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RESEARCH ARTICLE

Level of Awareness on E-waste Hazards and Management in a University Set-up: Basis for Policy Development

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ABSTRACT

This study investigates the level of awareness on e-waste hazards and management within a university setting which aimed to provide a basis for policy development. The research focuses on identifying the demographic profile of respondents, their frequency of use and reasons for acquiring electronic devices, their awareness of e-waste hazards and disposal methods, personal views on e-waste regulations, and the perceived health, environmental, and climate change impacts of e-waste. Utilizing a descriptive research design, data were collected through surveys and interviews with university employees and students.

The findings reveal that the majority of respondents are young predominantly male and single. Mobile phones are the most frequently used and owned electronic devices followed by laptops and headphones with desktop computers, printers, and scanners being less common. The primary reasons for acquiring these devices are related to academic or work needs, communication, and entertainment, with a strong interest in keeping up with technological advancements.

Although there is a general understanding of what constitutes e-waste, significant knowledge gaps exist regarding the hazardous materials within e-waste and the benefits of recycling. Only a small percentage of respondents are aware of the toxic substances such as lead and mercury, present in e-waste which pose serious risks to health and the environment if not properly disposed of. Furthermore, many are unaware of the global scale of the e-waste problem and the necessity for proper management practices to prevent environmental pollution and health hazards.

In terms of disposal practices, the majority of respondents retain their electronic devices for sentimental reasons even after they are no longer functional while others dispose them in trash or landfills which contributes to environmental risks. A smaller percentage engage in responsible disposal practices by bringing their devices to recycling centers or donating them. The study also reveals moderate awareness of existing e-waste regulations with respondents expressing uncertainty about waste segregation policies and the enforcement of sanctions for non-compliance.

Respondents recognized the toxic chemicals in e-waste and their potential to cause serious health issues such as neurological damage and cancer as well as environmental problems like soil, water, and air pollution. However, awareness of the broader global impact of e-waste and its effects

on disadvantaged communities is limited. The study highlights the need for targeted educational initiatives and more strong regulations to address these gaps, promoting sustainable e-waste management practices to protect health and the environment.

INTRODUCTION

The proliferation of electronic devices has revolutionized modern life, bringing about unprecedented convenience, connectivity, and access to information. However, this rapid technological advancement has also led to the emergence of a significant environmental challenge: electronic waste, commonly referred to as e-waste. Further, the rise of electronic garbage, or "e-waste," which is a consequence of this technological advancement is a significant and frequently ignored concern. In fact, it is one of the fastest-growing types of waste globally. E-waste is defined as the waste produced from discarded electronic and electrical equipment (EEE) including all its parts and components (Shahabuddin et.al, 2023). These devices include televisions, computers, printers, and mobile phones, among others. The disposal of e-waste has become a significant environmental and health concern due to the hazardous substances that they contain. These substances include lead, mercury, cadmium (M.C Vats et. al, 2014), and polybrominated diphenyl ethers (PBDEs), which are dangerous to human health and the environment if not disposed of correctly.

According to the United Nations Institute for Training and Research (global E-waste Monitor 2024), e-waste is the fastest-growing waste stream globally and it is rising five times faster than documented e-waste recycling with a record of 62 million tons of e-waste in 2022 which was up to 82% from 2010 and on the track to rise by 32% which is estimated to be 82 million tons in 2030. It was also reported that there were 537 million kilograms of e-waste in the Philippines, translating to 4.7 kilograms of e-waste per capita in 2022 which has made the Philippines as one of the largest producers of e-waste in Southeast Asia.

Since 2002, the Basel Convention and the "European Union Waste of Electronic and Electrical Equipment Directive" have raised awareness on the management of e-waste (Parajuly et. al, 2019). E-waste is a problem because of its annual volume growth which is a result of rising consumption and shorter product lifespans (Halim et. Al, 2019). Over the past decades, e-waste has emerged as the most rapidly growing waste stream expanding at a rate of 3-4% per year while a mere 15% of it undergoes recycling (Sahajwalla and Gaikward, 2018).

Educational institutions with their frequent technological upgrades and high usage rates play a non-negligible role in this scenario. Universities are major consumers of electronic devices for their academic and administrative activities. As a result, universities generate a significant amount of e-waste, which requires proper management to mitigate its harmful effects.

