The Preliminary Online Survey on E-waste Literacy in Nepal

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ABSTRACT

Electrical and electronic wastes (E-wastes) are complex waste and a new to the community. They are boon of new advanced technology serving the sophisticated society on the Earth; however, they are disaster from environmental point of view. E-waste is complex in its composition with small quantities of expensive metals such as Gold, Silver, Platinum, Copper and even toxic metals such as Lead, Cadmium, and rare earth metals (including Yttrium, Indium and many more). Knowing the value of these metals and their recyclability as well as the toxicity of some constituents, it has become important to develop proper regulations as well as appropriate strategies and technologies to extract and detoxify all the elements present in them. Moreover, that one should know the type of waste he or she is producing and be responsible for its proper management. With these concerns, from September 6 - Oct 6, 2020 during Covid-19 lockdown period, an online survey was conducted by creating a Google form in which 453 participants submitted their opinion responding to the queries prepared in the form. The survey was requested by sending group E-mails and the virtual platform of Facebook, messenger with tagging many people in academia, waste management, stakeholders of science waste workers and many other people in community for wide dissemination of survey. During the pandemic lockdown the whole world was subjected to virtual platform. Education sector came first in the virtual platform during lockdown and the data response show that women from education background are in majority due to their free time waiting for virtual class. The survey showed ratio of women respondents higher than men, (with women to men ratio of 1.6:1 and 76 % were students). The higher numbers of replier were from the age group of 17-40. The replies indicated that 63% of reporters were aware of the E-wastes. However, 83% of people know the health hazard of E-waste. The interesting part of the survey was that 73.7% of respondents were segregating E-waste from other wastes due to their economic value. As 75% reported their knowledge about precious metal contents in it and 80.6% knew their recyclability. The survey revealed that a significant fraction of the population, especially comprising the students, was literate on E-wastes knowing about their economic values and possible hazards to health and the environment.

Keywords: Electrical and electronic equipment (EEE), E-waste, International policies, Online survey, Nepal

1. Introduction

Electronic wastes (E-wastes) are non-functional Electrical and Electronic Equipment's (EEE), such as computers, laptops, mobiles, handsets, televisions, refrigerators, and other appliances which have been dumped by users at the end of their economic value and cannot be reused further (Giri & Adhikari 2020). The European Union Directive 2012/12/19/EU refers E-waste as Waste of Electric and Electronic Equipment (WEEE) (Directive 2002/96/EC 2003; Directive 2012/19/EU 2012). This WEEE are classified as a special waste (13.030 wastes) in the International Classification of Standard's (ICS) catalog 13.030.3, along with nuclear waste, hospital waste, and other hazardous waste by International Organization for Standardization (ISO). Due to rapid technical innovations, planned obsolescence in the electronics sector and rising consumer demand for new electronic devices, E-waste is the fastest over growing waste on the planet. The yearly introduction of new version of smartphones, computers, and other electronic gadgets, results in the accumulation of unutilized older versions. E-waste is fast increasing due to the shorter invention periods and poor recycling levels (Perkins *et al.* 2014) Electronic items make life easier and have become a status symbol, leading to an increase in electronic trash. Furthermore, as technology advances, the price of electronic devices fall and become more accessible, allowing people to dispose of their old gadgets with ease (Okwu & Onyeje 2014). In addition to that, manufacturers' purposeful impermanence of their EEE by continuous releasing new models with greater features persuades customers to believe that purchasing new gadgets is often cheaper and more convenient than upgrading current ones. The liquid crystal display (LCD), displays, easily replaced cathode-ray tube (CRT) monitors which are smaller and consume less energy, and is the best example of this trend, resulting in a significant CRT monitor disposal. Similarly, aggressive marketing and enticing incentives by the manufacturers, lure people to seek out new EEEs.

The vast majority of the EEE are made up of the two primary units: i) polymer, and ii) the inner complex metallic setting, sensor coated printed circuit board (PCB) which consist of the variety of harmful and non-harmful inorganic such as expensive gold (Au), silver (Ag), Copper (Cu) and Palladium (Pd)), toxic and heavy metals such as Nickel (Ni), Tin (Sn), Lead (Pb), Chromium (Cr), and iron (Fe) and organic components such as polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), and brominated flame retardants (BFR) (Needhidasan et al. 2014). Lead and Cadmium (Cd), in circuit boards and mercury (Hg) in switches, are extremely poisonous causing major health problems in the central nervous system, blood circulation system, excretory organs, and brain growth, etc (Rawat *et al.* 2020).

One of the study shows, E-waste causes, physical, mental, and neurological retardation (Grant *et al.* 2013). Copper being a flame retardant metal acts as a catalyst for dioxin formation when burned (Cui & Zhang 2008). It has been noticed that thyroid and lungs functioning, reproductive health, growth, and changes in physiochemical activities in cell are harmed by exposure to E-waste (Grant *et al.* 2013; Beiyuan *et al.* 2016). Contrary to this, EEE is inextricably linked to global economic growth. Increased discretionary incomes, urbanization, mobility, and industrialization in various regions of the world are contributing to rise EEE consumption. One of the data showed, the average intake of the overall weight (excluding photovoltaic panels) of global EEE increases by 2.5 million metric tons (Mt) per year (Forti *et al.* 2020) which ultimately converts to WEEE.

Asia produced highest amount of the E-waste in 2019, (24.9 Mt), followed by the Americas (13.1 Mt) and Europe (12 Mt). In term of per capita, Europe ranked first then Oceania (Forti *et al.* 2020). The management part of collection and recycling is 42.5% done by Europe in 2019, later followed Asia.

During covid-19 lockdown 1.3 billion students started online class and 300 millions people started working from home in the virtual plate using EEE which after 10 years anticipated to convert to WEEE (Li & Lalani 2020; International Labor Organization 2020; International Data Corporation 2020). Thereafter, the amount of WEEE will increase by 3% per year which is higher than the world wide population growth (Yu *et al.* 2020).

