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## Students' Awareness and Behavior towards E-Waste Management: A Study in Tobruk

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### ABSTRACT

Libya is expanding in all sectors, which presents a significant difficulty when it comes to managing garbage, particularly e-waste. One of the most important strategies for reducing the production of e-waste is e-waste management. This necessitates taking the appropriate steps to change public awareness and disposal behaviour. This study was done among Tobruk Institute students. Surveys were given to 235 students who were registered for classes in April of the 2021 academic year. It recommends assessing students' attitudes and behaviours regarding e-waste management. In addition, the research aims to find out why devices need to be replaced as well as how students currently dispose of their electronic devices. This study used the analytical-descriptive approach by using (SPSS). The findings of this study show that only 55.9% of students have some awareness about e-waste. At the same time, the analysis of the students' behaviour indicates that, in general, they do not dispose of their electronic waste in an appropriate and environmentally friendly manner. This suggests that despite having some awareness about e-waste, the students' actual behaviour and practices when it comes to managing their own e-waste are lacking. The results have shown that the development of technology is the main reason behind replacing electronic products (54%). More than 80% of students replace their mobile phones within a period of less than two years. Keeping unused electronic products (PCs and laptops) at home was the most common method of discarding e-waste by students, and throwing mobile phones in the trash along with other waste was the second method.

### وعي الطلاب وسلوكهم تجاه إدارة النفايات الإلكترونية: دراسة في طبرق

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### الكلمات المفتاحية:

الوعي  
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استبيان  
المعهد العالي للعلوم والتكنولوجيا

### المخلص

تشهد ليبيا نمواً في جميع القطاعات مما يجعلها تواجه تحدياً كبيراً في التعامل مع النفايات وخاصة النفايات الإلكترونية. تعد إدارة المخلفات الإلكترونية أحد الخيارات الأكثر أهمية للحد من توليد المخلفات الإلكترونية. وهذا يستدعي اتخاذ الإجراءات اللازمة تجاه سلوك التخلص والتوعية العامة. أجريت هذه الدراسة بين طلاب المعهد العالي للعلوم والتكنولوجيا / طبرق. تهدف هذه الدراسة لتقييم وعي وسلوك الطلاب فيما يتعلق بإدارة المخلفات الإلكترونية. بالإضافة إلى ذلك تهدف إلى التعرف على أسباب استبدال الأجهزة الإلكترونية وكذلك تحديد الطرق الحالية للتخلص من الأجهزة الإلكترونية من قبل الطلاب. تم توزيع الاستبيانات على 235 طالباً وطالبة كانوا يدرسون في شهر إبريل من العام الدراسي 2021. اعتمدت هذه الدراسة على استخدام المنهج الوصفي التحليلي باستخدام (SPSS). حيث تظهر نتائج هذه الدراسة أن 55.9% فقط من الطلاب لديهم بعض الوعي حول النفايات الإلكترونية. ويشير تحليل سلوك الطلاب إلى أنهم بشكل عام لا يتخلصون من نفاياتهم الإلكترونية بطريقة مناسبة وصديقة للبيئة. يشير هذا إلى أنه على الرغم من وجود بعض الوعي حول المخلفات الإلكترونية، إلا أن السلوك والممارسات الفعلية للطلاب عندما يتعلق الأمر بإدارة المخلفات الإلكترونية الخاصة بهم غير موجودة. وتبين بالنتيجة أن التطور التكنولوجي هو السبب الرئيسي وراء استبدال المنتجات الإلكترونية

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بنسبة 54%. أكثر من 80% من الطلاب يستبدلون هواتفهم المحمولة خلال فترة أقل من عامين. الاحتفاظ بالمنتجات الإلكترونية غير المستخدمة (أجهزة الكمبيوتر الشخصية وأجهزة الكمبيوتر المحمولة) في المنزل هو أعلى طريقة للتخلص من النفايات الإلكترونية من قبل الطلاب، وإلقاء الهواتف المحمولة في صناديق القمامة إلى جانب أنواع النفايات الأخرى هي الطريقة الثانية.