However, Harris (2018) found that there is a lack of awareness among university stakeholders on e-waste hazards and management and poses a risk to the health of staff, students, and the environment (Nnorom and Osibanio, 2008). The majority of universities do not have e-waste management policies (Tanskanen, 2013) or systems in place, and there is a limited information on e-waste generation, disposal, and recycling (Balde et.al, 2015).

Although electronic equipment is considered safe during use, the potential for release of the toxic constituents increases during storage or disposal. Because of the growing number of discarded electronic devices resulting from rapid product obsolescence, this type of waste is an emerging concern among developing countries.

Not only does this create a general waste management issue – due to the presence of many materials and chemicals in electronic products, resulting waste has the potential to severely compromise

human health and the environment (Celestial, 2018). Wang et.al, (2015) reported that hazardous chemicals commonly present in e-waste can transform into dioxins and furans when incinerated at high temperatures as well as polychlorinated biphenyls (PCBs). Thus, the toxic chemicals derived from these consumer goods can have a high bodily accumulation capacity, are carcinogenic, or are highly detrimental to the nervous system, kidney, bones, and reproductive and endocrine systems. Without effective government regulation of the disposal of electronic consumer goods, and without public awareness of the inherent hazards, accumulation of such waste will have dire consequences for the human population.

Hence, the disposal of e-waste is a critical issue that requires urgent attention. With the increasing use of electronic devices in academic and administrative functions, there is a need for proper management of e-waste.

LITERATURE REVIEW

E-waste Management Practices in Educational Institutions

E-waste management in educational institutions is concerned with the appropriate recycling and disposal of electronic equipment that is no longer in use such as computers, cellphones, and other digital gadgets. A growing volume of e-waste results from universities and institutions regularly upgrading their equipment as a result of the rapid evolution of technology. Hazardous materials like lead, mercury, and cadmium contained in electronic trash can cause harm to the environment and pose health hazards, therefore proper treatment is crucial to preventing these effects. Academic institutions are starting to use a number of strategies to address this problem, including e-waste collection stations, collaboration with recycling firms, and staff and student participation in recycling initiatives.

In a study conducted by Dayaday and Galleto (2022), majority of HEIs, both private and public colleges and universities end up putting their electronic and electrical devices into storage followed by stripping for spare parts or materials. This indicates that HEIs have yet to adopt efficient e-waste disposal practices and instead, their primary method of disposal is storing unused electronic devices in storage rooms and at times they hand over to e-waste collectors (Meneses and Galita, 2015). Likewise, Moorthy (2024) discovered that institutions were aware of e-waste but suggested a lot of strategies to reduce the e-waste in the educational institutions. A study conducted by Kassaye (2018) in a university revealed that the waste management system is not often practiced due to lack of institutional coordination and a shortage of skilled manpower resources. Hence, increasing awareness about the effects of improper e-waste disposal on human health can contribute to better management practices (Maphosa, 2022).

METHODOLOGY

The study utilized the descriptive research design aimed to describe and quantify the current awareness levels among various university stakeholders including students, faculty, and staff regarding e-waste hazards and their management practices. The research gathered relevant data on knowledge, attitudes, and behaviors related to e-waste. Moreover, the descriptive approach facilitated the identification of gaps in awareness providing a strong foundation for the development of evidence-based policies aimed at improving e-waste management within the university.

The respondents of this study were students, faculty, and staff members from various departments within the university as they play significant roles in the generation and management of e-waste in the Campus. A convenience sampling technique was employed to select participants who are readily available and willing to take part in the study.

Data for this study were collected using a combination of survey questionnaires and semi-structured interviews. The survey questionnaire was designed with both closed-ended and likert-scale questions which measured the respondents' awareness of e-waste hazards, their knowledge of proper e-waste management practices, and their attitudes towards e-waste disposal. Semi-structured interview was conducted with selected faculty, staff, and administrative personnel to gain additional information on institutional policies and practices related to e-waste management. The data collection procedure begun with the distribution of surveys via both online platforms and physical copies. This combination of quantitative and qualitative data collection methods ensured a comprehensive understanding of the awareness levels and practices regarding e-waste in the university.