The time has come to implement correct E-waste management policies as these E-wastes are being illegally traded and dumped which cost approximately $19 billions every year (UNEP 2015). The agreement in Basel convention and Basel Ban are not being regulated by the signatory countries, however, developed countries do not allow E-waste to enter into the normal trash (Li *et al.* 2013). It goes to recycling sectors which focus on labor intensive process and cause severe complications in health and the environment of the local

territory (Han *et al.* 2018; Dias *et al*. 2019; Pariatamby & Victor 2013).

The developed countries such as Germany, Japan, Europe, China have implemented strict policies of E-waste management such as Extended Producer Responsibility (EPR), Polluters Pay, per-purchase tax payment, many laws and principles of 3R's, 7R's which suits their EEE business circular economy (the ElektroG) (Wang *et al.* 2017; Sander *et al.* 2007; Walther *et al.* 2010; Bhutta *et al.* 2011; Otmar 2014). At the same moments China refused foreign trash as it has been the world's largest junkyard since 2014 (Zhang 2020; Li *et al.* 2006; Pariatamby & Victor 2013; Tong & Yan 2013; *Wang et al.* 2017). In case of southern Asia, India become the first to implement EPR based E-waste management which came in action on 1st May 2012 (PACE Nepal Pvt. Ltd., 2017; Suja *et al.* 2014; Rathore *et al.* 2011; Khetriwal *et al.* 2019).

Nepal is importer of EEE, from neighboring countries and third world countries. According to Global E-waste monitor in 2020, Nepal had accumulated 28 kilo tonns of E-waste in 2019 i.e. 0.9 Kg per inhabitant (Forti et al. 2020). Nepal Telecommunication Authority (NTA) had also collected the cellphone import data from Tribhuvan International Airport (TIA) custom department in early 7 months in 2075/76 BC fiscal year which was 2,686,648 pieces which is many times higher than the earlier fiscal year 2074/75 (Nepal Telecommunication Authority 2021; Aryal 2020). It clearly indicates the ratio of E-waste production in near future in Nepal (Awale 2018; PACE Nepal Pvt. Ltd. 2017).

Article 30 of Nepal's 2015 constitution establishes a legal right to live in a clean environment and right to compensate for damage caused by environment degradation. In this scenario, Nepal is also showing concern to protect environment from the waste and regulate the solid waste management Act in 2011, however, there is no mention for E-waste management. E-waste is the complex waste which needs to be handled differently and for that, skilled hands are necessary (Nepal Telecommunication Authority 2017; Mandal 2021; Satyal 2017, Parajuli *et al.* 2018; Turaga *et al.* 2019).

As EEE are the high-tech gadgets and from the stage of its manufacture to its end use and its waste management require high level of knowledge and understanding. Therefore, this survey tries to explain the literacy of the EEE users specially the youth who started their online teaching learning program and work from home during lockdown period of covid-19 pandemic.

2. Survey Objective and Methodology

2.1 Online Survey

The status and effects of E-waste in Nepal and the analysis of the awareness concerning E-waste management, a short pilot online survey was conducted using Google form. The survey was run for about a month, Sept 6- Oct 6, 2020, the time of the global crisis "COVID-19 pandemic" during lockdown period. Physical separation and quarantine were required to mitigate the impacts of the COVID-19 epidemic. To comply with this demand, different aspects of human activity (such as purchasing, learning, working, meeting, and entertaining) have transferred to online, resulting in a faster adoption of developing digital technologies by the general public. Electronics like televisions, computers, laptops, and cellphones have been increasingly popular, particularly during this epidemic. Looking at the pace of the technological advances, it did not take much longer for these devices to be discarded and replaced with their newer versions.

In the survey, pre-designed questionnaires were set targeting E-gadget users. The main objective was to collect information on the majority usage of Electrical and Electronic Equipment (EEE) by certain age groups, professions, and the ratio of family members. In addition to that, the questionnaires also revealed the habits of users regarding the disposal or storage of E-waste. The survey focused on the respondent's quantity of electronic devices, their purpose for using them, their awareness of recycling trends, practices employed for managing their E-waste, and their satisfaction with E-waste handling.

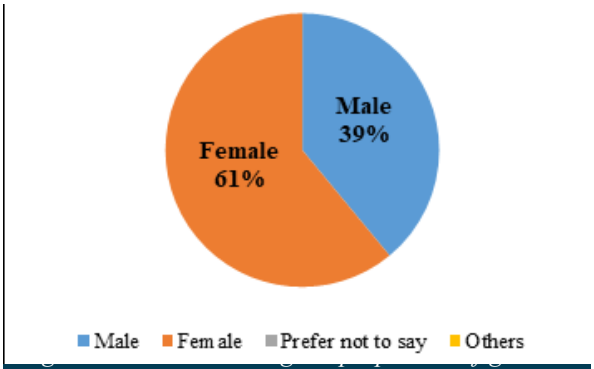
[Google form link: https://docs.google.com/forms/d/e/1FAIpQLSepAnlL5ifImgmiq6HjAlkqgsIky5h3hPBcRoj5k18C_MKU5A/viewform]

2.1.1 Respondents

In all, 453 people took part in the survey, representing various age groups and occupational backgrounds.