## 1. Introduction

Nowadays, the generation of waste is one of the biggest consequences of life for the environment and human health. Day by day, the generation of a new type of waste (the waste of electrical and electronic equipment (EEE) or E-waste) is growing due to the increasing penetration of electrical and electronic devices into every aspect of modern lifestyle. According to Singh and Zeng (2016), the global production of electronic waste is approximately 41 million metric tons per year. In 2018, Balde et al. (2015) stated that this number is anticipated to increase to almost 50 million metric tons. Interestingly, electronic waste is expected to become the fastest growing waste stream globally, with annual growth rates ranging from 3% to 5% per year. This rapid rate of e-waste generation outpaces the growth of other types of solid waste (Kumar et al., 2017). Furthermore, a UN report confirmed that e-waste has risen by 21% in the last five years, with 74 million metric tons expected by 2030. Okoye and Odoh (2014) have observed that this trend is indicative of the increasing dependence on information and communication technology (ICT) worldwide. The increasing amount of electronic waste produced worldwide is directly related to technological advancements. Notably, the use of electronic devices such as personal computers, mobile phones, and entertainment electronics has been rapidly increasing, particularly among the youth population. This surge in electronic device usage is a key factor driving the growth of e-waste globally.

A recent study found that e-waste represents 1-3% of the global municipal waste production, which totals 1636 million metric tons per year (Konya et al., 2015). In Morocco, the total e-waste reached 18,500 metric tons (Moossa et al., 2023). European countries produce e-waste at a rate of 11.6 million metric tons, equivalent to 15.6 kg per person, making it the highest producing region in the world (Kumar et al., 2017). Nigeria, for example, sees around 1.1 million metric tons of electrical and electronic equipment become obsolete each year.

Unfortunately, reliable published statistics on the specific amount of e-waste generated in Libya are quite difficult to find. This is due to limited data availability, a lack of centralized e-waste monitoring, and informal recycling and disposal practices. According to Moossa et al. (2023), the average per capita production of electronic waste in Libya is about 11.5 kg. Furthermore, around 75% of e-waste is stored in homes, government institutions, industries, and private offices, as people are uncertain how to properly dispose of or discard such equipment (Ogunbuyi et al., 2012). Because every member of society produces waste, awareness and behavior have an impact on the waste management system. Thus, raising public awareness of e-waste is crucial to safeguarding both human health and the environment.

## 2. Problem Statement

A high percentage of the overall toxic waste in landfills comes from e-waste. Additionally, if e-waste is disposed of in the landfill or through incineration, the presence of e-waste in the landfill will have disastrous environmental effects. According to Bazargan et al. (2012), it has been estimated that around 20 million PCs (about 7 million metric tons) have become obsolete. About five hundred million PCs contain nearly 2,872,000 metric tons of plastic, 718,000 metric tons of lead, 1363 metric tons of cadmium, and 287 metric tons of mercury. These materials represent around 8% of the volume of municipal waste in rich countries. All of these quantities will negatively affect the environment if they are disposed of directly in landfills without any separation or treatment. In this case, hazardous materials from e-waste may leach into water sources, cause contamination of water and soil, and pose associated health dangers. Even a small amount of e-waste entering landfill sites can contain a relatively high amount of heavy metals and toxic substances due to the high concentration of the materials (United Nations University, 2020). Therefore, due to its hazardous nature, e-waste should be disposed of or discarded in an environmentally sound manner. For that reason, it

is necessary to address the e-waste management of these unused products to ensure that these products do not end up in landfills, dumpsites, or incineration. On the other hand, a lack of facilities and information about how and where to properly dispose of e-waste, as well as the absence of effective regulation and policy, all contribute to e-waste being frequently discarded alongside other types of solid waste. In Libya, regulations do not focus on households and individuals; they just focus on industrial sectors. According to different researchers, many countries suffer from a complete lack of effective control systems or legal frameworks to control e-waste treatment (Tiep et al., 2015). The absence of research on student awareness about e-waste management in Libya is a gap in this study. The aims of this study are to assess students' awareness and behavior regarding electronic waste management, identify the reasons and times for replacing unused electronic devices by students, and determine the current methods of discarding electronic waste by students.

