RESEARCH ARTICLE

# Public awareness, involvement, and practices in electronic waste management in Addis Ababa, Ethiopia

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**Received:** 19/07/2019 **Accepted:** 19/02/2020 **Available online:** 30/06/2020

## ABSTRACT

Following the upsurge of technological developments escorted with scale economies, the electronic industry has decidedly grown and brought along one of the major environmental problems known as electronic waste or e-waste. The objective of this study is to examine the public's awareness about e-waste and their engagement level in e-waste management practices. Data were gathered both from primary and secondary data sources. A total sample of 100 respondents were selected from Bole and Nefas Silk Lafto sub-cities. In addition, a total of 72 sample respondents were selected from educational institutions and government sector offices. Data were analyzed using statistical methods such as mean, percentage, chi-square test, and ordinal regression model. The findings discovered that households' level of awareness about e-waste and its management was much lower than the general service department personnel. Evidently, the ordinal regression model output revealed differences in many aspects of e-waste-related activities between the households and the institutions. E-waste is considered and treated like other types of municipal solid wastes. It is ostensible that there were newly purchased electronic equipment that were not yet serviceable because of the absence of manuals, their sizes and designs, and lack of knowhow. Therefore, in view of these veracities, the study discernibly highlighted the implications of the existing status and suggested certain recommendations to raise public awareness about-waste to reduce the impacts on environment and human health.

**Keywords:** electronic equipment; e-waste; e-waste management; practices; public awareness

## 1. INTRODUCTION

Following the outburst of technological developments escorted with scale economies, the electronic industry has decidedly grown and brought along one of the major environmental problems known as electronic waste or e-waste. Particularly, in the developing countries, e-waste management is a much more terrible challenge owing to factors such as lack of proper infrastructure, weak enforcement of laws, and low awareness among citizens (Baldé et al., 2015). It is evident that increasing storage-stockpiles and e-waste production levels are indicators of the limited success of reuse, refurbishment, and recycling efforts in developing countries. In addition, associated with an increase in the affordability of new products and advanced technologies, it is

Access this article online

DOI: 10.25079/ukhjss.v4n1y2020.pp21-36 **e-ISSN:** 2520-7806

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easier for the people to purchase rather than repair, thus leading to the disposal of the obsolete equipment (Arora, 2008). The problem is aggravated by the continuing generation of e-waste at an alarming rate in developing countries. A study by Yu, *et al*. (2010) estimated that by 2017 developing countries will start to generate more electronic waste than developed countries.

Improper management and disposal can be awfully hazardous for the environment and health. Where there is lack of policy, e-waste legislation, and weak protections, incorrect practices of e-waste management and disposal occur at landfill sites, and illegal dumps have posed a threat to human and environmental health (Kiddee *et al*., 2013; Baldé *et al*., 2015). Besides, Baldé *et al*., (2017) asserted that the increasing levels of e-waste, improper and unsafe treatment, and disposal through incineration or in landfills pose significant challenges to the environment and human health and to the achievement of the Sustainable Development Goals.

Likewise, there is low public awareness toward the hazardous nature of e-waste and the rudimentary waste management methods practiced in developing countries. Besides, it is realized that there are poor data on how much e-waste is generated and where, and to where it is exporting. This condition is aggravated by the recent system of information collection, in which second-hand, old, and non-functional products are imperceptible to national statistics on production, sale, and trade in goods (Lundgren, 2012).

The challenges of solid waste management have been growing all over Ethiopia by leaps and bounds in the recent past. Since Ethiopia has adopted a pathway to progress, exploring Information and Communication Technology (ICT) possibilities, e-waste or the waste generated out of electronic and electric gadgets have emerged as major constituents of solid wastes in urban Ethiopian. The gradual but conspicuous growth of e-waste demands early, planned strategies for dealing with it. Improper e-waste management is an escalating problem all over Ethiopia, but eluding necessary attention (Gudeta *et al*., 2015). A report from United Nations University (UNU)-hosted Solving the E-waste Problem (StEP) initiative indicate that about 4,300 tons of televisions, computers, mobile phones, and refrigerators are stored in major urban centers of Ethiopia, particularly in Addis Ababa. Furthermore, the report asserted that e-waste treatments have been carried out improperly, while a huge volume e-waste is simply stored in offices and homes as assets rather than as electronic waste that need to be discarded (UNU, 2013).

In order to obtain an in-depth understanding of the matter, the researcher attempted discussing the issue with various government officials and inhabitants of the city. In the course of those informal discussions, it was presumed that there were tons of e-waste kept on the premises of residential units, educational institutions, governmental offices, and business organizations. The discussions also revealed that the concerned householders, officers, managers, and ICT experts have been discussing the issue informally. For instance, they posed questions like “why did e-waste increase?”; “How could it be managed?”; “Who are the stakeholders in managing e-waste?”; “Is there any regulatory framework to manage e-waste?” Therefore, it can be understood from these emerging questions that the efforts made toward e-waste management in the city were far from adequate. With this understanding, this study was conducted to examine what is really on the ground and the major activities performed in relation to e-waste management in the city of Addis Ababa.

By its nature, the disposal of e-waste is more complicated than normal household waste because of its hazardous content and is more than just lack of space as commonly the case is with solid waste management. Lack of appropriate facilities, weak enforcement of (or lack of) law and regulation, and low level of awareness among the society may lead to indiscriminate or improper disposal (such as

disposing of e-waste together with household's solid waste) (Tengku-Hamzah, 2011; Chibunna *et al.,* 2012).