2.1.2 Male / Female ratio

This survey received responses from 176 men and 276 women, with a male participation rate of 39% and a female participation rate of 61% as shown in the pie chart [Fig. 1].



who responded to the survey

2.1.3 Age bars

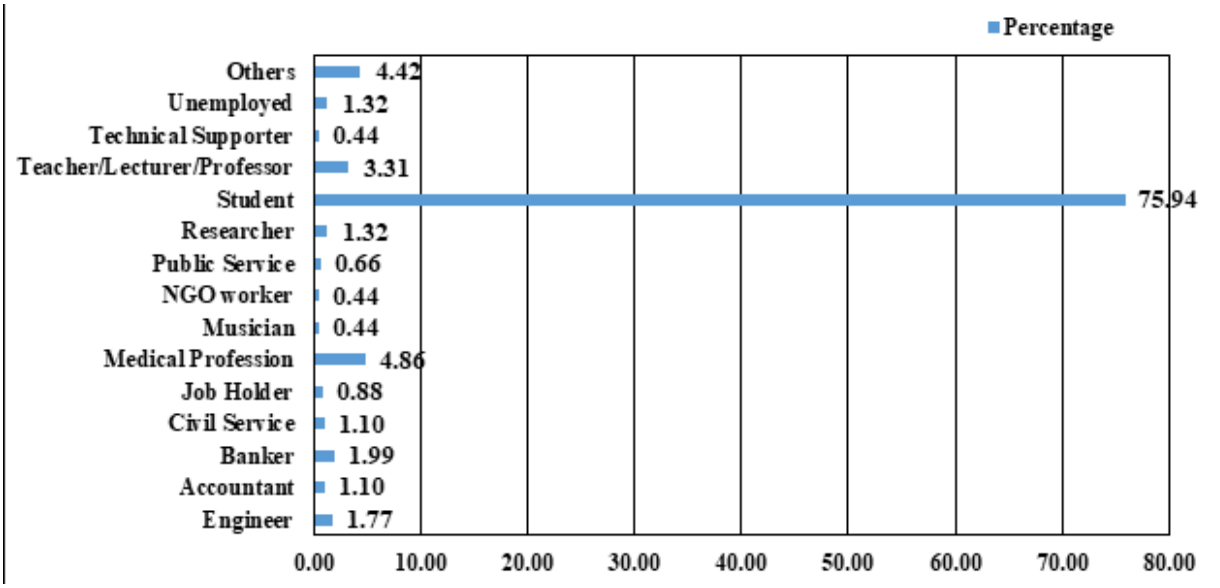
The respondents were classified into different sub-groups according to their age as shown in Table 1. Among the total 227 respondents, the age group 17-22 had the largest participation, followed by the age group 23-40, with 221 respondents. These age groups are considered to be most familiar with the usage and application of E-gadgets.

Table1: Division of respondents into various sub-groups as per their age

Age Group (in years)	1-16	17-22	23-40	41-50	51-60	Total
Responses	1	227	221	2	2	**453**

2.1.4 Profession

This poll drew a wide range of responses based on the occupation of the respondents as shown in (Fig. 4). Students accounted for the bulk of replies (about 76%), followed by medical professionals (5%), teachers/lecturers/professors (4%), and others (4%).



2.2 Literacy on E-waste

2.2.1 Male /Female ratio

The ratio of female to male respondents in this survey is about 1.6:1. This indicates that the use of E-gadgets is more popular among the female population here in Nepal. In Nepalese society, females are more active in domestic activities justifying the higher usage of electrical equipment like microwaves, ovens, freezers, vacuum cleaners, and other similar technologies for a more convenient living (Matinga *et al.* 2019).

2.2.2 Age bars

Table 1 indicates that the age group from 17-22, which accounts for about half of all respondents, uses more E-gadgets than the other age groups. This age group often includes students who have taken the SEE and are looking for high schools, as well as those who are currently enrolled in colleges or institutions. The age group from 23-40 falls second on the list and in general consists of graduate students who are in search of employment or higher education. According to the National Population and Housing Census of Nepal 2011 report, the population of age group 15-24 years is 21.86 % (male 3,176,158 / female 3,169,721) and 25-54 years is 35.99% (male 4,707,264 / female 5,740,985) with a median age of 21.6 years (Central Bureau of Statistics Nepal 2012). These statistics reveal that the younger generation makes up a higher share of the Nepalese population and is more familiar with electronic devices than other age groups, which is supported by the highest number of participants from this age group in this survey.

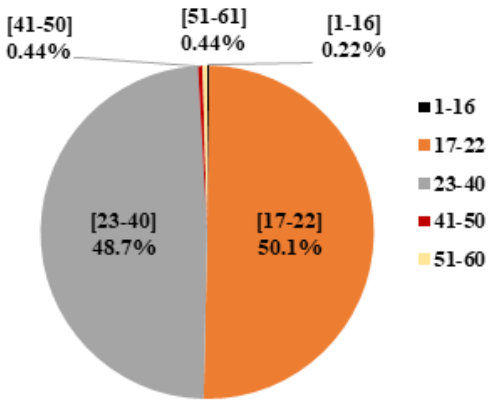


Fig. 3: Participation of different age groups in the survey in terms of percentage

2.2.3 Profession

As shown in Fig. 2, the use of E-gadgets is highest among the students, which resembles the data in Table 1. The age group from 17-22, in general, constitutes college or university graduate students and are more likely exposed to different EEEs like laptops, desktops, smart-phones, printers, etc. for their academic commitment or social media usage. The number of internet users climbed to 10.78 million in January 2021, according to national statistics. Nepal's internet users increased by 567 thousand (+5.5%) between January 2020 and January 2021, with 36.7% internet penetration in January 2021 (Data Reportal 2021). This was during the covid-19 pandemic which directly affected the teaching-learning activities of nearly 8,796,624 students as estimated by UNESCO. Most schools and colleges opted for online platforms which might be one of the reasons for maximum usage of E-gadgets by the students (Pal *et al.* 2021)

In this survey, medical professionals are the second-highest consumers of E-gadgets. Since the survey was conducted during the COVID-19 pandemic, health workers and medicinal professionals were more exposed to the use of electrical equipment like ventilators, breathing systems, and other life support equipment (GlobeNewswire 2021).

Professors, teachers, and lecturers are the third most frequent users of E-gadgets. Since the survey was conducted during the commotion of the COVID-19 pandemic, the reasons for the results are quite evident with the whole education system undergoing digitization. It has been reported that by the end of 2020, every student took at least one online class and a professional attended at least one virtual training (Mishra *et al.* 2020). This certified the increase in the use of E-gadgets among consumers.