## 3. Methodology

A questionnaire was used as a measurement tool (Appendix 1), and it was distributed among students at the higher institute of science and technology (Tobruk) to assess their awareness and behavior regarding e-waste management. The questionnaire was translated into Arabic to make participants more comfortable answering all questions. The survey was divided into five sections, each designed to achieve a specific goal, as shown in Table 1. In addition, the Statistical Package for Social Sciences (SPSS) version 26 was used to conduct different statistical analyses of the data.

According to Krejcie and Morgan (1970), the formula for calculating the sample is as below:

$$s = \frac{X^2 NP (1 - P) \div d^2 (N - 1) + X^2 P (1 - P)}{1}$$

$$s = \frac{(1.96^2 * 1032 * 0.5)(1 - 0.5)}{0.05^2(1032 - 1) + 1.96^2 * 0.5(1 - 0.5)} = \frac{991.13}{3.5379} = 280.14$$

s = required sample size.

$X^2$  = confidence level (3.841).

N = population size = 1032 students.

P = population proportion (assumed to be 0.5).

d = degree of accuracy expressed as a proportion (0.05).

The total number of respondents that can be utilized to represent the sample should be 280, according to the formula above. Out of the 280 students who received the questionnaires, only 235 completed them, accounting for more than 82% of the sample size.

**Table 1:** Design of the questionnaire

Part	Classification and description	No of items
A	Personal Information (gender, age, and electronic gadget used)	3
B	To assess students' awareness regarding E-waste management	7
C	To assess students' behaviour regarding E-waste management	8
D	To identify reasons and time of replacing electronic devices by students	2
E	To determine the current methods of discarding E-waste by students	1
<b>Total of items</b>		<b>21</b>

4. Result and Discussion

4.1 Respondents' Demographic

This part shows some of the details that represent respondents' demographics, as follows:

Male respondents made up 59% of the sample, with female respondents making up 41% of the sample. The age group of 20 to 29 years old accounted for 39% of the total respondents, while the age group of 40 years and older accounted for 2%. As seen in Fig. 1, the respondents who exclusively use mobile phones make up the biggest share of the sample.

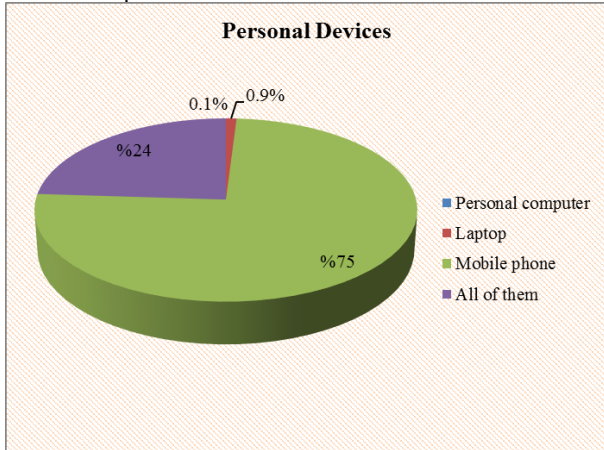



Fig. 1: Personal devices

4.2 Students' Awareness Regarding E-Waste Management

The awareness of respondents with regard to e-waste management is displayed in Table 2. Students were asked seven questions pertaining to various concepts in electronic waste management, including the definition of e-waste, its symbol, its hazards, its effects on the environment, and regulations.