The other challenges are associated with lack of skill and knowledge toward the handling and treatment of e-waste. In this regard, Tyagi *et al.* (2015) admitted that informal sector is managing the major e-waste in India. The collection has been done by the local scrap vendors. After collection, recycling process involves segregation and dismantling the products. Primitive techniques are used in this process, which may include (i) disassembling of electronic equipment; (ii) heating or manual dismantling of printed circuit boards; (iii) recovering metals by opening or cutting cables; (iv) breaking or melting plastics; (v) toner sweeping; and (vi) metal recovery by open-acid leaching of e-waste. The author points out that most of the scrap vendors are not much educated; moreover, the people working under them are also not skillful and educated. They also do the repair and refurbishment of old products, which will be sold in second-hand market. They just use their older and traditional illegal methods of burning the products to extract the metals – in many cases, they are not aware of the health risks involved.

Studies show the challenges identified with (i) the low level of resident consciousness on the unsafe effects of e-waste on the environment, their wellbeing, and protection (ii) the government sector offices managing waste administration have constrained ability to manage e-waste administration and are not working in an organized way that could assemble cooperative energy. E-waste administration has not been given the attention it merits among government authorities and (iii) insufficient assets and duty toward tending to the issues and difficulties related with it, and (iv) satisfactory formal training has not been given to the issues of WEEE administration (Otieno and Omwenga, 2015).

Also, Lundgren (2012) featured that there is by and large low public familiarity with the perilous idea of e-waste and the unrefined waste administration methods utilized as a part of developing nations. It was confirmed that data toward electronic waste management are lacking particularly on the volume of e-waste produced and the sources and on where it is going to. The same author further admitted that this condition is exacerbated by the present information gathering system, in which utilized, second-hand, and waste products are all things considered, undetectable to national insights on generation, deal, and exchange goods.

The aim of this study is to examine the awareness and engagement level of people in e-waste management practices based on the data gathered from household heads of Bole and Nefas Silk Lafto sub-cities and general service department workers of the educational institutions and governmental sector offices.

## 2. RESEARCH METHODS

The study employs both descriptive and explanatory type of research design. It utilizes both primary and secondary data sources to acquire relevant information that is required to analyse, discuss, and present the data. The primary data sources were acquired through questionnaire surveys and in-depth and semi-structured interviews. On the other hand, the secondary data sources used in this study were obtained through review of documents, books, websites, conference papers, journals, and relevant published and unpublished materials. The researcher had purposively selected two sub-cities namely Bole and Nefas Silk Lafto (NSL), eight Private Educational Institutions (PREIs), eight Public Educational Institutions (PUEIs), and eight Governmental Sector Offices (GSOs). With regard to the selection of study participants, the study employs both probability and non-probability sampling techniques. Through systematic random sampling, 100 household heads (HHs) were selected from two sub-cities; Bole and Nefas Silk Lafto. On the other hand, key respondents for this

research were selected based on their intimate links with the issue under investigation and they were specifically approached as 'key informants' named as General Service Department (GSD). Then, three GSD personnel from each of the Educational Institutions (EIs) and GSOs were included in the study. This constitutes seventy-two (72) sample respondents, of which 48 were selected to fill the questionnaires while 24 interviewed. Finally, six (6) Higher Governmental Organizations (HGOs) were purposively selected in filling the questionnaire and interviews. The analysis constitutes both descriptive and inferential statistics.

## 3. RESULTS AND DISCUSSIONS

### 3.1 Awareness of e-waste and its management in Bole and NSL sub-cities

The term e-waste was first introduced in the 1970s and 1980s following the onset of environmental degradation that was caused by the hazardous products that were imported into developing countries (Otieno and Omwenga, 2015). Electronic waste is a new, rapidly growing waste, and its concept is not widely understood by the people and governments. In developing countries, wider emphasis has been given to other types of wastes such as municipal, domestic, and other industrial wastes than to e-waste management.

Borthakur and Sinha (2013) disclosed that most of the consumers are unaware of the impacts of improper disposal of e-waste and continue to discard their end-of-life appliances with regular household waste. On the other hand, Tengku-Hamzah (2011) has also asserted that the low level of awareness among the society has been considered as one of the challenges in e-waste management. The same author found that "low level of awareness among the society may lead to indiscriminate or improper disposal such as disposing of e-waste together with household's solid waste." Furthermore, NCHEWM (2013) proclaimed that many people do not understand what it is or how it affects them, the world, or the environment.

In view of this, the study examined the awareness level of the HHs of electronic waste and its management in two purposively selected sub-cities of Addis Ababa. To this end, the data were acquired from 100 HHs through questionnaire surveys. Accordingly, the results of the study revealed that the HHs' awareness of electronic waste and its management was low. These include awareness of e-waste, amount of e-waste, the environmental and health impacts of e-waste, local or international laws and activities governing e-waste, and safe disposal of e-waste. Majority of the respondents were not aware of the concepts and activities regarding electronic waste.

More explicitly, the respondents' awareness about what it meant by e-waste or about the meaning of e-waste revealed that the majority of the respondents in both the sub-cities (60%) were familiar with the term e-waste, while, (23%) and (17%) do "not" know e-waste and are "uncertain" about e-waste, respectively. It was found that being familiar with the term e-waste was not associated with the educational status of the households, hence, in the $X^2$ test result $p > 0.05$. On the other hand, it was revealed that the majority of the households were "not" conscious of the volume of e-waste they generated while 30% were uncertain about it. As far as the respondents' awareness of the environmental impacts of e-waste is concerned, the majority of the sample respondents were not aware of the environmental impacts of e-waste. Besides, the study found a significant difference between the respondents based on their educational qualifications in responding to this question. The $X^2$ test result (23.334, and $p = .010$), $p<0.05$, was statistically significant that the educational status of the respondents influences their awareness in understanding the impact of e-waste on the environment. Hence, more educated respondents were more aware of the impacts of e-waste on the environment. Besides, most of the respondents

from both of the sub-cities were not aware of the health risks associated with electronic waste.

