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Exploring E-waste Practices and Awareness: Educational Institutions of Haryana as a Case Scenario

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Abstract

This study delves into electronic waste (e-waste) practices and awareness within educational institutions in Haryana, with a focus on students. The surge in electrical and electronic-equipment's globally has led-to a substantial increasing discarded devices, contributing to environmental and health concerns. The research explores the life cycle of electronic-waste, the causes of the global e-waste problem, and the concept of circular economy (CE). It highlights the role of consumers, particularly students, in evaluating the fate of e-waste and emphasizes the significance of awareness in proper disposal. The study's objectives include assessing the penetration of information and communication technology (ICT) for academic purposes and understanding the willingness of students and faculty toward e-waste recycling. The methodology involves surveys in various academic institutions in Haryana, analyzing demographic profiles, electronic device usage, and environmental consciousness. Results indicate a high level of awareness of e-waste among respondents but a limited understanding of e-waste materials and policies. Despite environmental concerns, knowledge gaps persist, especially regarding valuable and toxic materials in electronic devices. The study concludes with recommendations for establishing e-waste management centers, enhancing environmental awareness, enforcing regulations, and engaging stakeholders to address the e-waste challenge effectively.

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Introduction

Undesired or useless materials are considered waste. Everyone bears the obligation of making sure that hazardous waste is disposed of in a way that is both safe and environment-friendly while adhering to all waste disposal laws. At a growth rate of 20–25% each year, e-waste is significantly rising. Because of its high rate of obsolescence, replacement market, and market spread combined, e-waste is the waste stream that is developing the fastest. The use of

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less energy, less equipment, less hazardous and non-hazardous products, and less energy overall is what is meant by pollution prevention. Reducing the need for transportation and disposal, as well as operating expenses, can all be achieved through efficient waste management. This waste stream has several facets and contains both valuable and rare materials.

The rapid growth of electrical and electronic equipment (EEE) across the globe has made these gadgets indispensable. Large volumes of abandoned electrical and electronic equipment have been produced as a result of the growing demand for such products.

The number of devices nearing their end of life (EoL) has increased as a result of ongoing technical improvements shortening the lifespan of EEE goods.[1,2] Electrical and electronic trash, or "e-waste," is the term used to describe EEE products at their end of life. Large equipment, small equipment, displays and monitors, IT or telecommunication devices, temperature exchange equipment, and lighting are the six main categories into which e-waste is divided.[3]

As mentioned by Kumar *et al.*[3] some literature reviews have previously included toys, automatic dispensers, medical devices, and recreational and sports equipment in the category of e-waste; however, it is important to note that "these equipment are no longer included in the European Union Directive".

When managed improperly, the growing amounts of e-wastes causes a major hazard to the ecosystem and human health.[4,5] This is explained by the wide range of dangerous materials—more than a thousand in total—that are discovered in e-waste, including persistent organic pollutants and toxic metals.[6-8]

The production and consumption of electronic and electrical equipment have grown exponentially worldwide throughout the last 20 years. The increased market penetration of items in developing countries and the emergence of a replacement cycle in industrialized countries are the main causes of this spike (UNEP, 2007). A greater number of people can now afford electronic equipment because of rising salaries and falling prices. Furthermore, as technology has advanced quickly, many new electronic goods have been introduced, but their lifespan has also decreased as a result of being rendered obsolete. The rise in the electronic waste can be attributed to the shift from analog to digital technology, as well as the widespread use of flat-screen TVs, monitors, and small, multipurpose gadgets like the iPad, iPhone, and Kindle.[9,10]

Kiddee *et al.*[7] have pointed out that the main cause of e-waste in the developing countries is the introduction of electronic devices and garbage from developed countries. Most of the equipment in these consignments is old, environmentally harmful equipment that was discarded by Western countries.[11] According to Joseph[12] the principles of free trade allow e-waste from affluent countries to easily enter less industrialized countries.

E-waste has its life cycle. The time interval during which an electronic device approaches the end of its useful life is known as the average life cycle and obsolescence rate. According to Adediran and Abdulkarim,[13] it is a total of three factors: active-life, passive-life, and storage. Active life is the number of years that hardware can be used effectively; passive life is the amount of time that passes after active life during which the equipment can be reconditioned or used again; and storage is the amount of time that the equipment is kept in storage and at repair shops before being disassembled.

