Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

ASSESSING ORIENTATIONS OF UNIVERSITY STUDENTS TOWARDS E-WASTE FOR INFORMED DECISION-MAKING; MESSAGES FROM DEVELOPING COUNTRIES

HAJIRA BASHIR
Department of Environmental Science, International Islamic University, Sector H-10, Islamabad, Pakistan.

NADIA AKHTAR
Department of Environmental Science, International Islamic University, Sector H-10, Islamabad, Pakistan.

AMBRINA KANWAL
Department of Computer Science, Bahria University, Islamabad Campus, Islamabad.

SARAH AMIR
Department of Environmental Science, International Islamic University, Sector H-10, Islamabad, Pakistan.

MUHAMMAD MUBBIN*
Department of Geography, Government Graduate College, Asghar Mall, Rawalpindi, Pakistan. *(Corresponding Author)

MUHAMMAD ZAMAN-UL-HAQ
Department of Environmental Science, International Islamic University, Sector H-10, Islamabad (44000), Pakistan.

SYED ATIF BOKHARI*
Department of Geography, Government Graduate College, Asghar Mall, Rawalpindi, Pakistan.
*(Corresponding Author)

Abstract

Electronic or E-waste has increased significantly due to economic development, digital transformations, and rapidly changing technologies. During COVID-19, confinement in homes accelerated the use of electronic gadgets. The unusual situation augmented the demand for new electronic gadgets, specifically mobile phones, laptops, and internet devices. The tendency is gaining impetus due to growing online learning and communication inclinations. It is anticipated that these products reach their end-of-life within 3-4 years, resulting in a surge of E-waste posing severe threats to developing economies like Pakistan. Besides this, Pakistan receives tons of E-waste from developed countries which ultimately goes to informal recycling markets. At the same time, it's also the right time to convert looming threats from electronic waste into opportunities. The present study was designed to assess university students' knowledge and orientations regarding e-waste. Data was collected using a structured questionnaire. It focuses on the students' inclinations towards E.waste. The designed questionnaire was circulated among university students of Islamabad through Google Forms, an application provided by Google, Inc. Moreover, the researchers made field visits for data collection. Resultantly, a total of 368 responses were obtained. The key findings formulate that most undergraduate and graduate-level respondents were aware of the consequences of E-waste on the health and environment. It transpired that students possess pro-environment propensities towards E-waste collection and recycling. It emerged that consumers' decisions about electronic devices significantly impact E-waste generation. Thus, there is a strong need to promote environmental awareness to ensure environmentally informed decisions. This study concludes that

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

focusing on formal education about E-waste, pragmatic regulations, and policymaking will encourage consumers (students) to opt for eco-friendly and sustainable electronics and waste management practices..

Index terms: E-waste, Regulatory framework, WEEE, Online learning, Perception and Practices

1. INTRODUCTION

Discarded electronic products are often called E-waste. It constitutes the world's fastest-growing waste stream [1] which contains hazardous and toxic substances. Thus, posing severe threats to human and environmental health [2]. Therefore, Electronic waste or E-waste is an emerging environmental hazard dubbed as an "emerging problem of the 21st century." The reliance on information technology (I.T.) enhanced during COVID-19. During the pandemic, the dependence on electronic and electrical gadgets increased due to "working from home." The growing reliance on I.T. infused a newfound quest for online education and digital-technology-based interactions [3]. Consequently, it is massively contributing to the generation of E-waste [4]. United Nations Institute for Training and Research (NITAR) report (2021) predicts that E-waste generation will enhance in the future [5].

Technological advancements, urbanization, industrialization, and economic development simultaneously push for electrical and electronic gadgets. The quantum of electrical and electronic equipment worldwide is multiplying [6, 7]. It ultimately joins the growing tide of E-waste. The careless disposal of such discarded material contributes to environmental degradation [8]. The issue is more pressing for developing countries as they heavily rely on many end-of-life electronic products (E-waste). The countries like Pakistan import E-waste from developed countries [4] and use it without due diligence [2]. Thus, E-waste import is a "new normal" and an "emerging paradox" for developing economies.

E-waste contains non-biodegradable toxic materials. It is usually disposed of in the landfills of developing countries [9]. The seepage from the poisonous materials causes groundwater and soil pollution [10, 11]. Environmental degradation damages the environment and human health. Due to its long-term repercussions, E-waste management is more challenging for developing countries [12]. Thus, managing E-waste is a pressing concern for such countries.

The lack of documentary evidence about E-waste generation and its unchecked import makes the matter trickier and more challenging for these transforming economies. The absence of a coherent policy about the safe disposal of E-waste is also culpable for the observed laxities/tendencies. It necessitates problem identification and focusing on practical recommendations. Therefore, novice strategies and approaches are required to deal with the looming concern of E-waste management in developing countries [13].

Pakistan is the fifth most populous country in the world and is expected to be in fourth place by 2050 with developing infrastructure and transforming economy [14, 15]. However, the majority in Pakistan cannot purchase the latest ultra-modern electrical items, so they mostly buy handed-down or discarded products [16]. This situation creates a demand for cheaper second-hand or end-of-life equipment imported into the country.

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

Consequently, Pakistan receives massive E-waste from developed countries as "second-hand" products [17]. Moreover, during COVID-19, reliance on I.T. equipment increased [18]. It will soon become obsolete and turn into E-waste. The carelessness of legislative organizations and governmental bodies has led to a situation in which Pakistan has no accountability for the domestic generation of E-waste nor the illegal import of discarded products.