Concerning awareness about safe disposal of hazardous frictions of electronic waste, most of the respondents were not aware that some hazardous fractions of e-waste need a special treatment in order to be safely disposed of. Only 29% of the respondents were aware of it. The $X^2$ test result (6.535, p = .038) showed that there was a significant difference among the respondents from both of the sub-cities. Thus, more respondents from NSL sub-city were aware of the safe disposal of some hazardous frictions of electronic waste than those in Bole sub-city. This indicates more awareness creation programs should be facilitated to Bole sub-city households.

The mobile phone is one of the rapidly generating types of e-waste in the world associated with its shortest lifespan. Owing to its relative affordability and rapid obsolescence rate, it would add a significant volume of e-waste. Across Africa, a combination of population growth and increased access to mobile phones and other technology will produce a surge in e-waste over the next five years (YSFES, 2014). Moreover, the disposal of cell phone batteries needs special care that if thrown down with other municipal wastes, it might pose a threat to the environment. In light of these, the study found that the majority of the respondents were aware that used dry-cell batteries need to be disposed of as safely as possible.

Unlike other types of waste, electronic waste management is a complex and challenging task because of its hazardous components. Therefore, it requires the formulation and enforcement of laws, legislations, and guidelines that specifically deal with e-waste to lessen the impacts it might pose to the environment and human health. Furthermore, awareness creation program should address this component so that customers would abide by those laws and guidelines either to recycle or dispose of the electronic equipment. The respondents were not familiar with any local/international laws governing the electronic waste management and any programs or projects related to electronic waste, respectively. This might be associated to the absence of e-waste management policy or legislation in the country. The issue had been discussed widely under the sub-topic of e-waste management challenges.

E-waste not only contains hazardous chemicals but also valuable parts that can be sold in the market (Adediran and Abdulkarim, 2012; Otieno and Omwenga, 2015). Thus, awareness creation in this regard will encourage the households to properly handle and dispose of the e-waste. The result obtained from the survey showed that majority of the respondents were not aware whether some parts of electronic waste are profitably sold to recyclers. However, the $X^2$ test result showed a significant difference between the respondents of Bole and NSL sub-cities (6.708, p = .013). Thus, more respondents from the NSL sub-city were aware that some electronic parts may be profitably selling to recyclers than those from Bole sub-city.

Similar studies were performed on the role of public awareness in electronic waste management. For instance, Theodros (2010) confirmed that in the city of Addis Ababa a lot of awareness-raising activities took place through Mass Media such as television, radio, and poster pertaining to the solid waste management; but not to any specific hazardous wastes like the e-waste. Likewise, Gudeta *et al. (*2015) reported that most of the sample households of the city of Addis Ababa had no comprehensive idea about the health risks of electronic waste. This is congruent to the assumptions made by earlier studies that gross lack of awareness about e-waste is a major problem (Gudeta *et al.,* 2013).

These findings support the assertion made by Adediran and Abdulkarim (2012), that there is no public awareness on the inherent dangers of handling e-waste in Nigeria. Other authors have also mentioned that household awareness level is an important factor in determining the readiness of the public to deal with different environmental issues

(Fraige *et al.,* 2012). Similarly, Sivakumaran (2013) has highlighted that the public awareness is essential for the advancement of e-waste management system. According to Askari and Ghadimzadeh (2014), the percentage of knowledge about current management process for e-waste management is low, i.e., most people do not know how to manage the process. Furthermore, the reasons for poor e-waste management are a poor collection system for EOL products, insufficient information system, and lack of awareness among consumers (Geethan *et al.,* 2012). In conclusion, therefore, the launching of the awareness creation program should be one of the major pillars of e-waste management programs if the government is aiming to bring change in e-waste management.

### 3.2 Engagement level in e-waste management practices in Bole and NSL sub-cities

Concerning the engagement level of the respondents in e-waste management practices, an attempt was made to present and discuss the obtained results. Accordingly, this section discusses the major results on the explanation of the mean score, percentages, the $X^2$ test results, and the ordinal regression outputs (see Table 1).

**Table 1:** Engagement level in e-waste management practices in the HHs

| Items | Sub-city | Engagement Level | | | Mean |
|---|---|---|---|---|---|
| | | Always | Sometimes | Never | |
| How often do you keep inventories of the equipment you discard/store? | Bole | 3 | 27 | 20 | 2.34 |
| | NSL | 2 | 23 | 25 | 2.46 |
| I recycle electronic products/gadgets which can still be recycled. | Bole | 1 | 19 | 30 | 2.58 |
| | NSL | 1 | 16 | 33 | 2.64 |
| I buy new electronic gadgets even if the older ones are still working. | Bole | 35 | 9 | 6 | 1.42 |
| | NSL | 18 | 26 | 6 | 1.76 |
| I buy gadgets with brands that are reputable for their durability and longer life over other brands. | Bole | 46 | 4 | 0 | 1.08 |
| | NSL | 36 | 9 | 5 | 1.38 |
| I observe proper waste segregation practices. | Bole | 2 | 7 | 41 | 2.78 |
| | NSL | NSL | 3 | 10 | 37 |
| I buy second-hand gadgets and/or “re-assembled” gadgets. | Bole | Bole | 0 | 7 | 43 |
| | | NSL | 1 | 22 | 27 |
| | NSL | Bole | 6 | 23 | 21 |
| I trade or sell used electronic gadgets. | Bole | NSL | 3 | 23 | 24 |
| | NSL | NSL | 3 | 10 | 37 |

