of e-waste policies.

Cui & Forssberg (2003) observed that countries with established e-waste regulations, particularly in Europe, have significantly lower rates of improper disposal, highlighting the effect of robust regulatory frameworks.

CONCLUSION

This study highlights the necessity of incorporating e-waste awareness in a broader educational framework. Students across all fields should be educated about the risks to the environment and human health associated with improper disposal. It is essential to educate them on the significance of recycling and complying with relevant regulations. The urgent necessity for focused educational initiatives and policy implementation in India is underscored by this study. To diminish the incidence of improper disposal, it is crucial to tighten the enforcement of e-waste regulations at both institutional and

community levels. Future studies might concentrate on assessing the effects of intervention programs and investigating the long-term behavioral changes in students following awareness campaigns.

Conflicts of Interest : Nil

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