Therefore, a robust framework is needed for sustainable E-waste management. It requires synchronizing activities and efforts to regulate E-waste management. Contrarily, it would lead to health problems and environmental disruptions. Thus, the emerging scenario urges pragmatic responses through improvising options and actions based on the understanding and realization of the problem. For this purpose, awareness and capacity-building are obligatory for a doable response. It requires integrated measures through holistic appraisals[19]

In this context, this study aims to assess university students' behavior, practices, and perception regarding E-waste. Moreover, it mainly weighs the orientations of university students toward E-waste handling, management, and disposal practices. The investigation will provide valuable insights concerning the perceptions and preferences of the respondents regarding E-waste disposal. The understanding is vitally required as they meaningful influence the production, consumption, and regulation of E-waste processes and the associated choices of stakeholders [13]. Thus, the study will substantiate the effort to achieve the objectives linked with "the triple bottom line." for ensuring sustainable ecological, social, and economic developments.

2. MATERIAL AND METHODS

2.1. Study Area

The current study assesses university students' perceptions, behaviors, practices, and trends regarding E-waste. Therefore, the data for this exploratory investigation was obtained from the university students of Islamabad (Figure .1). For this purpose, the students from the Computer and Environmental Science departments of International Islamic University Islamabad (IIUI), Quaid-I-Azam University Islamabad (QAU), Bahria University Islamabad Campus (BUI), Institute of Space Technology Islamabad (IST), National University of Science and Technology (NUST) Islamabad, and Riphah International University (RIU), respectively, were mainly focused. However, the students of the other disciplines were also consulted (Figure.1).

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

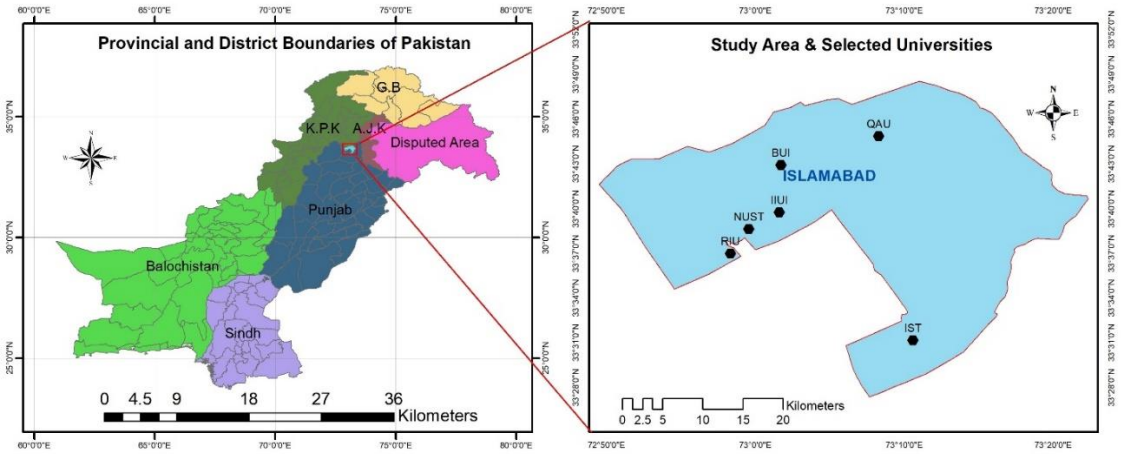

Figure 1: Study Area and Respodents

2.2. The Data Collection, Processing, And Analysis

The responses were retrieved through a structured questionnaire. The instrument for data collection inherently focuses on the inclination regarding E-waste among students. The questionnaire comprises three distinct sections: Section a studies the preferences for emerging technologies, and Section B focuses on the awareness of E-waste. While section C exclusively deals with the disposal practices deployed by the respondents (Annexure 1). Subsequently, the data collection was performed through a convenience sampling technique. Therefore, the instrument for data collection was distributed through "Google Forms." It empowers the researcher (s) to contact the potential respondents without physical linkages. For this purpose, the "would-be" respondents were approached through instant messaging applications such as WhatsApp, Instagram, and Facebook. However, it transpired that the mechanism is not proving productive due to a lack of attention from respondents. Thus, field visits to selected universities were arranged for data collection. It enabled researchers to get one-on-one responses from students. The data collection process took almost three months, from September 2022 to December 2022. Collectively 368 responses were received for this cross-sectional study. Data shows 61.4% of respondents were females while 38.6 were males, respectively. Further processing was done using Microsoft Excel (Microsoft Office Ver. 365) and R (Version 3.4.2) for descriptive statistics and statistical inferences (Figure 2).

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

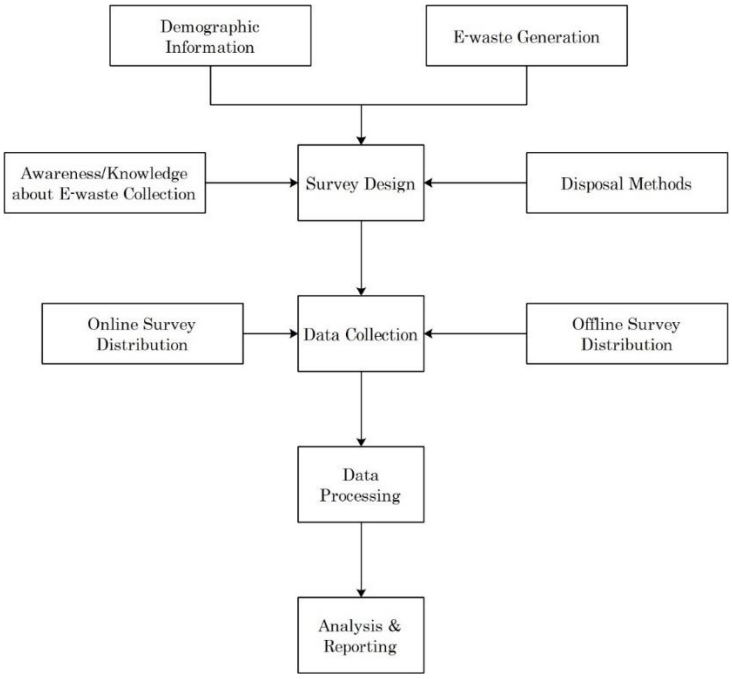

Figure 2: Methodological framework for assessments

3. RESULTS

The significant assessments based on socio-economic and demographic parameters have been summarized (Table 1). It emerged that most of the respondents are female; they belong to younger age groups and undergraduates. The environmentalist and respondents from the computer science domains collectively constitute approximately (50.8%) of the total respondents. At the same time, the remaining (49.2%) of respondents are from other disciplines. These predictor variables were relied upon for inferences and assessments.