Source: Field survey, 2017

As far as the mean score is concerned, the mean scores ranged from 1.08 to 2.86, which means it ranges between ‘always’ and ‘never’ for most parts of the items. However, variations occur in some of the items. The $X^2$ result (13.710), $p = .001$, hence $p<0.05$ is, however, statistically significant that the majority of Bole sub-city respondents ‘always’ buying new electronic equipment even if the older ones are still working than the respondents of NSL sub-city. The $X^2$ test result (8.143) and $p = .017$, which was statistically significant, showed the high-income groups, which were mainly from Bole

sub-city had 'always' buying reputable equipment than middle-income groups (NSL sub-city).

An ordinal regression was carried out to predict ordinal-dependent variables given one or more independent variables. Accordingly, gender, monthly income, and educational level were considered as independent variables that will affect the ordinal-dependent variables ranging from "never" to "always" for all items. It was understood that gender and educational level did not affect the households' engagement level toward e-waste-management-related actions. While monthly income did affect some aspects. The summary result is presented in Table 2 and Table 3.

**Table 2:** HH's Engagement level in buying gadgets with brands that are reputable (ordinal regression output)

| | | | | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|
| | | Estimate | Std. Error | Wald | Df | Sig. | Lower Bound | Upper Bound |
| Threshold | [Q24 = 1.00] | .029 | .812 | .001 | 1 | .972 | 1.029 | .210 | 5.055 |
| | [Q24 = 2.00] | 1.500 | .882 | 2.890 | 1 | .089 | 4.480 | .795 | 25.245 |
| | Income | -4.511E-005 | 2.255E-005 | 4.002 | 1 | .045 | 1.000 | 1.000 | 1.000 |
| Location | | | | | | | | | |
| | [Gender=1.00] | -.071 | .546 | .017 | 1 | .896 | .931 | .319 | 2.716 |
| | [Gender=2.00] | 0[a] | . | . | 0 | . | 1.000 | | |

Source: Field survey, 2017

Similarly, the ordinal regression output clearly showed that the increase in monthly incomes (expressed in ETB) was associated with an increase in the odds of the respondents 'buying gadgets with brands that are reputable for their durability and longer life over other brands', with an odds ratio of 1.000 (95% 1.000 to 1.000), Wald $X^2$ (1) = 4.002, p < .045 (see Table 2). It also depicts that the increase in monthly income (expressed in ETB) was associated with a decrease in the odds of the respondents 'buying second-hand gadgets and/or re-assembled gadgets', with an odds ratio of 1.000 (95% 1.000 to 1.000), Wald $X^2$ (1) = 7.072, p < .008 (see Table 3).

**Table 3:** HH's Engagement level in buying second-hand gadgets (Ordinal regression output)

| | | | | | | | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|
| | | Estimate | Std. Error | Wald | Df | Sig. | Lower Bound | Upper Bound |
| Threshold | [Q26 = 1.00] | -3.320 | 1.188 | 7.805 | 1 | .005 | .036 | .004 | .371 |
| | [Q26 = 2.00] | .559 | .694 | .650 | 1 | .420 | 1.750 | .449 | 6.819 |
| Location | Income | 4.951E-005 | 1.862 E-005 | 7.072 | 1 | .008 | 1.000 | 1.000 | 1.000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| [Gender=1.00] | -.333 | .477 | .488 | 1 | .485 | .716 | .281 | 1.826 |
| [Gender=2.00] | 0a | . | . | 0 | . | 1.000 | | |

Source: Field survey, 2017

This implies that the majority of the respondents 'always' engaged in buying a new electronic gadget even if the older one is working and tend to buy gadgets with brands that are reputable for their durability and longer life over other brands. Therefore, it can be understood from these results that the e-waste volume was influenced by the monthly incomes, the preferences, and tastes of the respondents and rapid technologies. In this regard, Veit and Moura (2015) noted that the life cycle of many electronic goods has been substantially shortened because of advancements in electronics, attractive consumer designs, and marketing and compatibility issues. For example, the average life cycle of a new computer has decreased from 4.5 years in 1992 to an estimated 2 years in 2005 and is further decreasing (Veit and Moura, 2015).

On the contrary, the majority of the respondents 'never' recycle electronic gadgets that can still be recycled and have never observed proper waste segregation practices. This strengthens the data obtained regarding the e-waste disposal methods that households have practiced. Thus, it gives rise to the increase in the volume of e-waste. This implies that e-waste recycling centers should be established in the city to facilitate the recycling process. Hence, the recycled materials can be used in developing new equipment that opens great opportunities for innovation of new products, retrieval of valuable materials, and minimization of the environmental effects of improper disposal of e-waste.

The study revealed that the majority of the respondents (78%) were 'never' involved in proper waste segregation practices while 17% of the respondents 'sometimes' involved in proper waste segregation practices. This result indicates poor activities and involvements in e-waste segregation practices in the city. The majority of the respondents (70%) would 'never' buy second-hand gadgets or re-assembled electronic items while 27% of them sometimes buy these kinds of electronic gadgets. When we see the differences in between the respondents of Bole and NSL sub-cities, the $X^2$ test result (12.416, p = .002) that was statistically significant, and compared to the respondents of Bole sub-city, the majority of the NSL residents 'sometimes' buy second-hand gadgets. The implication of this result is that the monthly incomes of the respondents were determining factors for the households to rely on for the purchase of an original electronic equipment (for Bole sub-city respondents) and the purchase of second-hand equipment (for NSL sub-city respondents).