Only 20% (8.9 Mt) of the 44.7 *10^9MT of electronic waste produced worldwide in 2016 was collected and recycled through the appropriate channels, according to the United Nations University (UNU).[14,28] The unreported e-waste flow is still increasing, and according to Solving the E-waste Problem's (StEP) 2015/2016 annual report, recoverable materials were lost in 2014 for almost US$ 40.6 billion (StEP, 2016). As a result of the realization that components from e-waste may be reused, recycled, and remanufactured, the circular economy (CE) idea has acquired international attention. Comprehensive action plans for material recovery have been developed by the European Union (EU) to reduce reliance on material and metal imports by 53% by the year 2050 (StEP, 2016). In the context

of the CE system, users or consumers are crucial in deciding where waste materials end up. However, consumers must be aware of this particular type of waste to make educated decisions about its proper disposal, comprehend its material value, and be aware of any potential negative environmental effects. Additionally, consumers play a crucial role in the overall management scenario.[14] The amount of e-waste generated at the domestic level is far more than that from other sources, and the successful long-term development of strategic e-waste management systems is thought to be largely dependent on consumer knowledge.[15]

Alavi *et al.*[16] looked into and measured the amount of e-waste that different electrical and electronic devices produced. Krishna *et al.*[17] assert that stringent laws governing businesses' "take back" initiatives are crucial. Kottapalle *et al.*[18] sought to understand the origins of e-waste as well as its effects on human health and ecology. Motasem[19] estimated how much e-waste Jordan would produce in the future, taking into account items like computers, televisions, refrigerators, washing machines, and cell phones. Forti *et al.*[20] published "E-waste Statistics Guidelines on Classification, Reporting, and Indicators," which offers a trustworthy framework for assessing e-waste statistics. They argued for the inclusion of both statistical and non-statistical data sources in e-waste statistics. In 2015, Shibly and Samantha[21] were interested in finding out more about the existing state of Sri Lanka's electronic waste recycling infrastructure.[22]

The knowledge and management of e-waste by young adults and students is one of the most important sustainability-related challenges. According to Wang *et al.*[23] this is a reference to end-of-life gadgets that users have thrown away since they have no intention of utilizing them again. E-waste amounts have surged recently due to the increased use of electrical and electronic gadgets. A record 53.6 million metric tons (Mt) of e-waste were produced in 2019, and the Global E-Waste Monitor 2020 projects that this amount will rise to 74 Mt by 2030.[24] Due to the rapid obsolescence of electronics, e-waste has emerged as the waste stream with the fastest rate of growth globally, attributable to the exponential rise of the information and technology revolution. As a result, several developing nations disassemble, repair, and resale these electrical gadgets. These products have hazardous elements that could endanger both the environment and public health, even when they also contain recyclable precious materials. Younger generations who largely rely on e-devices need to be made aware of the proper treatment of these used gadgets to limit the footprint of e-waste.[25] Academic institutions now account for a significant portion of the market for electrical and electronic equipment due to the introduction of information and communication technology in the education sector. One of the main producers of e-waste in academic institutions is the student. This is a result of both the availability of replacement parts and the regular advancements in technology. Research suggests that one's general attitude affects how one intends to behave toward things, people, and circumstances. Student's attitudes on the generation, collection, and segregation of e-waste are crucial for influencing their future behavior, which is influenced by attitudes.[26.32-34]

The disposal of e-waste affects all parties involved, including end users and legislators. Therefore, it is crucial to evaluate the total sustainability of e-waste while taking the three pillars—environmental, economic, and social—into account. Adopting sustainable development techniques is a call to action for higher education institutions hoping to improve the community.

The emotional component of an attitude is acquired from students, parents, instructors, and peer groups. The current study assesses Haryana's academic institutions student attitudes regarding electronic waste.

Objectives

To research how ICT is being used for educational purposes in different Haryana academic institutions to investigate the attitudes of faculty and students toward the safe disposal and recycling of e-waste in different Haryana educational establishments.

Methodology

Several academic institutions supported the current study in Haryana. Graduate and postgraduate colleges and universities make up these institutions. For these educational institutions' students and

faculty, questionnaires were designed. The questionnaire was designed with the different types of usage and potential attitudes towards the generation and disposal of e-waste in mind. The researcher was able to interview students between the ages of 17 and 25 in this way. The sample population included faculty members who were employed by engineering colleges, management institutions, and universities. Following in-depth focus group interviews with the stakeholders, which included waste collectors, recyclers, NGOs, and government agencies, e-waste recycling attitudes were included in the questionnaire. Aspects from the different literature surveys were also used to investigate the mindset of e-waste management and collection techniques.