2.3.1 Consumption pattern

According to the annual household survey 2015-16, the average household size is 4.6 persons per family in Nepal which is 4.2 in urban and 4.8 in rural (Central Bureau of Satistics Nepal 2017). Given that at least one family member has access to certain E-gadgets, the poll included a question on the number of family members accessing any kind of E-gadget. There were a total of 2217 family members registered in our survey, based on 453 respondents considered each responder belongs to a separate family. This concluded that the average household size is 4.89, which is almost similar to data

published by the annual household survey 2015-16 or we can analyze this data in another way that there is a certain increment in the average number of family members in Nepal from 2016 to 2020. So, at minimum, there is an average of 5 members per family who get access to at least one E-gadget. The total number of households in Nepal as per the population census of 2011 is 5,427,302. By prediction, at least 27,136,510 E-gadgets are operating within these families, excluding offices, business sectors, schools, etc. The average size of family predicts the total number of users who are dependent on different E-gadgets in their daily life.

2.3.2 Type of Electronic Devices in practice

The study also aimed at finding the most widely used E-gadgets, such as desktops, laptops, televisions, mobile / smart-phones, refrigerators, printers, microwaves, and other electric home appliances. Table 2 shows the data of some commonly used electronic devices in our daily life. According to the observed data, cellphones/gadgets are the most commonly used electronic equipment, accounting for about 16% of all respondents (excluding basic E-gadgets such as electric bulbs, fans, and so on). A total of 1636 mobile phones are in use, out of 453 respondents which is about an average of 3.6 (~4) mobile phones per person. Besides that, the other gadgets in use are laptops 646 (6%), televisions 513 (5%), refrigerators 440 (4%), desktops 213 (2%), etc., among 453 respondents. A whopping total of 10,038 electronic devices were recorded from 453 respondents and the ratio of total E-gadgets in use to total respondents is 22:1 i.e. 1 respondent holds 22 E-gadgets.

Table 2: The data showing the number and types of E-gadgets used by 453 respondents

E-waste	Number	E-waste	Number
Electric Bulb	2256	Television	513
Cellphone/Gadgets	1636	Refrigerator	440
Electric Fan	1292	Water Pump	437
Earphone/Headphone	903	Desktop	213
Other	722	Vacuum Cleaner	181
Laptop	646	Printer	134
Wi-Fi Router	549	Microwave	116
		Total	**10,038**

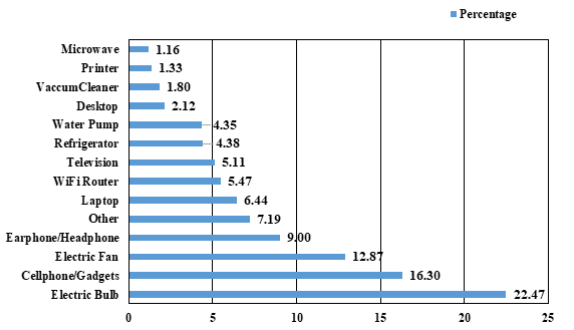


Fig. 4: The chart showing different types and percentages of the E-gadgets currently in use by the respondents

2.3.3 Replacing Practices of E-gadgets

In Nepal, there is a strong demand for the import of E-gadgets and cellphones. The import of more short-lived E-gadgets from foreign countries is also one of the major reasons for the increase in the number of E-waste. Due to the low economic status of the majority of Nepalese people, E-gadgets merchants and businessmen focus on importing low-cost, low-quality electronic goods with short lifespans, contributing to a high amount of E-waste production (Khatri 2019). The lifespan of many electronic equipment have been shortened by appealing new designs, marketing, and compatibility concerns. In the previous decade, the typical lifespan of a new computer has fallen from 6 to 2 years (Bhutta *et al.* 2011) the global market of electrical and electronic equipment (EEE). Cell phone companies design phones that aren't built to survive long, forcing consumers to buy new phones more frequently (Lamichhane 2017).

In general, a total of 1299 cellphones were replaced by 453 respondents within 5 years, as per the survey. In five years, about 6.4% of all respondents changed five cell phones, 8.6% replaced four cell phones, 28.03% replaced three cellphones, 37.74% of all respondents changed two smartphones, and 12.14% replaced at least one cellphone. On average, 2.87(~3) cellphones were replaced by each respondent within the 5 years duration. That means, the average number of cellphones as E-waste produced per person within 5 years of interval is 3.

2.3.4 Budget/ Expenses in E-Gadgets

According to our findings, each person annually

spends about NRs. 33,946.00 on E-gadgets. The annual expenditure by 453 respondents on E-gadgets is about NRs. 15,377,745.00. This indicates increase in the inclination of Nepalese people in buying new, sophisticated, and updated versions of smart E-gadgets.

2.4 E-waste generated

The E-waste generated per family was calculated by dividing the total number of generated E-waste by the total number of respondents recorded in this survey, considering each responder belong to a different family. The total sample size of 453 respondents, gave an average E-waste generation per family. In these 453 families, there was a total of 4781 pounds of E-waste generated. There are 2,217 people in total in 453 households. As per the calculation, every single person in this survey is responsible for converting every 3 E-gadgets into E-waste. Out of the total E-waste (4781), 1020 are electric bulbs (21%), 881 are cellphones (18%), 777 are headphones (16%), 432 are electric fans (9%), 227 are televisions (5%), and 461 are other forms of E-gadgets (10%). Table 3 shows the number of various E-gadgets reported in the survey.