These findings are consistent with the findings of Borthakur and Sinha (2013), which proclaimed that the considerable price difference between the new and used EEE makes the consumer go for the purchase of the second-hand EEE in developing countries. Circulate (2017) stated that the customers are looking for durable products and updatable appliances. Sotelo *et al*. (2016) further found that customers are motivated by new models, thus increasing the waste flow, so electronic waste volume increases faster than the rest.

### 3.3 Awareness of e-waste and its management in Educational Institutions and Governmental Sector Offices

Public education and outreach may be the most important component in the management of e-waste. That is because no matter what infrastructure is available and developed, what the laws are, and

what the option is, no one will be aware of it without public education (Sinha *et al.,* 2005). As depicted in Table 4, the study examined the GSD personnel's awareness of e-waste and the impacts of e-waste. Accordingly, the findings of the study revealed that the GSD personnel were aware of what it meant by e-waste, the volume of e-waste generated, and health risks from the inappropriate e-waste disposal methods, the threat of e-waste on environment, a special treatment of some hazardous fractions e-waste and safe disposal of dry-cell batteries, and the possibilities to sell some parts of electronic waste to recycler. The $X^2$ test results show no significance for all items except for some questions. Thus, the majority of GSD personnel from the PREIs were 'uncertain' about the impacts of e-waste on the environment, and the used dry-cell batteries need a special treatment in order to be safely disposed of. The implications of these results are that though majority of the GSD personnel were aware of e-waste and the impacts, a significant number of the GSD personnel from the PREIs need awareness creation program on some of the impacts of e-waste. The outcome of these results was not consistent with the findings of previous studies, for instance, Oomman (2014), the pointed majority of the people were not aware of the effects of improper disposal, any recycling initiatives, and harmful chemicals in e-waste. There is generally low public awareness of the hazardous nature of e-waste management techniques used in developing countries (Samarakoon, 2014). Therefore, there is a need to examine and recognize the awareness level based on various criteria than going for generalizations.

**Table 4:** Summary of responses to e-waste and its impacts

| ITEMS | Response | Institution's Name | | | Total | X 2 | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| | | PREI | PREI | PREI | | | |
| Do you know electronic waste? | Yes | 25 | 31.3 | 29.2 | 85.4 | | .310 |
| | No | 8.3 | 2.1 | 4.2 | 14.6 | | |
| | uncertain | 0 | 0 | 0 | 0 | | |
| Are you conscious/aware of the volume of electronic waste that you generate? | Yes | 20.8 | 10.4 | 20.8 | 52.1 | | .218 |
| | No | 10.4 | 20.8 | 8.3 | 39.6 | | |
| | uncertain | 2.1 | 2.1 | 4.2 | 8.3 | | |
| Are you aware of any health risk/s associated with electronic waste? | Yes | 20.8 | 25 | 20.8 | 60.4 | | .408 |
| | No | 0 | 8.3 | 8.3 | 31.3 | | |
| | uncertain | 12.5 | 0 | 4.2 | 8.3 | | |
| Does electronic waste pose a serious threat to the environment? | Yes | 20.8 | 25 | 20.8 | 66.7 | | .024 |
| | No | 0 | 8.3 | 8.3 | 16.7 | | |
| | uncertain | 12.5 | 0 | 4.2 | 16.7 | | |
| Are you aware that used dry-cell batteries need to be disposed | Yes | 14.6 | 22.9 | 22.9 | 60.4 | | .408 |
| | No | 6.3 | 8.3 | 10.4 | 25 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| of as safely as possible? | uncertain | 12.5 | 2.1 | 0 | 14.6 | | |
| Are you aware that some hazardous fractions in e-waste need a special treatment in order to be safely disposed of? | Yes | 25 | 16.7 | 27.1 | 68.8 | | |
| | No | 8.3 | 8.3 | 4.2 | 20.8 | | .024 |
| | uncertain | 0 | 8.3 | 2.1 | 10.4 | | |

Source: Field survey, 2017

Conversely, as indicated in the Table 5, the majority of the GSD personnel were not aware of any local or international laws pertaining to electronic waste management. Besides, about 75% of the respondents also reported that they were not aware of any policy/legislation on e-waste management at the federal/state level. Similarly, most of the GSD personnel were not aware of programs, activities, and projects toward e-waste management. Finally, it was found that most of the GSD personnel argued that there are no e-waste recycling centers in Addis Ababa or elsewhere in the country. This implies that there were poor or no e-waste management activities in the city that were aggravated by the absence of e-waste legislations and absence of recycling centers.