Table 1: The Socio-Demographic Profile of the Respondents

Questions	Nature	Frequency	Percentage
Gender	Male Female	142 226	38.6% 61.4%
Age	18-24 Years 25-34 Years 35-44 Years 45 and above	315 42 6 5	85.6% 11.4% 1.6% 1.4%
Academic Qualification	Under-Graduate Graduate Post-Graduate (Ph.D.) Other	263 94 7 4	71.5% 25.5% 1.9% 1.1%

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

Questions	Nature	Frequency	Percentage
Field of Interest	Environmental Science Computer Science Any Other	135 52 181	36.7% 14.1% 49.2%
Average Lifespan	1-2 Years 3-4 Years Five and more Years	79 164 124	21.5% 44.6% 33.7%
Early Adoption of Technology	Yes No Neutral	186 74 108	50.5% 20.1% 29.3%

3.1. Age and Gender of Respodents

Age is a crucial factor that influences perceptions, practices, and knowledge regarding E-waste. The majority of the respondents are young. Approximately, about 85.6% of respondents belong to the age group ranging from 18-24 years, and 11.4% lie in the age category ranging from 25-34 years. A tiny percentage, i.e., 1.6% and 1.4%, are in the age range from 35-44 and 45 above, respectively. While about 61.4% are females, and 38.6% of respondents are males (Figure 3).

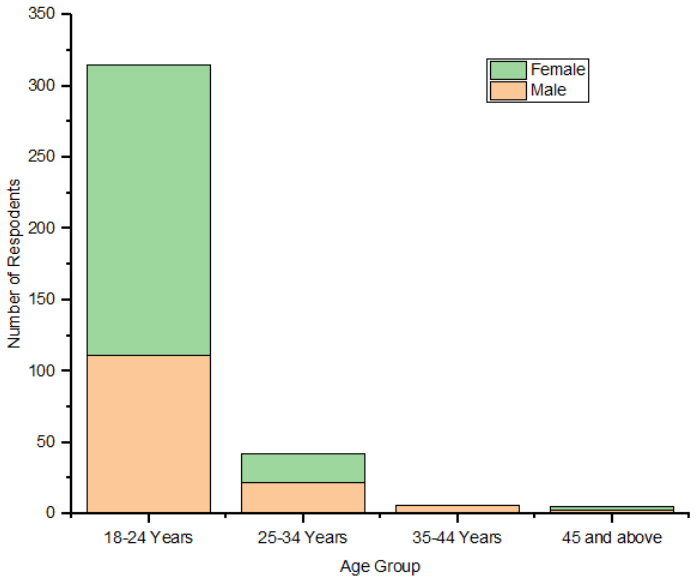

Figure 3: Age and Gender of the Respondents

3.2. Academic Qualification and Respondents

Academic qualification and grooming have noticeable imprints on human inclinations and responses. Therefore, for data collection, multiple departments of different universities were approached. However, the students with a background in Environmental science, computer science, and relevant fields such as software engineering, electrical

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

engineering, etc, primarily focused and contacted. Hence, 36.7% of the respondents directly belong to environmental science, 14,1% to computer science, and 49.2% are from other engineering and technology fields. The academic qualification of students shows that about 71.5% are undergraduates and about 25.5% are graduates. While about 1.9% of respondents are post-graduate (Ph.D.), and 1.1% belong to other educational groups (Figure 4).

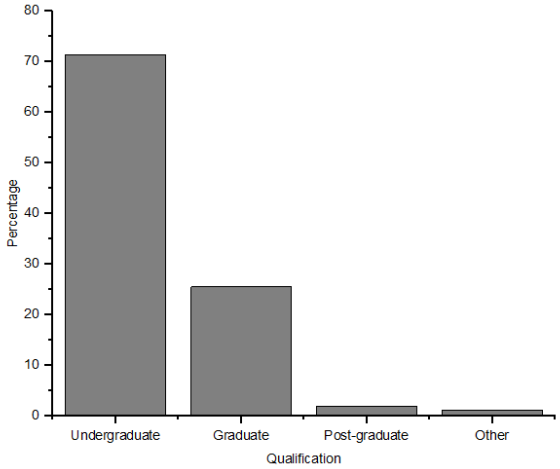

Figure 4: The Academic Qualification and Respondents

3.3. Average useable life of Electronic Products

The useable life of a product determines the generation of E-waste. Thus, assessments regarding the average lifespan of products are essential. It defines a product's useful life for the consumer. About 44.6% of respondents used their electronic product for at least 2-4 years, and 33.7% utilized it for around five years, a very healthy approach for environmental sustainability. At the same time, 21.5% of respondents reported using electronic devices for 1-2 years only (Figure 5).

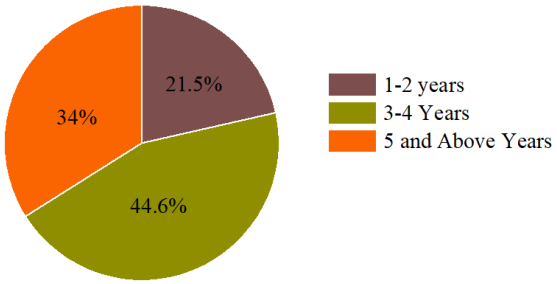

Figure 5: The Lifespan of Products and Respondents

3.4. Technological Innovations and Respodents

Respondents were enquired about their inclinations for technological innovations. A considerable population of respondents comprising 50.5%, affirmed that they are early

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

adopters, while the answer of the other 20% was No; the remaining responders opted for the option neutral against this question. It construes that the majority of the respondents frequently upgrade their electronic devices (Figure 6).