Table 2: Descriptive analysis of students' awareness variables

Item	Statistics	Yes	No	Not Sure	Std. Dev.	Weighted Mean
Do you know what is "electronic Waste" or E-waste?	Frequency	167	27	41	0.687	2.60
	Percent (%)	71.1	11.5	17.4		
Do you know what does this symbol  represent?	Frequency	135	35	65	0.378	2.43
	Percent	57.4	14.9	27.7		
Do you know that some components of electronic devices contain toxic/hazardous materials?	Frequency	158	31	46	0.717	2.54
	Percent	67.2	13.2	19.6		
Are you aware that these toxic/hazardous materials require special treatment for environmentally sound disposal?	Frequency	122	30	83	0.704	2.39
	Percent	51.9	12.8	35.3		
Does the disposal/treatment method in use for E-waste have any impact on the environment?	Frequency	152	28	55	0.700	2.53
	Percent	64.7	11.9	23.4		
Are you aware of any company that collects discarded E-waste for recycling?	Frequency	108	54	73	0.800	2.23
	Percent	46.0	23.0	31.1		
Is there any regulation/law that manages the E-waste?	Frequency	79	39	117	0.689	2.17
	Percent	33.6	16.6	49.8		

In general, students have some knowledge about concepts related to e-waste and its management. According to the respondents' descriptive analysis of awareness items, the overall awareness percentage is 55.9% (SD = 0.667, M = 2.41), which indicates a low level of awareness. Afroz et al. (2013) observed a similar outcome in their study, finding that only 59% of respondents have some knowledge about e-waste and its impacts on the environment and human health, and that most respondents consider environmental factors when purchasing new electronic products for their homes. Similarly, in Australia, a lack of awareness of e-waste was observed among citizens regarding issues related to e-waste. Thus, the effectiveness of e-waste management is subject to consumer involvement, technical capacity, and different legislation and policies (Li et al., 2015). The highest percentage (71.10%) was for the first question, indicating that students are familiar with the term "e-waste." This suggests that the concept of e-waste is relatively well-known among the students. This result is similar to a study conducted in India, which found that 77.06% of respondents were aware of the term e-waste (Jain & Garg, 2011). On the other hand, only 33.6% of students are aware of laws and regulations that manage e-waste. Furthermore, they do not know of any companies that collect e-waste, which may have a negative impact on e-waste management in the future. A similar result was found in a study by Oomman (2014), which noted that 88.5% of respondents were not aware of any companies that collect e-waste. The results show that students' awareness regarding the concept of e-waste itself is higher than their awareness of the regulations and laws surrounding e-waste management. This suggests that while students are familiar with e-waste as a term, they lack understanding of the available recycling methods and facilities provided by the government and other agencies. Improving students' awareness in this area could lead to more effective e-waste management practices in the future.

4.3 Student's Behavior Regarding E-Waste Management

In order to evaluate the respondents' attitudes regarding e-waste management, the students were given eight questions to answer. The responses were on a five-point Likert scale, from "strongly agree" to "strongly disagree." The statistical analysis of the conduct of the respondents is presented in Table 3.

Table 3: Descriptive analysis of students' behavior variable items

Item	Statistics	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Std. Dev.	Weighted Mean
I feel good about myself when I discard my E-waste properly.	Frequency	47	0	5	16	15	1.0	3.6
	Percent	20.0	4.3	2.2	6.8	6.4		
	Cumulative	64.3						
I have enough information about how to discard my E-waste properly.	Frequency	34	0	5	25	14	1.0	3.5
	Percent	14.5	4.3	2.2	10.6	6.0		
	Cumulative	59.2						
I think, E-waste discard is an easy task.	Frequency	31	9	5	43	10	1.0	3.3
	Percent	13.2	3.9	2.2	18.3	4.3		
	Cumulative	52.8						
I care that discard E-waste with other kinds of waste can be bad for my health and the health of others.	Frequency	34	0	5	32	9	0.9	3.5
	Percent	14.5	4.3	2.2	13.6	3.8		
	Cumulative	58.3						
I think	Frequency	34	1	4	32	7	0.8	3.7