**Table 5:** Responses to e-waste legislation, policies, and recycling

| ITEMS | Response | Institution's Name | | | Total | X 2 | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| | | PREI | PREI | PREI | | | |
| Are you aware of recycling/trading fairs for electronic wastes? | Yes | 16.7 | 16.7 | 16.7 | 50 | 3.200 | .525 |
| | No | 12.5 | 6.3 | 12.5 | 31.3 | | |
| | uncertain | 4.2 | 10.4 | 4.2 | 18.8 | | |
| Are you aware that some electronic parts may be profitably selling to recyclers? | Yes | 20.8 | 22.9 | 14.6 | 58.3 | 3.752 | .441 |
| | No | 12.5 | 8.3 | 14.6 | 35.4 | | |
| | uncertain | 0 | 2.1 | 4.2 | 6.3 | | |
| Do you know of any local or international laws pertaining to electronic waste management? | Yes | 8.3 | 8.3 | 6.3 | 22.9 | 1.925 | .750 |
| | No | 18.8 | 18.8 | 25 | 62.5 | | |
| | uncertain | 6.3 | 6.3 | 2.1 | 14.6 | | |
| Is there any policy/legislation on e-waste management at the state/federal level that your institution is aware of? | Yes | 0 | 14.6 | 10.4 | 25 | 9.461 | .051 |
| | No | 22.9 | 10.4 | 12.5 | 45.8 | | |
| | uncertain | 10.4 | 8.3 | 10.4 | 29.2 | | |
| Are you aware of local programs, projects, or activities | Yes | 6.3 | 6.3 | 10.4 | 22.9 | 1.465 | .833 |
| | No | 18.8 | 20.8 | 18.8 | 58.3 | | |
| | uncertain | 8.3 | 6.3 | 4.2 | 18.8 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| pertaining to electronic waste management? | | | | | | | |
| Are there e-waste recycling sites in Addis Ababa or elsewhere in the country that you know of? | Yes | 6.3 | 16.7 | 12.5 | 35.4 | 3.795 | .434 |
| | No | 20.8 | 14.6 | 16.7 | 52.1 | | |
| | uncertain | 6.3 | 2.1 | 4.2 | 12.5 | | |

Source: Field survey, 2017

This is because electronic waste management is quite different from other types of waste management because of its complex nature in its management. It is the rapidly growing waste stream in the world. In addition to this, it is composed of both hazardous and valuable materials, and the recycling and dismantling process requires high and special skills. Thus, designing of specific laws and legislations, guidelines, or regulations that deal with e-waste is paramount. This finding is consistent with MICT (2013), which points out that although government institutions are the biggest generators of e-waste, most have no idea on how to dispose of e-waste that is lying idle in their stores awaiting disposal.

### 3.4 Engagement level in e-waste management practices in Educational Institutions and Governmental Sector Offices

The findings of the study regarding the activities of EIs and GSOs related to inventory of e-waste, establishing departments handling e-waste, adopting e-waste policy, e-waste recycling, storage of e-waste, and awareness creation programs (see Table 6). Accordingly, the study highlighted that e-waste inventories were practiced among EIs and GSOs. These include e-waste identification and characterization, labeling, and recordings. Despite the fact, it was hardly possible to obtain data on temporal dimension of electronic waste, which hinders the presentation on the e-waste generation level in the last five years.

Electronic waste management, owing to its nature, should be handled by special bodies who are knowledgeable and professionals with basics of e-waste categorization, dismantling, refurbishing, and recycling. In this regard, it was found that there were no independent units that were responsible for handling e-waste in the majority of the selected EIs and GSOs. Furthermore, the GSD personnel considered and treated e-waste like other types of waste. This implies the awareness creation programs should be facilitated by the GSD personnel on how to handle e-waste.

The study also revealed that the majority of the GSD personnel reported that they had no policy or legislation governing e-waste management. Besides, there were no appropriate and sufficient storage areas to handle the discarded electronic waste. This indicates fewer concerns regarding e-waste management and the lack of proper handling of discarded appliances. Regarding types of electronic waste that EIs and GSOs consider hazardous, the result shows there were types of electronic waste, which were considered hazardous by GSD personnel. In this aspect, the chi-square test result to see whether there was a significant difference between EIs and GSOs was statistically significant at .045.

**Table 6:** Summary of the activities performed in e-waste management

| ITEMS | Response | Institution's Name | | | Total | $X^2$ | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| | | PREIs | PUEIs | GSOs | | | |
| Do you keep inventories of the equipment you discard/store? | Yes | 25 | 22.9 | 20.8 | 68.8 | 2.682 | .612 |
| | No | 8.3 | 6.3 | 10.4 | 25 | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | uncertain | 0 | 4.2 | 2.1 | 6.3 | | |
| Is there any unit that is specifically responsible for e-waste management in your institution/office? | Yes | 10.4 | 20.8 | 10.4 | 41.7 | 7.962 | .093 |
| | No | 22.9 | 12.5 | 18.8 | 54.2 | | |
| | uncertain | 0 | 0 | 4.2 | 4.2 | | |
| Does your institution have a policy for the management of electronic waste management? | Yes | 14.6 | 20.8 | 10.4 | 45.8 | 5.827 | .212 |
| | No | 14.6 | 12.5 | 14.6 | 41.7 | | |
| | uncertain | 4.2 | 0 | 8.3 | 12.5 | | |
| Does your office/institution have appropriate and sufficient storage to handle e-waste and discarded electronic items? | Yes | 16.7 | 10.4 | 8.3 | 35.4 | 3.815 | .432 |
| | No | 16.7 | 20.8 | 20.8 | 58.3 | | |
| | uncertain | 0 | 2.1 | 4.2 | 6.3 | | |
| Are there types of electronic waste that you consider hazardous? | Yes | 14.6 | 12.5 | 18.8 | 45.8 | 9.720 | .045 |
| | No | 18.8 | 14.6 | 4.2 | 37.5 | | |
| | uncertain | 0 | 6.3 | 10.4 | 16.7 | | |
| Is there any electronic equipment that is not giving service because of its design/size/features? | Yes | 10.4 | 16.7 | 16.7 | 43.8 | 2.597 | .565 |
| | No | 14.6 | 12.5 | 14.6 | 41.7 | | |
| | uncertain | 8.3 | 4.2 | 2.1 | 14.6 | | |
| Is your institution currently addressing the growing need for knowledge and skills relating to resource consumption or electronic waste? | Yes | 20.8 | 20.8 | 8.3 | 50 | 7.000 | .136 |
| | No | 8.3 | 6.3 | 10.4 | 25 | | |
| | uncertain | 4.2 | 6.3 | 14.6 | 25 | | |