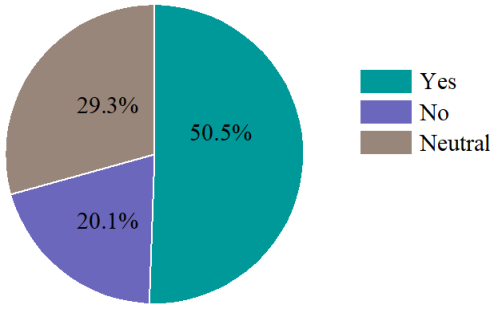

Figure 6: The Inclinations for Technological Innovations

3.5 Awareness and Knowledge about E-waste

The assessments were made to learn about the knowledge and awareness of respondents regarding E-waste. Approximately 64% of respondents claimed they knew about E-waste, while the remaining showed their lack of awareness (Figure 7 and Figure 8). It conveys that the majority of students have a clear understanding of E-waste. However, most students had a fair idea about E-waste, while only 38% of respondents affirmed that they had received formal education regarding the consequences of E-waste.

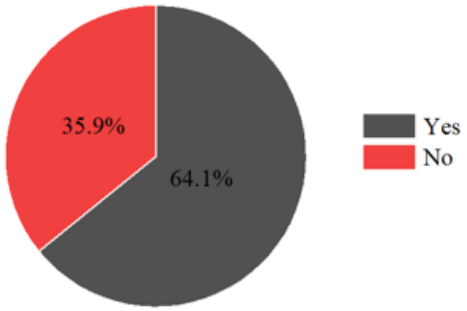

Figure 7: Awareness about E-waste and Respondents

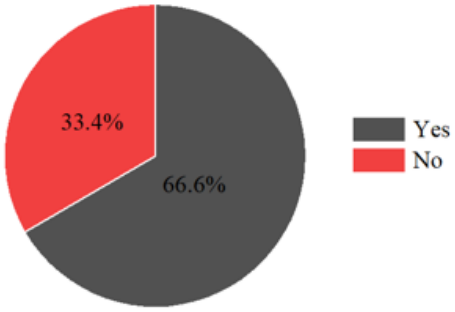

Figure 8: Formal Education regarding E-waste

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

3.6 Knowledge about the Impacts of E-Waste

The inquiries were made to assess the respondents' understanding of health hazards and environmental risks associated with E-waste. It emerged that about 62% of respondents knew about the adverse impacts of E-waste (FFigure 9). The finding substantiates that the majority of respondents have an overall concept of E-waste.

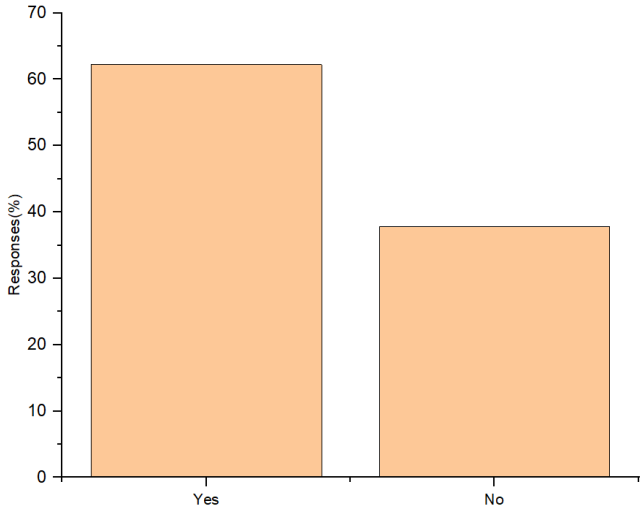

Figure 9: Knowledge about the Impacts of E-Waste

3.7 E-waste Disposal and Respondents

E-waste treatment and safe disposal are two principal components of E-waste management. It emerged that 51.9% of respondents believe that E-waste generally requires treatment before disposal. In comparison, 48.1% of respondents were unaware of such requirements. Similarly, 77.4% of respondents do not know about the presence of such a facility for the safe disposal of E-waste in Pakistan. A tiny population of respondents, i.e., only 22.6%, reported their awareness regarding this matter (Figure 10).

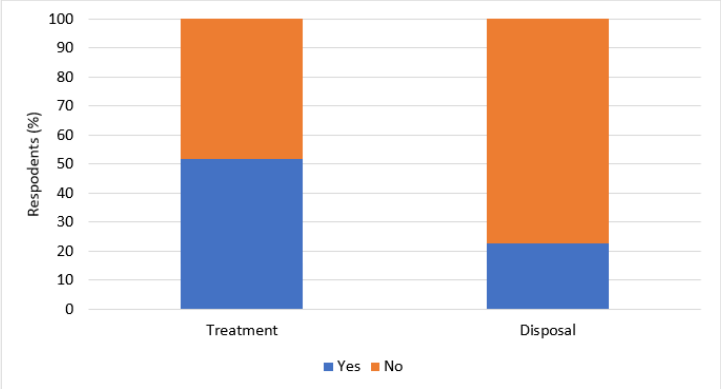

Figure 10: The Inclinations toward Treatment and Disposal of E-Waste

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

3.8. Respondents and Regulatory Framework for E-waste

The study analyzes respondents' awareness of laws and regulations concerning E-waste in Pakistan. The assessments revealed that about 79% were unaware of the regulatory framework to deal with E-waste in Pakistan. Only a small group of respondents (21%) affirmed that they knew about the regulatory framework (Table 2). It is not an encouraging scenario; urgent actions are needed to streamline E-waste management in Pakistan.