Variables Used

The devices utilized by participants from diverse groups were recorded to determine the degree of ICT adoption among instructors and students at different colleges and universities. A questionnaire was designed to find out how professors and students felt about the creation, separation, and collection of e-waste. Since these institutions do not currently have an efficient system in place for collecting electronic garbage, the amount of electronic waste produced was equal to the amount of electronic waste that the respondents disposed of. The data analysis and graphs were done using SPSS.[29,30]

Result and Discussion

A demographic profile of the survey population, including gender, age, designation, and type of institution. The data from 1000 respondents was gathered during the survey; 630 (63%) of them identified as female, and 370 (37%) as male. The majority of responders 850 (85%) were between the ages of 18 and 24, and only 150 (15%) were between the ages of 56 and 65 and beyond. Of the responses 90% were students and 10% were staff members. Of the student responders, 47% were graduate students, and the majority, 53%, were undergraduates.

The respondents ranked the five electronic devices (desktop, laptop, tablet, mobile phone) in order of "most often used" to "used least often" in this section of the questionnaire. The findings showed that 88% of respondents replied that mobile phones were the electrical gadgets they used the most frequently. Desktop and laptop computers came next, at 2% and 8%, respectively. The surveyed population utilized tablets least frequently (1%) (Figure-1). Postgraduate students (80%) use these e-devices for academic purposes.

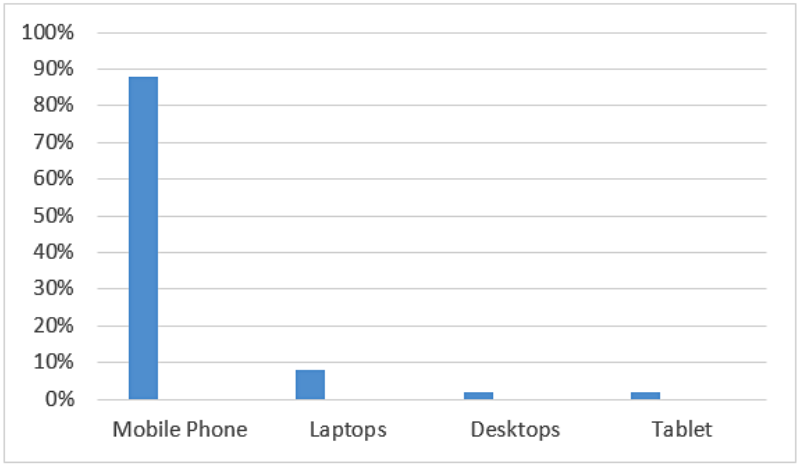

Fig. 1: E-device used for educational purposes

In total, 740 (74%) respondents said they were environmentally concerned because they reduced, reused, and recycled their garbage, and 90% said they were environmentally conscious. The majority of respondents (840, 84%) in the questionnaire survey indicated that they were familiar with the word "e-waste" before, showing that they were well-informed about the phrase. A small percentage

of respondents, 160 (16%), had never heard of the term "e-waste." The majority of responders, 340 (40%), learned about e-waste through reading.

The results of the questionnaire survey show that respondents had a high level of knowledge of the worldwide e-waste problem, with the majority (70%) indicating that there is an e-waste problem for a variety of reasons. The percentage of respondents who said there is no e-waste problem was very low (10%). Around 200 people had never heard of e-waste before and gave the N/A response.

Merely 330 respondents (33%) were able to explain their response when asked why there is a global e-waste problem. This led to the identification of five main causes: improper disposal, environmental degradation, excessive electronics use, ignorance about e-waste, and large amounts of e-waste. A majority of respondents (n=390) stated that improper disposal of electronic equipment is the reason for the worldwide e-waste problem (31%). According to 330 respondents (25%), the second most common cause of the global e-waste problem is that e-waste pollutes the environment, which is followed by high electronic device consumption (19%), lack of awareness (15%), and high quantities (10%) of e-waste, respectively (Fig- 2).