Source: Field survey, 2017

The study found that there was electronic equipment that was non-functional because of the absence of manuals, their sizes, their designs, and lack of knowhow to operate the equipment in about 47% of the selected EIs and GSOs. This indicates that electronic equipment needs special care and knowledge during the purchase, consumption, and disposal. Finally, the study highlighted that about half (50%) of the selected EIs and GSOs were currently addressing the growing need for knowledge and skills relating to resource consumption or electronic waste. This practice should be expanded to an extent that it covers the population of the city.

Studies indicated that Africa is the latest destination for e-waste, referred to as the 'digital dump' by the Basel Convention Network (BAN), since many Asian countries are now coming up with legislation that bans uncontrolled import of certain categories of used EEE (Adediran and Abdulkarim, 2012). Almost half the e-wastes of US and Australia are dumped as landfills while the rest are exported to Asia and Africa (Sivaramanan, 2013). It is estimated that 75% to 80% is shipped to countries in Asia and Africa for "recycling" and disposal (Devin *et al*., 2014). Many African countries receive second-hand equipment. Veit and Moura (2015) avowed that most electronic equipment exports to Africa are not pre-tested for functionality. The same author further notes that it is not possible to assess whether these exports are legally defined as hazardous waste under the Basel Convention.

In this regard, the study discovered that the majority of the selected EIs and GSOs received electronic equipment from donating organizations and other institutions abroad. This has an implication on the volume and speed of e-waste generation. Townsend (2011) asserted that '*debate is still underway regarding the role of international transfer of old electronic equipment to developing countries. Certainly, the donation of working computers to households and students who otherwise would not have such equipment is of benefit, but the EOL implications must be considered.*'

In addition to the activities, this section also presents the results and findings obtained on the engagement level of the selected EIs and GSOs in some of the electronic-waste-management-related activities (see Table 7). Thus, it was found that the GSDs' engagement level in some electronic-management activities ranged from 'always' to 'never'. However, there were variations in the mean score among the three cases were 'sometimes' engaged in all of the activities listed in the table, hence the mean value for the whole activities is 2.11. Besides, the X 2 test results were significant at (p=.001, .007, .040), which indicates significant differences among EIs and GSOs in responding to

questions such as: "I observed proper waste segregation practices," "the institution bought electronic equipment from brands that are reputable for their durability and longer life over other brands," and "the institution trades or sells used electronic equipment." These results were clearly indicated in the ordinal regression outputs (see Table 8 and 9).

**Table 7:** Engagement level in e-waste management in EIs & GSOs

| Items | Institutions | Level of Engagement | | | Mean | Sig. |
|---|---|---|---|---|---|---|
| | | Always | Sometimes | Never | | |
| It recycles electronic products/gadgets that can still be recycled. | PREI | 2.1 | 12.5 | 18.8 | 2.31 | .184 |
| | PUEI | 0 | 22.9 | 10.4 | 2.50 | |
| | GSO | 4.2 | 10.4 | 18.8 | 2.43 | |
| It buys new electronic gadgets even if the older ones are still working. | PREI | 6.3 | 27.1 | 0 | 1.75 | .478 |
| | PUEI | 8.3 | 25 | 0 | 1.81 | |
| | GSO | 12.5 | 20.8 | 0 | 1.62 | |
| It buys electronic equipment with brands that are reputable for their durability and longer life over other brands. | PREI | 20.8 | 12.5 | 0 | 1.56 | .338 |
| | PUEI | 14.6 | 18.8 | 0 | 1.37 | |
| | GSO | 12.5 | 20.8 | 0 | 1.62 | |
| I observe proper waste segregation practices. | PREI | 4.2 | 20.8 | 8.3 | 1.81 | .001 |
| | PUEI | 12.5 | 14.6 | 6.3 | 2.12 | |
| | GSO | 0 | 6.3 | 27.1 | 2.81 | |
| It buys second-hand gadgets and/or "re-assembled" equipment. | PREI | 6.3 | 16.7 | 10.4 | 2.75 | .007 |
| | PUEI | 2.1 | 4.2 | 27.1 | 2.12 | |
| | GSO | 0 | 4.2 | 29.2 | 2.87 | |
| It traded or sells used electronic equipment. | PREI | 14.6 | 14.6 | 4.2 | 2.12 | .040 |
| | PUEI | 6.3 | 16.7 | 10.4 | 1.68 | |
| | GSO | 2.1 | 12.5 | 18.8 | 2.50 | |
| It donates some old electronic equipment to other institutions. | PREI | 0 | 14.6 | 18.8 | 2.06 | .170 |
| | PUEI | 8.3 | 14.6 | 16.7 | 2.56 | |
| | GSO | 8.3 | 16.7 | 8.3 | 2.00 | |
| Average | | | | | 2.11 | |