electronic waste should be arranged for continece collection by manufactures for recycling.	y	1	8		56	2	
	Percent	14.5	4.8	2.0	13.6	3.0	
	Cumulati ve					63.0	
I think electronic waste should be taken back to the retailer/shop.	Frequenc y	38	1	6	18	2	
	Percent	16.2	0.4	2.6	7.7	0.9	
	Cumulati ve					65.1	
Even if I know where I can drop the electronic waste, I have no time to go there.	Frequenc y	4	1	5	1	3	
	Percent	1.7	0.4	2.1	0.4	1.3	
	Cumulati ve					70.6	

In summary, the results indicate that students at the Higher Institute of Science and Technology in Tobruk have a lack of awareness about e-waste. Due to this lack of awareness, the students' overall behavior towards e-waste management is also moderate, with an overall behavior percentage of 58.78% (SD = 0.948, M = 3.67). Which indicates a moderate level of behavior. Raising students' awareness regularly will eventually lead to environmentally sound behavior and, ultimately, improve e-waste collection efficiency. In a similar study conducted by Suwansri & Piwthong (2015) in Bangkok, it was shown that the index of the behavior of respondents was in the middle of 60%, which is similar to our result.

Moreover, 70.6% of students agreed that they do not have time to go to drop off their unused products at the collection centers, which means convenience has a significant effect on students' behavior. It is known that consumers still say convenience is a determining factor as to whether or not they discard their e-waste properly. Also, convenience can be taken into account, as can time, resources, and cost, which affect how individuals decide to discard their e-waste. The convenience of e-waste recycling can increase household participation, as it requires consumers's time, effort, money, and space (Domina & Koch, 2012). Therefore, convenience is one of the important factors that can be concluded from the statistical analysis results, as most of the students were willing to keep their personal electronic gadgets in their house when these gadgets became out of use.

#### 4.4 Identify the Reasons for Replacing Electronic Devices by Students

In order to identify the reasons for replacing electronic devices, students were asked one question, which was, "What was your reason for replacing a laptop, personal computers, or mobile phones?"

The responses of the respondents to this question are displayed in Fig. 2. The answer choices were distributed with almost convergent ratios, as 13% of respondents answered that the reason was physical damage. In response, almost 23% of students stated that there was a "loss of function," while 21% cited a "need for greater functionality." The respondents ranked "desire for the newest technology" highest (33%), making the total percentage of reasons related to technology 54%, the greatest ratio.

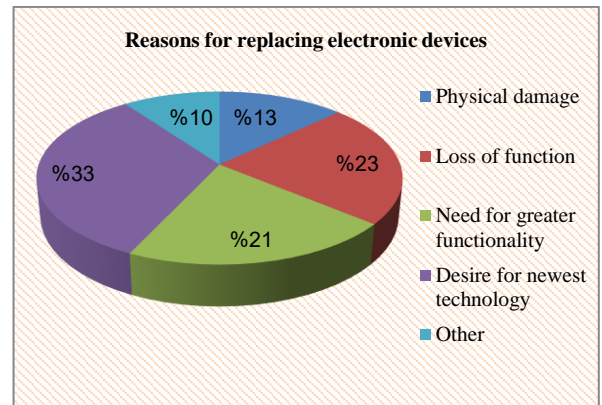


Fig. 4: Reasons for replacing electronic devices

#### 4.5 Identify the Time of Replacing Old Electronic Devices by Students

Students were posed one question to determine when to replace outdated electronic devices: "How many years later did you replace your PCs, laptops, and mobile phones?" The following were the outcomes:

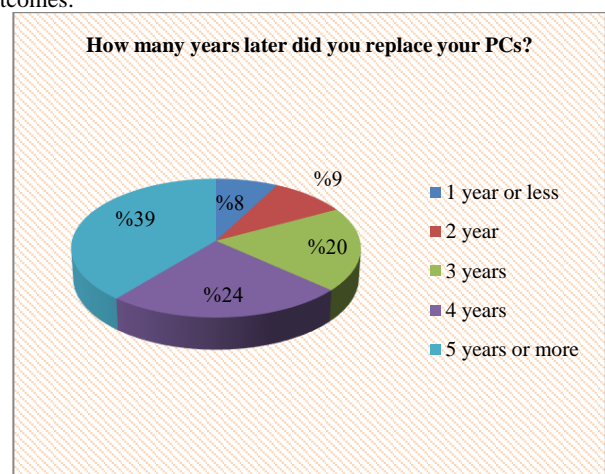


Fig. 3: Replacing PCs

PCs are more likely to be retained for a long time, as seen in Fig. 3, where 39.10% of respondents keep their computers for five years or more, 24% for four years, 20% for three years, and only 17% for less than that amount of time.

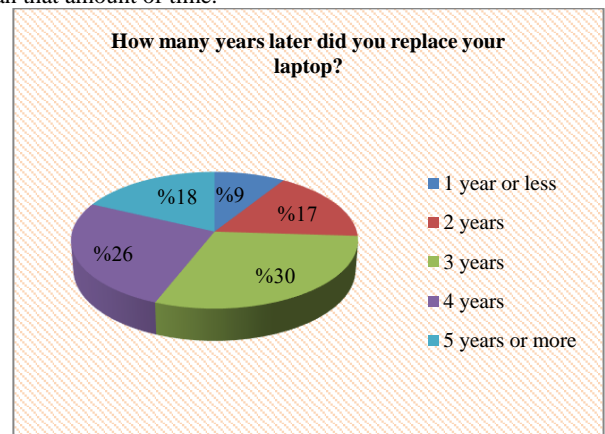


Fig. 4: Replacing the Laptop

As can be seen in Fig. 4, 56% of respondents keep their laptops for less than 5 years, indicating that laptops are likely to be replaced or thrown away more frequently than PCs. Of the respondents, 30% keep their laptops for 3 years, and 26% keep them for 4 years.

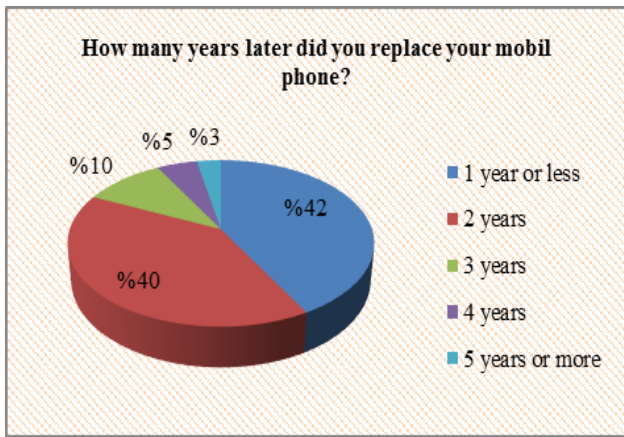


Fig. 5: Replacing Mobile Phones

According to Fig. 5, 42% of respondents only keep their phones for a year before replacing them, and 40% do so within two years, for an overall two-year mobile phone replacement rate of 82%. Students are inclined to change their mobile phones within two years, and mobile phones are likely to be replaced considerably more frequently than other technologies (PCs and laptops).

4.6 Determine the Methods of Discarding E-Waste by Students

Students were asked one question to examine the strategies for disposing of electronic waste: "How do you dispose of your unwanted electronic devices (PC, laptop, and mobile phone)?" The following were the outcomes:

4.6.1 Discarding Personal Computers

The respondents' responses to the first question regarding discarding PCs are displayed in Fig. 6. About 52% of those surveyed keep their computers at home. In addition, 10% of those surveyed gave their PCs back to the vendor in exchange for new goods. Almost 3% of respondents donate their PCs to charity; 22% place them in the trash with other trash; 8% give them to scammers; and five percent dispose of their PCs in other ways.