Table 3: The different types and numbers of E-waste reported by the respondents in the survey

E-waste	Number	E-waste	Number
Television	227	Microwave	51
Cellphone/Gadgets	881	Electric Bulb	1020
Laptop	188	Electric Fan	432
Desktop	146	Water Pump	158
Printer	63	Wi-Fi Router	184
Refrigerator	121	Earphone/ Headphone	777
Vacuum Cleaner	72	Other	461
		Total	4,781

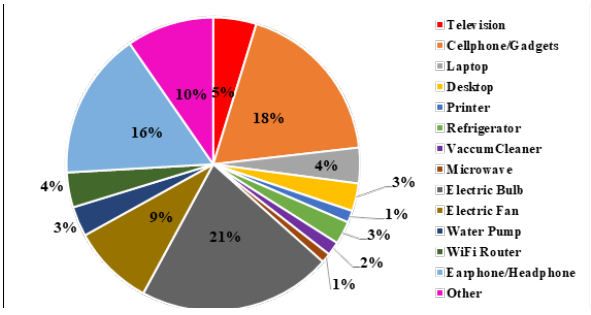


Fig. 5: The chart showing percent composition of different types of E-waste reported during the survey

2.5 Practices/ Responsibility

2.5.1 Practices

As per the survey, about 63.4% of total respondents were familiar with E-waste formerly, and the remaining 36.6% were unknown of E-waste. Around 83.1% of respondents knew about the consequences of E-waste on the environment and health, and roughly 78.7% were knowledgeable about the toxic substances included in E-waste, which is quite impressive. However, just 73.7% of all respondents separated their E-waste from other trash.

In terms of the recycling process, approximately 80.6% of the respondents were aware that E-waste may be recycled and refurbished. Moreover, around 85.9% were familiar with the 4R (reuse, reduce, recycle, redesign) process and around 75.1% of the respondents were aware that E-waste contains valuable metals such as gold, silver, copper, and many more.

Fig. 6 demonstrates that 45.5% of all respondents sell their E-waste to scavengers, while the remaining 5.5% sell it to scrap hawkers. About 33.8% of all respondents dispose their E-waste in municipal trash, 40.6% just keep it at home, 14.1% throw it away, and 7.1% burn it. About 15.9% of total respondents recycle their E-waste through E-waste recycling companies while 0.2% recycles by themselves.

In Nepal, there are many E-waste handlers such as Solid Waste Management Association Nepal (SWMAN), Blue Waste to Value Pvt. Ltd (BW2V)., Action Waste Pvt. Ltd., Creasion Nepal, Purano Kagaj, Fohar Malai, Kagaj Kabari, DOKO Recyclers, etc.

For our question, “Do you know any E-waste recycling company in Nepal?” 19.9% knew only about Khalisisi while 13.2% knew only about DOKO Recyclers and 18.3% knew about both the companies. Besides, only 0.4% knew about BW2V and 0.2% knew about Creasion Nepal.

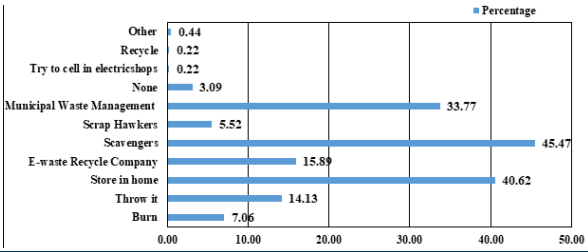


Fig. 6: The chart showing different types of E-waste management practices as reported by the respondents in the survey