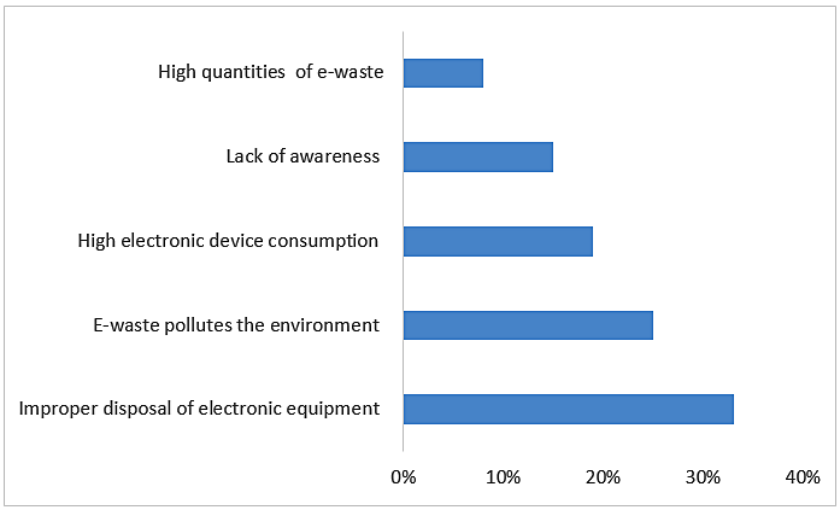

Fig. 2: Reasons for E-waste problems

The majority of respondents agreed that there is an issue with e-waste on a national (43%) and worldwide (42%) level. The findings show that respondents were well-informed on appropriate e-waste disposal since 441 (45%) of respondents strongly disagreed with the idea that e-waste should be landfilled, and 395 (40%) disagreed with the idea that it should be burned. Some respondents were unclear on whether or not e-waste should be stored, as the majority of respondents (42%) indicated that they were.

When asked to score their level of knowledge as "Good," "Okay," or "Poor," the majority of respondents said they knew little about the negative consequences that e-waste has on the environment (56%), as well as its health effects (59%) (Table 1). Furthermore, as shown in Table 1, the majority of respondents (72%) having "poor" knowledge about the harmful elements included in e-waste.

The data presented in Table 5.8 further demonstrates the low level of understanding of the national and e-waste management policies. The majority of respondents (89%) reported having "poor" knowledge of the national waste management policy, and 4 % good knowledge regarding the e-waste management policy.

Table 1: Knowledge of E-waste

Questions	Options	Number (%)
What is your familiarity with the national waste management policy?	Good	(9%)
	Okay	(15%)
	Poor	(76%)
How well-acquainted are you with the nation's policies on managing electronic devices/e-waste?	Good	(4%)
	Okay	(7%)
	Poor	(89%)
How much understanding do you have about the constituents used in e-devices/e-wastes?	Good	(17%)
	Okay	(20%)
	Poor	(63%)
To what extent are you informed about the environmental impacts of e-waste/ electronic devices?	Good	(19%)
	Okay	(25%)
	Poor	(56%)
How well-versed are you in the health effects of electronic devices/e-waste on the environmental system?	Good	(12%)
	Okay	(29%)
	Poor	(59%)
Are you knowledgeable about any valuable resources present in electronic devices/e-waste?	Good	(29%)
	Okay	(21%)
	Poor	(50%)
Are you aware of any toxic constituents present in electronic devices/e-waste?	Good	(9%)
	Okay	(19%)
	Poor	(72%)