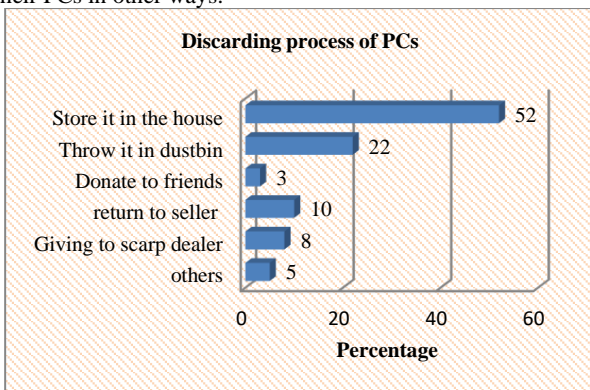


Fig. 6: Discarding Process of PCs

4.6.2 Discarding laptops

The answers to the second question, which asked how to dispose of computers, are displayed in Fig. 7. The findings indicate that 45% of participants keep their computers at home, 25% place them in the trash alongside other trash, and 4% dispose of their laptops in different ways.

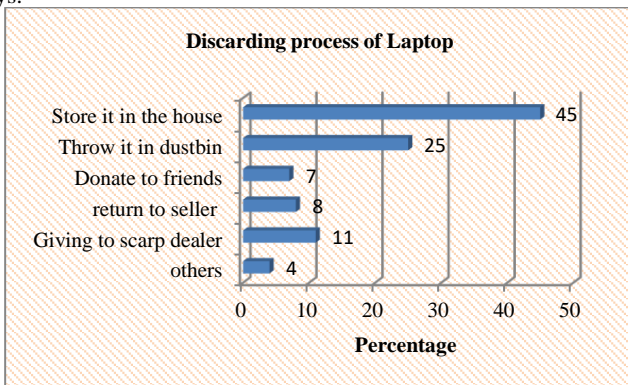


Fig. 7: Discarding Process for Laptops

4.6.3 Discarding Mobile Phones

The answers to the third question, which asked how to dispose of cell phones, are displayed in Fig. 8. According to the findings, 28% of participants keep their cell phones inside their homes. Almost 42% of those surveyed disposed of them in a dustbin with other trash. In exchange for new merchandise, 14% of respondents return their smartphones to merchants; roughly 5% of respondents donate their phones to others; 3% of respondents offer their phones to scammers; and 8% of respondents dispose of their phones in various ways.

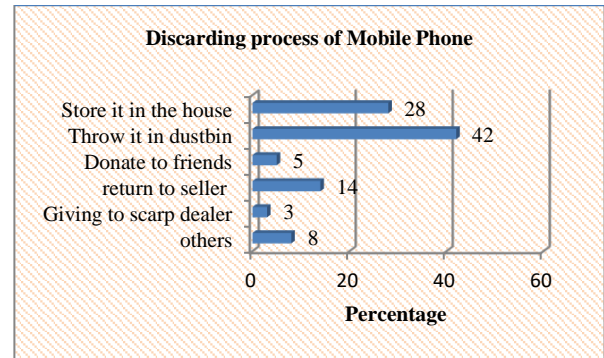


Fig. 8: Discarding Process for Mobile Phones

The findings indicate that rather than properly disposing of their unwanted PCs and laptops, the majority of respondents prefer to keep them in their homes. However, sizable portions of students place their cell phones in the trash, along with other types of trash. The small size of mobile phones may be the reason; although Attia et al. (2021) state that the amount of cadmium in a single mobile phone battery is only sufficient to contaminate roughly 600,000 liters of water.