Table 2: Regulatory Framework and Respondents

	Frequency	Percentage
Yes	79	21.5
No	289	78.5
Total	368	100.0

3.9. Purchasing Preferences and Respondents

The study also tried to decipher the consumers' purchasing preferences. The assessments formulate that about 37% of respondents give weightage to the product's performance. Around 23% prefer the durability of products, 14.4% favor attractive designs, and 11% are concerned about the price (Figure 11)

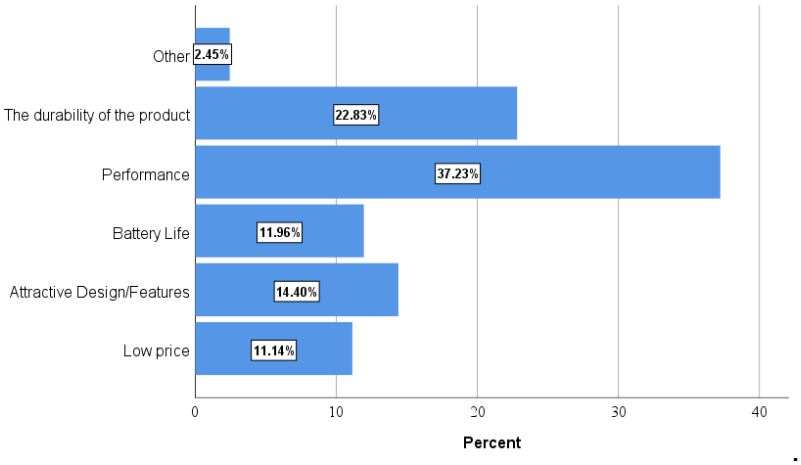

Figure 11: Purchasing Priorities and Respondents

3.9. Disposal Methods, Strategies, and Concerns

About 44.3% of respondents keep their obsolete electronic products at home due to security and privacy concerns (Figure 12). A moderate figure of 29.9% of respondents reported selling outdated products to local vendors. 19.8% of respondents throw their electronic products in the garbage. It ultimately ends up in open dumping areas or landfills. A small number comprising 4.8%, burn their obsolete products, and the remaining 4% keeping at home and use them as an alternative (Figure 12).

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

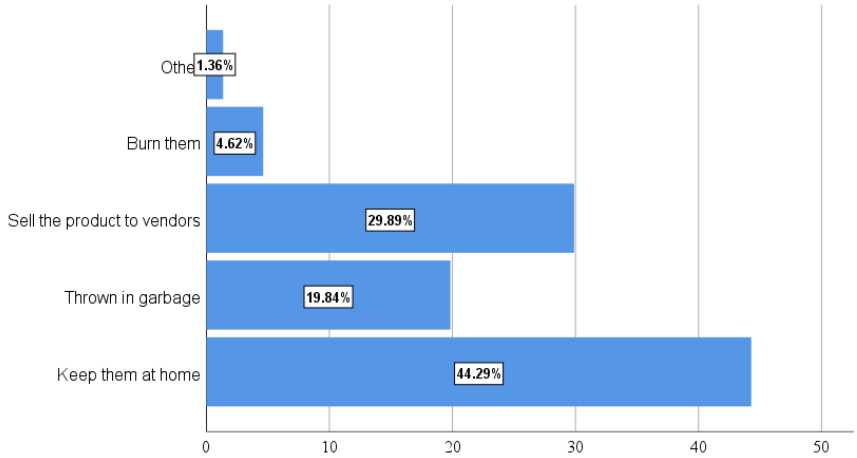

Figure 12: The Respondents and Strategies for E-Waste Disposal

While concerns for data security are another significant impediment to E-waste disposal (Figure 13), about 24.4% of respondents do not dispose of their obsolete electronic products only due to a lack of knowledge and awareness of proper disposal. While 16.3% of respondents keep their older electronic products as spare parts for future use, and 9.2% do not get rid of older products due to emotional attachments.

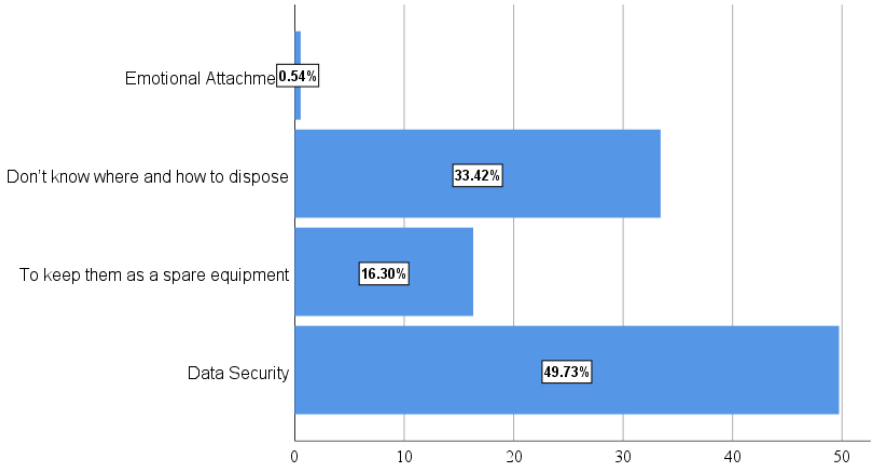

Figure 13: E-Waste Disposal and Concerns of Respondent

4. DISCUSSION

Industrialization and growing inclinations for digitization are causing a massive demand for electronics and electrical devices like computers. The electronics and electrical industries cater to the needs and earn billions annually. However, resource constraints compel developing countries to look for alternatives. Thus, reliance on second-hand equipment is a feasible choice to fulfill the demands. Consequently, developing nations

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

import discarded electronics and electrical gadgets from developed countries. It is causing a surge in E-waste imports and unleashing health and environmental complexities in countries like Pakistan. Moreover, the inclinations stimulate growth in electronic waste generation [20]