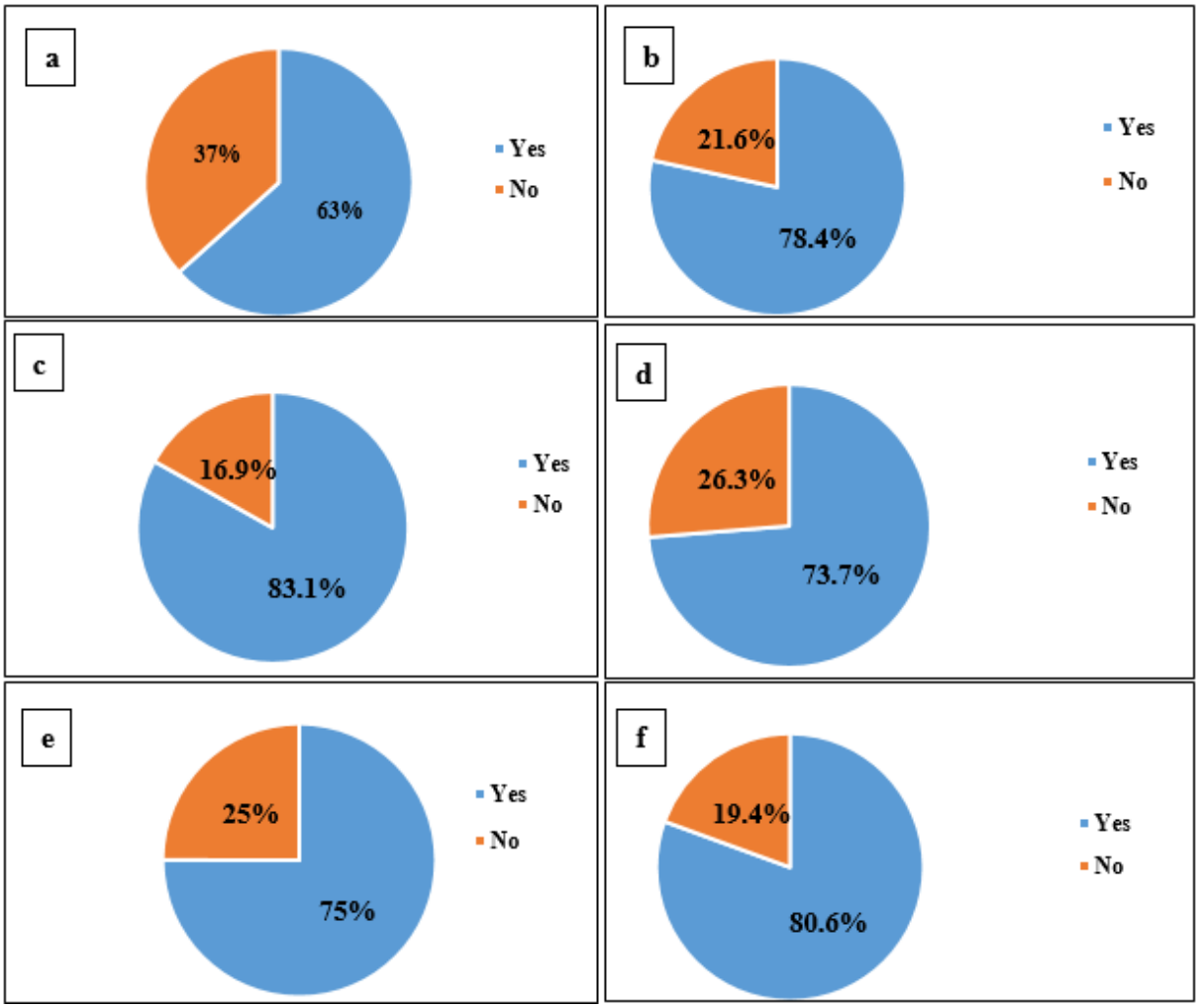


Fig.7. Percentage of respondents for the question; Do you a) know E-waste? b) know about hazardous elements in E-waste? c) know the health and environmental impacts of E-waste? d) separate E-waste from other waste? e) know E-waste contains precious metals? f) know E-waste can be recycled?

Fig. 7 gives the ratio of awareness regarding E-waste in the community which directly correlates with education level of consumers. As highly educated-Elite person used many EEE to amplify their working ability quantitatively as well as qualitatively who are also one of the major groups producing E-waste and as international policy of Extended Producer Responsibility (EPR) states that producer and their knowledge to E-waste will guide them to do proper E-waste management (Wang *et al.* 2017). In this survey all of the respondents are well educated in their respective subjects who are supposed to be responsible citizens of Nepal.

2.5.2 Responsibility

According to the Fig. 7, the majority of respondents were aware of E-waste, its consequences, and its economic value, but were unsatisfied with E-waste management in Nepal.

The survey came to show 24.9% of respondents claiming the government's responsibility for the proper management of E-waste but on the other side, 41.9% believed that the consumers were equally answerable. Moreover, 17.7% believed that manufacturing companies are liable while the remaining 6.6% argued that NGOs/INGOs are responsible for the E-waste management. But, in reality, all these sectors including consumers are responsible for this most challenging

issue which is agreed by 5.6% of the respondents.

2.6 Challenges of E-waste management in Nepal

To ensure proper management of the E-waste in Nepal, there should be a predefined model for the effective collection and disposal of the E-waste generated. Along with it, appropriate coordination with the local informal bodies is the most. Although certain measures and guidelines have been highlighted here in Nepal, several challenges need to be tackled for acquiring a sustainable E-waste management system. Some of the measures to tackle E-waste in Nepal are listed below

- The first step is to quantify all the electronic products that are being sold in the Nepalese market which can be achieved with the help of the Department of Customs (DoC) and Trade and Export Promotion Centre (TEPC). Along with that, it is important to document all the E-gadgets that enter Nepal *via* migrant workers to track the exact amount of electronic goods being circulated (Parajuly *et al.* 2018).
- An extensive research regarding the consumption and the usage patterns of the electronics among different groups of consumers shall help in getting comprehensive data about the E-waste generated.
- Implementing potent legislative guidelines and policies for the better management of E-waste is another crucial step in the management of E-waste. However, Nepal has not yet built its act and policy implemented for E-waste management.
- The informal recycling practices and bodies are of great concern in handling the E-waste across the globe. Without the strict guidelines and rules, the recognition of such informal practices here in Nepal is much more crucial (Khatri 2019). The majority of the waste collectors come from an underprivileged background which makes them more susceptible to health risks. Aside from that, most recyclers are victims of pay protection money, a disorganized trade and transportation system, and a risky business environment owing to the lack of strong regulatory standards in this industry. (Bajracharya 2022 August 22 onlinekhabar)
- Finally, there appears to be a lack of self-awareness among suppliers and consumers about the relevance of E-waste management and the necessity for an updated E-waste management system. So, all these learnings must be taken into consideration before building a resource-oriented sustainable waste management system here in Nepal (Parajuly et al. 2018).

3. Conclusion

E-wastes are hazardous to health and the environment, non-biodegradable, and accumulate in the environment, generating a global threat in garbage volume. E-waste belongs to a special type of garbage, and its management cannot completely rely on traditional and outdated methods; instead, it necessitates the use of cutting-edge of technologies. The COVID-19 epidemic has indeed exacerbated the problem of E-waste management even more. Industrial countries have cutting-edge waste management facilities, finances, and technologies, but it has been found that most of their electronic garbage is not recycled and instead exported to developing countries with laxer environmental regulations. Nepal, on the other hand, lacks the requisite technology for E-waste treatment, and with India's prohibition on E-waste imports, it would be possible that we have to deal with the worst E-waste management disaster in its history.

The present research was aimed to study the preliminary E-waste status and awareness in Nepal who are using E-gadgets (smart phone) frequently. It has been found that among 453 respondents, 61% of the respondents were females, implying that E-gadgets are more popular among Nepalese females. Likewise, the respondents belonging to the age group from 17-22 constitute the highest number of E-gadgets users (50.1%). Students are the most frequent users of E-gadgets accounting for 75.94% of all respondents. As per the survey, the average family size was 4.89 and every 1 out of 453 respondents owned twenty-two E-gadgets. In five years, each survey responder changed an average of three cell phones. The most commonly used E-gadget and the most discarded E-waste are operational and malfunctioning electric lamps. 63.4% of the total respondents were well acquainted with the term E-waste while, 78.7% were well aware about the hazardous elements present in E-waste and 83.1% were well informed about the harmful impacts associated with this E-waste. Even though 85.9% of respondents were conversant with 3R, only 73.7% of all respondents separated E-waste from other trash. 45.47% of respondents dispose of their E-waste by selling it to scavengers. 75.1% of those surveyed were knowledgeable about the valuable metals found in e-waste. DOKO recyclers seem to be more popular among the respondent as compared to

other listed recycling firms in Nepal. Finally, 24.9% agreed that the government should be fully responsible for E-waste management. This E-waste recycling issue in Nepal must be addressed to prevent the adverse consequences of E-waste recycling by implementing effective collecting and futuristic disposal strategies following international principal of EPR for sustainable E-waste management.