RESULTS AND DISCUSSION

Ownership, frequency of use and reasons for acquisition of electronic devices

Table 1. Ownership and frequency of use

Electronic Device	Ownership	Frequency of Use
Mobile Phones	99.29	Always
Desktop Computer	15.40	Always
Printer/Scanner	7.26	Rarely
Camera	5.13	Often
Laptops/Tablets	49.20	Often
Television	7.79	Always
Speaker	22.65	Often
Headphones/Earphones	51.68	Often
DLP/Projectors	0.88	Sometimes

Table 1 provides a brief overview of the prevalence and usage of several electronic devices among the respondents. The table shows that in terms of ownership, majority of the respondents or 99.29% owned and always use mobile phones and stand out as the most common device underscoring their pervasiveness in modern society as essential tools for communication and a variety of other tasks.

Those that own desktop computers however, tend to use them "always" even though their ownership percentage is lower (15.40%) than that of laptops. This implies that while being less popular, desktop computers still have a place in society especially for tasks that call for more powerful computers and larger screens.

With ownership percentages of 7.26 % and 5.13% for printers/scanners and cameras respectively, they are less popular. However, they show opposite patterns of use. While cameras are used "often" demonstrating a continuous interest in photography as a separate activity, printers/scanners are "rarely" utilized presumably indicating a trend towards digital documentation.

A significant ownership rate of 49.20% and frequent use of laptops and tablets indicate that they play a crucial role in many facets of life including work, education, and entertainment. Like speakers, headphones and earphones are "often" used with ownership rates of 22.65% for speakers and 51.68% for headphones and earphones respectively.

Lastly, DLP/projectors have the lowest ownership rate (0.88%) and are only sometimes used indicating that they are rather uncommon among respondents and are primarily used for specific tasks like presentations or home theater setups.

Table 2. Reasons for Acquisition of Electronic Devices

Reasons	Rank

Desire for new technology	4
Need for greater power / capacity	5
Loss of function	7
Physical damage	6
For communication	2
For entertainment	3
School/Work related	1

As shown in the table, the main reason for buying electronics is “school/work related”. This confirms the critical role that technology plays in professional and educational settings where the use of digital tools is essential for efficiency and learning.

The second most popular choice is "for communication" which highlights the essential role that modern technology plays in facilitating smooth connectivity and human communication. While "for entertainment" ranked third emphasizing the importance of gadgets for leisure pursuits like streaming, gaming, and multimedia consumption that have merged into contemporary lifestyles.

“Desire for new technology” is ranked fourth indicating that a sizeable portion of respondents buy electronic equipment only to keep up with the newest technological breakthroughs and trends, reflecting a consumer culture driven by innovation and novelty.

The fifth reason for acquisition is "need for greater power/capacity ". This implies that people look for gadgets with improved capabilities to satisfy their changing needs. These capabilities can include more processing power, storage, or performance.

Physical harm and loss of function are placed sixth and seventh, respectively. These explanations show the practical side of gadget purchasing where people upgrade or replace items as they become worn out, broken, or obsolete.

Awareness on e-waste hazards and e-waste disposal

Table 3. Level of Awareness on E-waste

Statements	Mean	Descriptive Rating
E-waste refers to discarded electronic devices that are no longer in use, such as computers, cellphones, televisions, and other electronic appliances.	3.89	Aware
E-waste contains hazardous materials such as lead, mercury, and cadmium which can be harmful to human health and the environment if not disposed of properly.	1.98	Not Aware
E-waste can be recycled and refurbished to reduce the amount of waste generated and recover valuable materials such as gold, silver, and copper.	1.19	Not fully aware
E-waste is a growing problem worldwide due to the increasing use of electronic devices and the high rate of obsolescence.	1.61	Not fully aware
E-waste management practices such as proper disposal, recycling, and	1.79	Not fully aware

refurbishment, are essential to prevent environmental pollution and health hazards.		

The table shows that respondents are aware (3.89) that e-waste includes discarded electronic devices that are no longer in use including products like computers, cellphones, televisions, and other electronic appliances. This fundamental knowledge of what defines e-waste is essential since it serves as the basis for making educated disposal decisions.