Resultantly, a noticeable increase in the quantum of E-waste is quite visible in such regions [21]. Its growth rate is three times faster than common waste [22]. It is unfolding nerve-wracking challenges for developing and developed nations. While the estimations formulate that by 2030, developing nations will discard twice as much E-waste as developed countries [23]. Moreover, the impediments such as lack of awareness, escape from responsibility, apathy from corporate sectors, neglect of healthcare, and compromised E-waste governance/management in developing regions accentuate the problem [13]. Resultantly, it is causing exacerbation for human health and the environment in such contextual settings. Thus, there is a dire need for an integrated response to increasing E-waste [24]

The scenario is posing novice challenges for such transforming economies. It entails coordinated efforts and integrated measures for safe transportation, handling, segregation, dismantling, and disposal of E-waste. Focus is more needed on those exposed and vulnerable to the toxicity of the discarded E-waste. Outdated and unused computers and their accessories constitute much of such stuff. Therefore, the present study inherently assesses the orientation of university students towards E-waste generation and management. The study relied on the cross-sectional data for analyzing attitudes, practices, and knowledge of university students of Islamabad regarding E-waste. For this purpose, the data was retrieved through a questionnaire.

The probes affirm that Pakistan is a signatory of the Basel Convention and ratified it on 24th July 1994. The agreement deals with the cross-border movements of hazardous waste. However, the signatories exploit the lacunas and import used or second-hand products without due care and diligence. The scrutiny formulates that global electronic waste generation reached a record high in recent years (53.6 million metric tons in 2019). Asia contributed almost half of the global E-waste in 2019[25]. Most of this is generated in Chin [26]. Most of the E-waste is hazardous and toxic, unfurl severe threats to public health. When improperly disposed of, it pollutes ecosystems [12]. Mihai, et al. [27] Expressed that the transboundary movement of E-waste supports sustainable development in countries with limited resources. However, unbridled access to outdated technology causes detrimental impacts on human health and the environments of importing regions. The scenario demands attention and rectification of trends and tendencies.

The electronics industry is the world's largest and most innovative industry. Electronic equipment becomes a complex waste matter after the end of- its –life-cycle. It contains many hazardous heavy metals, acids, toxic chemicals, and non-degradable plastic[28]. Thus, its management is quite challenging worldwide. New concepts and approaches are required to cope with the looming scenario of managing E-wast[20]. Hence, guidance and

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

education of the general public about safe disposal is an obligatory step for integrated management of these materials [19, 29]

Though many challenges are linked to E-waste management, the most important is the lack of legislation. Most developing countries like Pakistan do not have any E-waste legislation. Besides this, E-waste management and recycling are mainly executed by the informal sectors in these countries. They do not have the means, capacities, and intentions to handle toxic substances. Moreover, they primarily focus on profit maximization. It triggers complications and exacerbates the scenario. Therefore, in developing countries like Pakistan, immediate and coordinated efforts are required through legislation for adequate regulatory supervision.

In Pakistan, no documented information and official/authentic data are available about E-waste generation. Moreover, Pakistan is importing a vast amount of E-waste and becoming an E-waste dumping site. Thus, the insights based on this investigation will help to chalk out pragmatic strategies to tackle the emerging issue of E-waste management.

The assessments infer that reliance on electronic equipment multiplied during COVID-19 due to the lockdown, work, and education shifted from physical to online modes of communication. Many students claimed they purchased several new electronic equipments, including mobile phones, laptops, and internet devices, during COVID-19. Besides this, the findings formulate that the maximum number of students (92%) purchased new devices during COVID-19. They believe reliance on E-gadgets increased during lockdown when educational institutions shifted to an online teaching mode. It authenticates that the pandemic also proved a catalyst for adapting technology.

However, the culture of interacting through the "Soft Environment" is still in the embryonic stages. Most respondents claimed they interact through cyber-space but did not bother responding online. It is strange behavior but not discouraging. The reliance on computer-aided gadgets is gaining ground, and the tide is tilting toward a paperless mode of communication. A penchant is needed for the resilience of ecology and sustainability of the environment. This study indicated that most respondents (students) nourish a pro-environmental behavior while fewer depicted environment-destructive inclinations. Awareness and environmental education can be essential in creating and shaping positive environmental behavior among university students to provide and help them choose safe disposal options.

Most of the respondents who participated in the survey were females. The plausible reason for their active participation lies in the fact that the female authors of this manuscript did the data collection process in this study. It infers a healthy trend concerning woman's empowerment. Their active participation in decision-making is incumbent and gaining weight and acknowledgment. The findings deduce that the majority of respondents knew about E-waste. Moreover, they have a clear idea about the adverse impacts of E-waste. It corroborates the assertions that education and awareness contribute to capacity building [30-32]. However, most were unaware of Pakistan's

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

prevailing regulatory framework for E-waste. It calls for more focus on a coordinated effort to achieve sustainable development goals. The products' performance is a primary concern of students while purchasing new electronic devices. The assessments rendered that the durability of products, attractive designs, and product price are other considerations. As mentioned by the respondents, the average useable life of electronic gadgets is 3-4 years. Moreover, the fastly innovating electronic industry is resulting in the redundancy of the products without providing the opportunity to upgrade the device.

Besides this, respondents keep their obsolete electronic products at home due to security and privacy concerns. While a handful of respondents throw their electronic products in the garbage, ultimately ending up in open dumping areas or landfills. However, informed policymaking and improved E-waste governance can make this challenge an opportunity. Pakistan, a developing country, needs vital regulatory interventions to manage the flow of E-waste, as we currently do not have any regulations to deal with the emerging issue of E-waste. Students from different universities in Islamabad stressed the need for better E-waste management in Pakistan. The strategy should focus on educating, training, and capacity-building of informal recyclers. Many stockholders demand to gradually convert this informal sector into a formal industrial sector [33]

Since it is a preliminary study with limited resources and time shortage, it was restricted to only one city in Pakistan, i.e., Islamabad. For future research, it is suggested to include responses from students of other cities in Pakistan as well; it will enable us to analyze and depict the overall situation of the entire country. It is necessary to verify the indicators of the present study further to make them more reasonable and valid.