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References

Awale, S., 2018. What will Nepal do with its e-waste?As purchasing power rises, Kathmandu faces the problem of electronic waste disposal. *Nepali Times*.

Awale, S., 2018. What will Nepal do with its e-waste?As purchasing power rises, Kathmandu faces the problem of electronic waste disposal. Nepali Times.

Bajracharya, N., 2022. E-waste in Kathmandu is a growing problem, and here is a small effort to address this. Onlinekhabar, 2022, August 22.

Beiyuan, J., D. C. W. Tsang, Y. S. Ok, W. Zhang, X. Yang, K. Baek, and X. D. Li, 2016. Integrating edds-enhanced washing with low-cost stabilization of metal-contaminated soil from an e-waste recycling site. *Chemosphere*, **159**, 426–432. DOI: 10.1016/j.chemosphere.2016.06.030 PMID:27337434

Bhutta, M. K. S., A. Omar, and X. Yang, 2011. Electronic waste: a growing concern in today's environment. *Economics Research International*, **2011**, 1–8. DOI: 10.1155/2011/474230

Central Bureau of Statistics Nepal., 2012. National population and housing census 2011 (national report). *Government of Nepal, National Planning Commission*, **01**.

Central Bureau of Statistics Nepal., 2017. Annual household survey nepal 2015/16. *Government of Nepal, National Planning Commission*.

Cui, J., and L. Zhang, 2008. Metallurgical recovery of metals from electronic waste: A review. *Journal of Hazardous Materials*, **158**(2–3), 228–256. DOI: 10.1016/j.jhazmat.2008.02.001 PMID:18359555

Data Reportal., 2021. *Digital 2021: Nepal*.

Dias, P., A. M. Bernardes, and N. Huda, 2019. Ensuring best e-waste recycling practices in developed countries: an Australian example. *Journal of Cleaner Production*, **209**, 846–854. DOI: 10.1016/j.jclepro.2018.10.306

Directive 2002/96/EC., 2003. Of the European parliament and of the council on waste electrical and electronic equipment (weee). *Official Journal of the European Union*.

Directive 2012/19/EU., 2012. Of the European parliament and of the council on waste electrical and electronic equipment (weee). *Official Journal of the European Union*.

Forti, V., C. P. Baldé, R. Kuehr, and G. Bel, 2020. *The Global E-waste Monitor 2020* (Issue July).

Giri, J., and R. Adhikari, 2020. Urgency of proper e-waste management plan in Nepal: an overview. *Nepal Journal of Science and Technology*, **19**(1), 107–118. DOI: 10.3126/njst.v19i1.29790

GlobeNewswire., 2021. *Medical Electronics Market with Covid-19 Impact Analysis by Component, Device Classification, Application And Region - Global Forecast to 2026*.

Grant, K., F. C. Goldizen, P. D. Sly, M. N. Brune, M. Neira, M. van den Berg, and R. E. Norman, 2013. Health consequences of exposure to e-waste: a systematic review. *The Lancet Global Health*, 1(6), e350–e361. DOI: 10.1016/S2214-109X(13)70101-3 PMID:25104600

Han, W., G. Gao, J. Geng, Y. Li, and Y. Wang, 2018. Ecological and health risks assessment and spatial distribution of residual heavy metals in the soil of an e-waste circular economy park in Tianjin, China. *Chemosphere*, 197, 325–335. DOI: 10.1016/j.chemosphere.2018.01.043 PMID:29366953

International Data Corporation., 2020. *Traditional PC Shipments Continue to Grow Amid Global Economic Slowdown, According to IDC*.

International Labor Organization., 2020. Working from home: estimating the worldwide potential. In *ILO Brief April 2020*.

Khatri, B. B., 2019. E- waste management: an emerging challenge in Nepal. *NUTA Journal*, **6**(1–2), 1–4. DOI: 10.3126/nutaj.v6i1-2.23218

Lamichhane, S., 2017. Electronic waste disposal. *Rising Nepal*.

Li, C., and F. Lalani, 2020. The COVID-19 pandemic has changed education forever. this is how. World Economic Forum.

Li, J., B. N. Lopez, L. Liu, N. Zhao, K. Yu, and L. Zheng, 2013. Regional or global weee recycling. where to go? *Waste Management*, **33**(4), 923–934. DOI: 10.1016/j.wasman.2012.11.011 PMID:23337392

Li, J., B. Tian, T. Liu, H. Liu, X. Wen, and S. Honda, 2006. Status quo of e-waste management in mainland china. *Journal of Material Cycles and Waste Management*, **8**(1), 13–20. DOI: 10.1007/s10163-005-0144-3

Mandal, C. K., 2021. Use of electronic goods continues to grow but there's no policy for its disposal. *The Kathmandu Post*.

Matinga, M. N., B. Gill, and T. Winther, 2019. Rice cookers, social media, and unruly women: disentangling electricity's gendered implications in rural nepal. *Frontiers in Energy Research*, **6**, 140. DOI: 10.3389/fenrg.2018.00140

Mishra, L., T. Gupta, and A. Shree, 2020. Online teaching-learning in higher education during lockdown period of covid-19 pandemic. *International Journal of Educational Research Open*, **1**, 100012. DOI: 10.1016/j.ijedro.2020.100012 PMID:35059663 PMCID:PMC7832355

Needhidasan, S., M. Samuel, and R. Chidambaram, 2014. Electronic waste-an emerging threat to the environment of urban India. *Journal of Environmental Health Science & Engineering*, 12(36), 1–9. DOI: 10.1186/2052-336X-12-36 PMID:24444377 PMCID:PMC3908467

Nepal Telecommunication Authority., 2017. Consultation paper on regulatory framework for e-waste management. *Nepal Telecommunication Authority(NTA)*, *02*, 1–103.