5 Conclusion

The study's conclusions indicate that students' awareness of and behavior around managing e-waste were both lacking. It was noted that the majority of students were content to store their electronic devices at home when they were no longer required. Significant portions of students also do not know about the laws and rules governing e-waste management, nor do they know of any businesses that collect it. These facts could potentially have a negative impact on e-waste management in the future. The results of this investigation also suggest that improved behavioral outcomes are linked to increased awareness. It makes sense to begin the waste reduction process with e-waste management, which is the first step in encouraging students to separate their garbage at the source.

6. Recommendation

In light of the findings of this study, some recommendations are provided:

- By giving attention to consumers' convenience, the government should provide appropriate places to collect e-waste.
- Curriculums in universities should be revised in terms of the objectives of environmental education. In addition, modifications should be made that will positively affect student behavior regarding waste.
- Training students about recycling containers and placing these containers in easily accessible areas will help to increase the current low recycling rates for electrical or electronic waste.

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**Appendix 1**

**Part A**


Personal Information (please tick the appropriate box)

1. What is your gender?
  - 1- Male
  - 2- Female
2. What is your age?
  - 1- Less 19
  - 2- 20 to 29
  - 3- 30 to 39
  - 4- more than 40
- 3- What kind of electronic devices do you use more?
  1. Personal Computer
  2. Laptop
  3. Mobile Phone
  4. All of them

**Part B**

(Listed below are questions pertaining to assessing the level of students' awareness regarding e-waste management.) (Please choose one answer.)

- 1- Do you know what is "electronic waste" or e-waste?
  - 1-Yes
  - 2- No
  - 3-Not sure
- 2-Do you know what this symbol represents?
 



  - 1-Yes
  - 2- No
  - 3-Not sure
3. Do you know that some components of electronic devices contain toxic/hazardous materials?
  - 1-Yes
  - 2- No
  - 3- Not sure
4. Are you aware that these toxic/hazardous materials require special treatment for environmentally sound disposal?
  - 1- Yes
  - 2- No
  - 3- Not sure
- 5- Does the disposal or treatment method used for electronic waste have any impact on the environment?
  - 1-Yes
  - 2- No
  - 3-Not sure
6. Are you aware of any company that collects discarded e-waste for recycling?
  - 1-Yes
  - 2- No
  - 3- Not sure
7. Is there any regulation/law that manages the e-waste?
  - 1-Yes
  - 2- No
  - 3-Not sure

**Part C**

(Listed below are some statements pertaining to assessing the student's behaviour regarding e-waste management.) (Please choose one answer.)

No	Statements	Strongly agree	Agree	Neither agree	Disagree	Strongly disagree
1	I feel good about myself when I discard my e-waste properly.	1	2	3	4	5
2	I have enough information about how to discard my e-waste properly	1	2	3	4	5
3	I think e-waste discard is an easy task	1	2	3	4	5
4	I care that discard e-waste with other kinds of waste can be bad for my health and the health of others.	1	2	3	4	5
5	I think electronic waste should be arranged for continence collection by manufactures for recycling	1	2	3	4	5
6	I think electronic waste should be taken back to the retailer/shop	1	2	3	4	5
7	Even if I know where I can drop the electronic waste, I have no time to go there,	1	2	3	4	5

**Part D**

(Listed below are questions pertaining to identifying reasons and times replacing electronic devices by students.)

1. What was your reason for purchasing a new laptop, personal computer, or mobile phone?
  - 1- Physical Damage
  - 2- Loss of Function

- 
- 3- Need for Greater Functionality     4- Desire for the Newest Technology
- 5- Other    .....

2- How many years later did you replace the gadget:

Type of Equipment	Before 1 Year	1-2 Years	2- 3 Years	3-4 Years	More than 5 years
PCs					
Laptops					
Mobile phone					

**Part E**

(Listed below are questions pertaining to determining the current methods of discarding e-waste by students.)

1-Condition of the equipment while discarding:

type of equipment	store it in the house	throw it in dustbin along with other waste	donate to friends, relatives, schools, charitable institutions	return to the seller in exchange for a new product	give it to scrap dealer	Others specify
Personal computers						
Laptops						
Mobile phone						