5. CONCLUSION

Lack of national policy, improper E-waste management, and high recycling costs hamper the eco-friendly control of ensuing E-waste tides. It compels the developed countries to dump their E-wastes in transforming economies like Pakistan. Widespread poverty, inequality, exponential population growth, and lack of awareness concerning E-waste impacts also contribute to E-waste dumping in these countries. Thus, the research highlights an emerging issue of illegal and informal transboundary movement/import of E-waste in Pakistan. It is paradoxical as the stuff comes from eco-friendly and developed countries that ostensibly register their concerns about environmental resilience. The top ten countries shipping their discarded E-waste to Pakistan include the United Kingdom, Iran, United Arab Emirates, Saudi Arabia, USA, Belgium, Germany, Spain, Canada, and Italy, respectively. It requires an informed assessment to tackle the emerging problem of E-waste in Pakistan. The present study assessed university students' behavior, practices, and perception regarding E-waste. This assessment was performed based on input gathered and received from university students of Islamabad, Pakistan. This investigatory research revealed that students are not aware of the consequences of E-waste. According to this study, more than half of the educated community is unaware of E-waste's impacts on health and environmental hazards. Moreover, due to the high

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

generation rate and complex composition, the disposal and management of such discarded materials are challenging. The incoherence in policies, legislation and lack of awareness worsens the matter. Thus, awareness regarding the hazardous impacts of E-waste on the local environment should be initiated. It will protect humans and preserve nature from the ensuing/potential damages of E-wastes in Pakistan.

ANNEXURIES

Annexures 1

Greetings!

With the rapid development of the electrical industry, electronic waste has become a serious concern worldwide. The growing pool of used and obsolete electronic devices has been called the "**largest toxic waste problem of the 21st century**." This problem has become more severe due to increased reliance on I.T. infrastructure to meet the demand for online modes of education and work during covid-19. This survey intends to assess university students' e-waste generation and management trends during COVID-19.

We are from the Environmental Science Department of International Islamic University Islamabad; your honest responses will be highly appreciated and used solely for research purposes.

Thank you in anticipation; your input matters for a better environment.

Part 1: Demographic Information

Email_____

Q 1: Gender

- Male
- Female
- Other

Q 2: Age (years)

- 18-24
- 25-34
- 35-44
- 45 and above

Q 3: Academic qualification (currently enrolled)

- Undergraduate
- Graduate
- Post-graduate (Ph.D.)
- Other _____

Q4: The field of interest (Discipline)

- Environmental Science
- Computer Science

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

- Any other

Q5: What is the average useful life of electronic products you use?

- 1-2 Years
- 3-4 Years
- Five years and more

Q6: Are you an early adopter of technology and prefer new products with innovative features?

- Yes
- No
- Neutral

Part 2

Awareness/Knowledge about E-waste

This section intends to assess the knowledge of students regarding E-waste.

Q1: Do you know what E-waste or electric waste is?

- Yes
- No

Q2: Have you ever received formal education about E-waste?

- Yes
- No

Q3: Are you aware that E-waste contains harmful substances?

- Yes
- No

Q4: Are you aware of E-waste's health and environmental risks?

- Yes
- No

Q5: Do you know that E-waste requires special treatment before disposal?

- Yes
- No

Q6: Do you know any facility/market for E-waste recycling in Pakistan?

- Yes
- No

Q7: Are you aware of any facility that helps safely dispose of E-waste in Pakistan?

- Yes
- No

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

Q8: Do you know any legislation that deals with E-waste?

- Yes
- No

Q9: Which key features do you want to see, or what are your preferences while purchasing new electronic devices?

- Low price
- Attractive Design/Features
- Battery Life
- Performance
- The durability of the product

Part 3: E-waste generation during Covid 19

Q1: Do you think Covid-19 has increased reliance on electronic gadgets and made us more dependent on ICT than ever?

- Yes
- No

Q2: What were your purchasing practices for electronic devices during covid-19?

- Direct from the company
- Import (via family/friends)
- Local electronic market
- Online (Third party suppliers)

Q3: How many electronic gadgets have you purchased to meet the requirements of an online mode of education and work at the household level?

Gadgets	Desktops	Laptops	Mobile Phone	Internet Devices
Number				

Q4: What was the reason for purchasing new cell phones or computers rather than repairing older ones during covid 19?

- Physical Damage
- Loss of Function
- Need for Greater Functionality
- The desire for Newest Technology
- Non-availability

Q5: What were your preferences when you purchased electronic devices during covid?

- New products
- Used ones

Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

- I refurbished the older one

Part 4: Disposal Methods/Strategies

Q2: Which of the following mode of disposal for e-waste is used at your household level?

- Keep them at home
- Thrown in garbage
- Sell the product to vendors
- Burn them

Q3: What was your primary concern while disposing of the E-waste?

- Data Security Concerns
- To keep them as a spare equipment
- Don't know where and how to dispose
- Emotional Attachment

Q4: Can electronic waste serve any of the following purposes?