Nepal Telecommunication Authority., 2021. mis report. *Nepal Telecommunication Authority(NTA)*, 198(148), 1–10.

Okwu, P. I., and I. N. Onyeje, 2014. Open access extraction of valuable substances from e-waste. *American Journal of Engineering Research*, 03(01), 299–304.

Otmar, D., 2011. e-waste management in germany. *United Nations University Institute for Sustainability and Peace (UNU-ISP)*.

PACE Nepal Pvt. Ltd., 2017. *Final Report on Inventory Preparation of E-Waste and Its Management in Kathmandu Valley*.

Pal, K. B., B. B. Basnet, R. R. Pant, K. Bishwakarma, K. Kafle, N. Dhami, M. L. Sharma, L. B. Thapa, B. Bhattarai, and Y. R. Bhatta, 2021. Education system of Nepal: impacts and future perspectives of COVID-19 pandemic. *Heliyon*, 7(9). DOI: 10.1016/j.heliyon.2021.e08014 PMID: 34568606 PMCID: PMC8455144

Parajuly, K., K. B. Thapa, C. Cimpan, and H. Wenzel, 2018. Electronic waste and informal recycling in Kathmandu, Nepal: challenges and opportunities. *Journal of Material Cycles and Waste Management*, 20(1), 656–666. DOI: 10.1007/s10163-017-0610-8

Pariatamby, A., and D. Victor, 2013. *Policy trends of e-waste management in Asia*. 411–419. DOI: 10.1007/s10163-013-0136-7

Perkins, D. N., M. N. Brune Drisse, T. Nxele, and P. D. Sly, 2014. E-waste: a global hazard. *Annals of Global Health*, 80(4), 286–295. DOI: 10.1016/j.aogh.2014.10.001 PMID:25459330

Petrlik, J., J. Pucket, L. Bell, and J. DiGangi, 2019. *Weak controls: European e-waste poisons Africa's food chain*. *April*.

Rathore, P., S. Kota, and A. Chakrabarti, 2011. Sustainability through remanufacturing in India: a case study on mobile handsets. *Journal of Cleaner Production*, **19**(15), 1709–1722. DOI: 10.1016/j.jclepro.2011.06.016

Rawat, S., L. Verma, and J. Singh, 2020. Environmental hazards and management of e-waste. In *Environmental Concerns and Sustainable Development: Volume 2: Biodiversity, Soil and Waste Management* (pp. 381–398). Springer, Singapore.
DOI: 10.1007/978-981-13-6358-0_16
PMCID:PMC7278568

Sander, K., S. Schilling, T. Naoko, C. V. Rossem, J. Vernon, and C. George, 2007. *The Producer Responsibility Principle of the WEEE Directive*.

Satyal, U., 2017. Nepal lacks e-waste management lawsno title. *The Himalayan Post*.

Schluep, M., 2014. Informal waste recycling in developing countries. *Handbook of Recycling: State-of-the-Art for Practitioners, Analysts, and Scientists*, 439–444.
DOI: 10.1016/B978-0-12-396459-5.00029-5

Suja, F., R. A. Rahman, A. Yusof, and M. S. Masdar, 2014. *E-Waste Management Scenarios in Malaysia*. 2014.
DOI: 10.1155/2014/609169

Tong, X., and L. Yan, 2013. From legal transplants to sustainable transition: extended producer responsibility in Chinese waste electrical and electronic equipment management tong and yan epr in Chinese WEEE management. *Journal of Industrial Ecology*, 17(2), 199–212.
DOI: 10.1111/jiec.12013

Turaga, R. M. R., K. Bhaskar, S. Sinha, D. Hinchliffe, M. Hemkhaus, R. Arora, S. Chatterjee, D. S. Khetriwal, V. Radulovic, P. Singhal, and H. Sharma, 2019. E-waste management in India: issues and strategies:
DOI: 10.1177/0256090919880655

UNEP., 2015. *Illegally Traded and Dumped E-Waste Worth Up To $19 Billion Annually Poses Risks to Health, Deprives Countries of Resources, Says UNEP.* Environment Under Review.

Walther, G., J. Steinborn, T. S. Spengler, T. Luger, and C. Herrmann, 2010. Implementation of the WEEE-directive-economic effects and improvement potentials for reuse and recycling in Germany. *International Journal of Advanced Manufacturing Technology*, 47(5–8), 461–474.
DOI: 10.1007/s00170-009-2243-0

Wang, H., Y. Gu, L. Li, T. Liu, Y. Wu, and T. Zuo, 2017. Operating models and development trends in the extended producer responsibility system for waste electrical and electronic equipment. *Resources, Conservation and Recycling*, 127(May), 159–167.
DOI: 10.1016/j.resconrec.2017.09.002

Wang, L. K., M.-H. S. Wang, and Y. T. Hung, 2021. *Solid Waste Engineering and Management* (L. K. Wang, M.-H. S. Wang, & Y.-T. Hung (eds.); Vol. 1). Springer International Publishing.
DOI: 10.1007/978-3-030-84180-5

Yu, D. E. C., K. D. S. Yu, and R. R. Tan, 2020. Implications of the pandemic-induced electronic equipment demand surge on essential technology metals. *Cleaner and Responsible Consumption*, 1(November), 100005.
DOI: 10.1016/j.clrc.2020.100005

Zhang, K. S., 2020. *Turning Trash Into Treasure-A Comparative Study of E-Waste Recycling in China and the U.S. Through Systems Thinking*.