The awareness levels are noticeably lower when it comes to the hazardous materials contained in e-waste with a mean of 1.98 or a smaller portion of respondents acknowledging that these materials such as lead, mercury, and cadmium can pose serious risks to both human health and the environment if improperly disposed of. This infers a knowledge gap that must be filled to support ethical e-waste disposal.

Similarly, respondents are not fully aware (1.19) that e-waste can be recycled and reconditioned to cut down on trash production and recover valuable resources like gold, silver, and copper. Promoting this awareness is essential for minimizing e-waste as well as for maximizing its positive effects on the economy and environment.

The data further revealed that respondents are not fully aware that e-waste is a growing global problem driven by the increased usage of electronic gadgets and their high rates of obsolescence. Likewise, respondents are not fully aware (1.79) that proper e-waste management techniques such as dumping, recycling, and refurbishment are necessary to avoid environmental contamination and health risks. This awareness emphasizes how crucial it is to spread knowledge about ethical e-waste management procedures to protect both the environment and human health.

Table 3 reveals that while there is a basic awareness of what comprises electronic trash, there are knowledge gaps about the dangerous components contained in electronic waste and the potential advantages of recycling and appropriate disposal. To promote appropriate e-waste management and lessen its detrimental effects on the environment and public health, it is essential to close these gaps through education and awareness efforts.

Table 4. E-waste Disposal Practices

E-waste Disposal Practices	Frequency	Percent(%)
I dispose my electronic device in the trash or landfill	82	14.51
I donate to charities or organizations that refurbish electronic devices	23	4.07
I bring to recycling centers or e-waste drop off locations to ensure that they are disposed of properly and recycled.	93	16.46
I sell online to interested buyers to earn extra money.	61	10.80
I keep it even if they are no longer in use due to sentimental or nostalgic reasons.	306	54.16

Table 4 shows the e-waste disposal practices of the respondents. It reveals that 54.16% of the respondents kept their electronic equipment for sentimental or nostalgic reasons even after they were no longer in use. This indicates a deep emotional bond with electronics that can make it difficult to dispose of them properly. On the other hand, 16.46% choose to bring their gadgets to recycling facilities or e-waste drop-off sites indicating a dedication to appropriate disposal and recycling, 14.51% of the respondents admit that they have disposed of their electronic devices in a trash can or

landfill which can have negative effects on the environment. A very small percentage of 4.07% contribute to sustainability by donating devices to charities or organizations that refurbish them while a smaller percentage of 10.80% choose to sell their devices online to interested buyers stressing an environmentally conscious approach to recycling and possibly earning some extra income.

E-waste laws, policies and regulations

Table 5. Level of awareness on e-waste laws, policies and regulations

Statements	Mean	Descriptive Rating
RA 9003 is strictly implemented in the area	2.92	Neither Aware or Not Aware
There are provisions of waste segregation policies in the area	3.23	Neither Aware or Not Aware
The local government unit imposes sanctions on violations on waste management	3.22	Neither Aware or Not Aware
There is an information – dissemination activities on e-waste segregation.	3.04	Neither Aware or Not Aware
Existing e-waste rules are insufficient and that the government should implement more strict regulations to better manage the problem.	3.14	Neither Aware or Not Aware
E-waste rules should be more comprehensive and address the entire lifecycle of electronic products, from production to disposal.	3.19	Neither Aware or Not Aware
E-waste rules should prioritize the health and safety of individuals and the environment to over economic concerns.	3.39	Neither Aware or Not Aware
E-waste rules should be more uniform across different regions and countries to create a more consistent approach to managing e-waste.	3.34	Neither Aware or Not Aware

Table 5 shows the respondents' knowledge of e-waste laws, policies, and regulations. Most of the statements seem to be "Neither Aware nor Not Aware" to the respondents or they appear to have a fairly moderate level of awareness. This shows that there is potential for improvement in the respondent's knowledge of e-waste laws and policies through information dissemination.

Remarkably, "e-waste rules should prioritize the health and safety of individuals and the environment to over economic concerns" has the highest mean score of 3.39 emphasizing that people are more aware of and agree with this perspective. The data indicates that there is a need for more comprehensive and stringent policies as well as a consistent strategy in managing e-waste and for more efforts to educate and communicate about e-waste regulations.