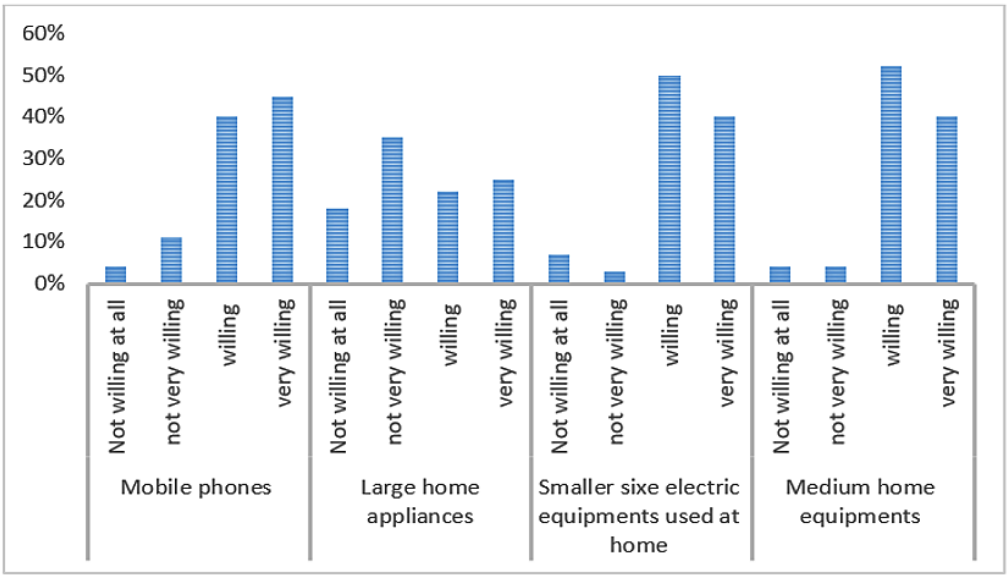

Fig. 3: Willingness to recycle different types of e-waste in educational institutions

The electronic waste type that respondents express the highest willingness to recycle on campus is small home electronic equipment. In this category, a majority of respondents indicated their willingness, with 50% stating they are willing and 40% expressing a high level of willingness to

recycle these electronics on campus. On the other hand, respondents showed a lower inclination to recycle mobile phones on campus, with only 40% expressing willingness. When it comes to large home appliances, respondents were least inclined to recycle this e-waste type on campus, with only 22% of respondents indicating their willingness.[27]

Solutions to reduce E-waste

Governmental, corporate, and individual approaches to e-waste reduction came together. Every participant expressed deep worry over the actions implemented by governments. They need to plan awareness campaigns, offer substantial or negligible rewards for disposing of e-waste, and impose penalties for disposing of non-e-waste. The government's role in boosting the disposal of e-waste was also highlighted by other quantitative studies.[35-36] The findings also indicated that companies making electronic devices needed to create a long-term plan for the extraction and disposal of precision metal. At the individual level, it is crucial to demonstrate significant concern regarding the exploitation of resources, especially metals.[31]

Recommendations

- Initially and foremost, it is imperative to build e-waste refurbishment, dismantling, and recycling centers to address the massive amount of e-waste that is kept in city homes, schools, and government offices.
- Raising managers' awareness of environmental issues and strengthening the way environmental regulations are enforced.
- Enough funds, infrastructure, and necessary logistics should be set aside to enable effective e-waste management in the city.
- In addition, better enforcement of environmental regulations will foster a favorable impression and view of the government and stakeholders' seriousness in addressing the e-waste problem.
- The management of electronic waste will be greatly aided by the expansion of the computer refurbishing and training center. Recycling end-of-usage products through the end-of-pipe technique is not the only way to solve the problem. To keep electrical and electronic devices out of the waste stream, the industry needs to reassess how these products are designed, made, utilized, and collected.
- The government, government service department employees, and other stakeholders should plan training sessions, start awareness-raising campaigns, conduct research, reorganize organizational structures, and engage in management of e-waste such as inventory and e-waste accounting.
- Appropriate and sufficient areas ought to be allocated for the storage of electronic trash. Proper e-waste services, including bins, box, shelves, and the like, should also be provided to help with the efficient treatment of e-waste.
- As a result, it will reduce the risk that electronic trash poses to the environment and public health by reducing the number of scratches that electronic debris accumulates.
- Government and lawmakers should take the lead in creating and implementing an e-waste management system and enforcing laws tailored to this sector. With e-waste continuing to accumulate and be produced, it is not only appropriate but also timely to develop an e-waste policy framework. Furthermore, mandates could be applied to specific activities that involve the disposal of e-waste and could negatively impact the ecosystem or public health.

Conclusion

In conclusion, this study highlights the knowledge for management of e-waste in educational institute and the current practices adopted for their management in various educational institution of Haryana, India. The findings underscore the necessity for robust e-waste management strategies, given the escalating global generation of e-waste. While there is a commendable level of awareness among respondents, knowledge gaps persist, particularly concerning e-waste materials and existing policies. The study advocates for multifaceted solutions, including the establishment of e-waste management centers, heightened environmental awareness, and stringent regulatory enforcement. The recommendations emphasize the pivotal role of consumers, especially students, in shaping e-waste management practices. By considering these recommendations, educational institutions in

Haryana can contribute significantly to mitigating the ecosystem and health impacts related with improper disposal of electronic waste.

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