- can be repaired or Reused
- Can Utilize Components / Raw Materials
- It can be used in case of emergency

Q5: Would you like to volunteer for any E-waste collection and recycling program?Yes

- No
- May be

References

1. D. Perkins, M. B. Drisse, T. Nxele, and P. Sly, "E-Waste: A global hazard Annals of Global Health," vol-80, 2014.
2. J. Donnelly, "Revealing the hidden pandemic: the impact of COVID-19 on the e-waste crisis," 2022.
3. UNEP-IETC. (2016, 26th December, 2022). The United Nations Environment Programme (UNEP)-International Environmental Technology Centre (IETC). Available: http://www.unep.or.jp/
4. L. Andeobu, "A Systematic Review of E-Waste Generation and Environmental Management of Asia Pacific Countries," 2021.
5. C. Baldé and R. Kuehr, "Impact of the COVID-19 pandemic on E-waste in the first three quarters of 2020," United Nations University (UNU)/United Nations Institute for Training and Research (UNITAR)–cohosting the SCYCLE Programme, Bonn (Germany), 2021.
6. J. N. Ribeiro, A. F. Melo Barbosa, A. V. F. Nardy Ribeiro, M. d. Godoi Pereira, J. P. de Oliveira, A. B. Zordan, et al., "E-waste and its consequence for environment and public health: Perspectives in covid-19 pandemic times," Global Journal of Health Science, vol. 14, p. 54, 2022.
7. W. Avis, "Technical Aspects of e-Waste Management," 2022.
8. J. N. Ribeiro. (2022, Februarary) E-Waste and Its Consequence for Environment and Public Health: Perspectives in Covid-19 Pandemic Times. Global Journal of Health Science.

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

9. V. Forti, C. P. Balde, R. Kuehr, and G. Bel, "The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential," 2020.
10. V. N. Kyere, "Environmental and health impacts of informal e-waste recycling in agbogbloshie, accra, ghana: recommendations for sustainable management," Universitäts-und Landesbibliothek Bonn, 2016.
11. K. Grant, F. C. Goldizen, P. D. Sly, M.-N. Brune, M. Neira, M. van den Berg, et al., "Health consequences of exposure to e-waste: a systematic review," The lancet global health, vol. 1, pp. e350-e361, 2013.
12. "The Growing Environmental Risks of E-Waste," 2022.
13. N. Akhtar, S. A. Bokhari, M. A. Martin, Z. Saqib, M. I. Khan, A. Mahmud, et al., "Uncovering Barriers for Industrial Symbiosis: Assessing Prospects for Eco-Industrialization through Small and Medium-Sized Enterprises in Developing Regions," Sustainability, vol. 14, p. 6898, 2022.
14. M. Afzal, "Population growth and economic development in Pakistan," The Open Demography Journal, vol. 2, 2009.
15. S. Parveen, A. Q. Khan, and S. Farooq, "The causal nexus of urbanization, industrialization, economic growth and environmental degradation: Evidence from Pakistan," Review of Economics and Development Studies, vol. 5, pp. 721-730, 2019.
16. S. Zafar and M. Armughan, "Assessing Consumers' Awareness, Disposal, and Participation Toward Electronic Waste in a Developing Economy: Evidence From Pakistan," Journal of Asian and African Studies, p. 00219096231173388, 2023.
17. R. Rasheed, A. Rizwan, H. Javed, F. Sharif, A. Yasar, A. B. Tabinda, et al., "Analysis of environmental sustainability of e-waste in developing countries—a case study from Pakistan," Environmental Science and Pollution Research, vol. 29, pp. 36721-36739, 2022.
18. C. W. Wong, A. Tsai, J. B. Jonas, K. Ohno-Matsui, J. Chen, M. Ang, et al., "Digital screen time during the COVID-19 pandemic: risk for a further myopia boom?," American journal of ophthalmology, vol. 223, pp. 333-337, 2021.
19. Ahirwar, "E-waste management: A review of recycling process, environmental and occupational health hazards, and potential solutions," Environmental nanotechnology, monitoring & management 2021.
20. Dutta, "Electronic waste pollution and the COVID-19 pandemic," Environmental Chemistry Letters 2021.
21. V. Forti, "E-Waste statistics Guidelines on classification, reporting and indicators," 2018.
22. P. a. Roman, "E-scrap exportation: Challenges and considerations," Conference: Electronics and the Environment, 2002 IEEE International Symposium on, 2002.
23. A. Shanika, S. Jay, and S. Brian, "Application of life cycle assessment to nanoscale technology: Lithium-ion batteries for electric vehicles," United States Environmental Protection Agency, US, 2013.
24. S. a. Patil, "Electronic Waste - A Literature Review," International Journal of Science and Research, 2013.
25. Forti, "Global E waste Monitor," 2020.
26. "Global E waste Statistics Partnership," 2020.
27. F.-C. Mihai, M. G. Gnoni, C. Meidiana, P. Schneider, C. Ezeah, and V. Elia, "A Global Outlook on the Implementation of the Basel Convention and the Transboundary Movement of E-waste," in Paradigm Shift in E-waste Management, ed: CRC Press, 2022, pp. 49-75.

ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 07 | 2023
DOI 10.17605/OSF.IO/7X8DT

28. J. Kishore, "E-Waste Management: As a Challenge to Public Health in India," Indian journal of community medicine. 2010.
29. I. Khan, M. I. Shanwari, N. Akhtar, S. Kanwal, M. Mubbin, M. Zaman-Ul-Haq, Et Al., "Socio-Economic Impacts On Urban Domestic Waste Management: Challenges And Options For Developing Countries."
30. S. Atif, Z. Saqib, A. Ali, and M. Zaman, "The impacts of socio-economic factors on the perception of residents about urban vegetation: A comparative study of planned versus semi-planned cities of Islamabad and Rawalpindi, Pakistan," Appl. Ecol. Environ. Res, vol. 16, pp. 4265-4287, 2018.
31. S. A. Bokhari, Z. Saqib, A. Ali, A. Mahmud, N. Akhtar, A. Kanwal, et al., "The impacts of land use/land cover changes on the supply-demand budget of urban ecosystem services," Arabian Journal of Geosciences, vol. 14, pp. 1-27, 2021.
32. M. Zaman-ul-Haq, A. Kanwal, A. A. Gardezi, H. Fatima, Z. Saqib, S. A. Bokhari, et al., "Assessing Spatial-Temporal Changes in Monetary Values of Urban Ecosystem Services through Remotely Sensed Data," Sustainability, vol. 14, p. 15136, 2022.
33. M. K. S. Bhutta, "Electronic Waste: A Growing Concern in Today's Environment," Economics Research International, 2011.