E-waster Health Hazards, Environmental Consequences and Climate Change Impacts

Table 6. Level of awareness on E-waste Health Hazards, Environmental Consequences, and Climate Change Impact

Statements	Mean	Descriptive Rating

	E-waste can contain toxic chemicals such as lead, cadmium, and mercury, which can cause health problems such as neurological damage, kidney damage, and cancer.	3.43	Aware
	Improper disposal of e-waste can lead to the release of hazardous substances into the environment, which can harm both human health and ecosystems.	3.54	Aware
	E-waste is the fastest-growing waste stream in the world, with an estimated 50 million metric tons generated annually.	3.25	Neither Aware or Not Aware
	The improper disposal of e-waste is a global problem, with much of it being shipped to developing countries where waste management practices are inadequate.	3.35	Neither Aware or Not Aware
	E-waste recycling can lead to significant health benefits, but it must be done in a safe and controlled manner to minimize health risks.	3.43	Aware
	The health hazards of e-waste are not just limited to the communities where the waste is produced, but can affect people living far away from the source of the pollution.	3.35	Neither Aware or Not Aware
	Children are particularly vulnerable to the health hazards of e-waste exposure due to their smaller size and developing bodies.	3.46	Aware
	The environmental consequences of e-waste include soil contamination, water pollution, and air pollution.	3.41	Aware
	E-waste contains valuable resources that can be recovered and reused, reducing the need for mining and extraction of new resources.	3.38	Neither Aware or Not Aware
	The production of new electronic devices contributes to climate change through greenhouse gas emissions from manufacturing and transportation.	3.41	Aware
	Consumer electronics manufacturers have a responsibility to design products that are not only innovative but also minimize health hazards associated with e-waste.	3.40	Aware
	Disadvantaged communities and developing countries are often disproportionately affected by the health hazards of e-waste due to inadequate waste management infrastructure and regulation.	3.32	Neither Aware or Not Aware
	Proper e-waste management can create new jobs and economic opportunities in the recycling and recovery industries.	3.40	Aware

	Raising awareness and education about the health hazards, environmental consequences, and climate change impacts of e-waste is crucial for reducing exposure and encouraging responsible e-waste management practices.	3.50	Aware

The table details the critical awareness and gaps in knowledge regarding the hazards and impacts of electronic waste as well as the importance of responsible e-waste management. The data indicates a general awareness of the health risks associated with toxic chemicals in e-waste such as neurological and kidney damage and cancer as well as the environmental dangers stemming from improper disposal practices that lead to soil, water, and air pollution. However, there is a noticeable lack of awareness or uncertainty about the scale of e-waste growth, its global disposal issues, and the potential for resource recovery from e-waste. Significantly, there is a broad recognition of the vulnerabilities of children to e-waste exposure (3.46), the role of consumer electronics manufacturers in minimizing e-waste hazards, and the significant climate impact from the production of new devices. The awareness extends to recognizing the disproportionate effects on disadvantaged communities and the potential for job creation through proper e-waste management. The high mean scores related to awareness issues indicate a general consensus on the importance of education and raising awareness to mitigate the health hazards, environmental consequences, and climate change impacts of e-waste. This reveals a critical need for enhanced education, regulation, and global cooperation to address the e-waste challenge effectively.

CONCLUSION

This study emphasizes the urgent need to improve awareness and management of e-waste hazards within a university setting particularly at Cagayan State University - Carig Campus. The research reveals that while respondents are generally aware of e-waste there are significant gaps in understanding its hazardous components and the benefits of recycling. Most respondents possess and frequently use electronic devices primarily for work, communication, and entertainment, yet many lack knowledge about the toxic substances in e-waste and its environmental impacts. Disposal practices vary with some opting for environmentally harmful methods indicating a need for better education on responsible disposal. Awareness of existing e-waste regulations is moderate with a consensus on the need for stricter enforcement and policies prioritizing health and environmental safety. The study underscores the importance of targeted educational initiatives and policy development to bridge knowledge gaps and promote sustainable e-waste management practices, emphasizing the broader implications for environmental protection and public health.

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