Source: Field survey, 2017

**Table 8:** The Status of EIs and GSOs in observing proper waste segregation practices (ordinal regression output)

| | | Estimate | Std. Error | Wald | df | Sig. | Exp_β | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Lower Bound | Upper Bound |
| Threshold | [Q49 = 1.00] | -4.055 | .820 | 24.485 | 1 | .000 | .017 | .003 | .086 |
| | [Q49 = 2.00] | -1.487 | .644 | 5.339 | 1 | .021 | .226 | .064 | .798 |
| Location | [PREIs] | -2.419 | .825 | 8.608 | 1 | .003 | .089 | .018 | .448 |
| | [PUEIs] | -3.361 | .881 | 14.571 | 1 | .000 | .035 | .006 | .195 |
| | [GSOs] | 0[a] | . | . | 0 | . | 1.000 | | |

Moreover, in order to predict an ordinal-dependent variable given one independent variable, the study conducts an ordinal regression. Accordingly, institution type (PREIs, PUEIs, and GSOs) was considered as an independent variable that might affect the ordinal-dependent variables ranging from

"never" to "always" for all items. The summary result is presented in Table 8, as follows. The ordinal regression result shows that the odds of Private Educational Institutions and Public Educational Institutions in observing proper waste segregation practices was .089 (95% CI, .018 to .448) and .035 (95% CI, 006 to .195) times that of Government Sector Offices, a statistically significant effect, Wald $X^2(1) = 8.608$, $p = .003$, and Wald $X^2(1) = 14.571$, $p < .001$, respectively (see Table 8). The odds of Private Educational Institutions in buying second-hand gadgets and/or "re-assembled" equipment was .067 (95% CI, .011 to .407) times that of Public Educational Institutions and Government Sector Offices, a statistically significant effect, Wald $X^2(1) = 8.641$, $p = .003$ (see Table 9).

**Table 9:** The Status of EIs and GSOs in buying second-hand gadgets and/or "re-assembled" equipment (ordinal regression output)

| | | Estimate | Std. Error | Wald | df | Sig. | Exp_β | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Lower Bound | Upper Bound |
| Threshold | [Q50 = 1.00] | -4.072 | .945 | 18.583 | 1 | .000 | .017 | .003 | .109 |
| | [Q50 = 2.00] | -1.965 | .761 | 6.673 | 1 | .010 | .140 | .032 | .622 |
| Location | [PREIs] | -2.698 | .918 | 8.641 | 1 | .003 | .067 | .011 | .407 |
| | [PUEIs] | -.543 | .988 | .302 | 1 | .583 | .581 | .084 | 4.027 |
| | [GSOs] | 0[a] | . | . | 0 | . | 1.000 | | |

Source: Field survey, 2017

As shown in Table 10, the odds of Private Educational Institutions in trading or selling used electronic equipment was .102 (95% CI, .023 to .445) times that of Public Educational Institutions and Government Sector Offices, a statistically significant effect, Wald X2(1) = 9.236, p = .002. As indicated in Table 11, the odds of Private Educational Institutions in donating some old electronic equipment to other institutions was 4.594 (95% CI, 1.140 to 18.518) times that of Public Educational Institutions and Government Sector Offices, a statistically significant effect, Wald $X^2(1) = 4.596$, $p = .032$.

**Table 10:** The Status of EIs and GSOs in trading or selling used electronic equipment (ordinal regression output)

| | | Estimate | Std. Error | Wald | df | Sig. | Exp_β | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Lower Bound | Upper Bound |
| Threshold | [Q51 = 1.00] | -2.550 | .636 | 16.055 | 1 | .000 | .078 | .022 | .272 |
| | [Q51 = 2.00] | -.270 | .496 | .297 | 1 | .586 | .763 | .289 | 2.018 |
| Location | [PREIs] | -2.281 | .750 | 9.236 | 1 | .002 | .102 | .023 | .445 |
| | [PUEIs] | -1.068 | .694 | 2.368 | 1 | .124 | .344 | .088 | 1.340 |
| | [GSOs] | 0[a] | . | . | 0 | . | 1.000 | | |

Source: Field survey, 2017

## 4. CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The findings discovered that households' level of awareness about e-waste and its management was

much lower than the EIs, GSOs, and HGOs. The respondents were not aware of e-waste policy/legislations, projects, activities, and e-waste recycling centers in Addis Ababa. Ethiopia had a no e-waste policy until recently except a single statement about e-waste in a proclamation named "Solid Waste Management Proclamation." Besides, there were no e-waste recycling centers in Addis Ababa or elsewhere in other secondary cities in Ethiopia except the CRTC. It is a recently established center to refurbish, dismantle, and maintain e-waste mainly on the computers.

The study found that educational status has influenced the awareness of the impacts of e-waste posed on the environment. This implies that the households with higher education status were likely aware of the environmental impacts of e-waste. However, the educational qualifications did not affect the remaining awareness-related questions presented in this study. On the other hand, the chi-square test result showed there was statistically significant difference in terms of the awareness of the respondents about the impacts of e-waste on the environment and safe disposal of dry-cell batteries among the PREIs, PUEIs, and GSOs. Accordingly, it was found that the majority of the GSD personnel in the PREIs were uncertain about the impacts of e-waste on the environment and safe disposal of dry-cell batteries than the PUIEs and GSOs. From these findings, in general, it was concluded that the GSD personnel and HGOs were more aware of the e-waste and issues in its management than the households of Bole and NSL sub-cities. This might be associated with several factors including the educational qualifications, exposition to various waste-management-related information, the working environments, and the office responsibilities. The improper disposal of e-waste poses a long-term threat to public health and the environment because it is the largest source of heavy metals and organic pollutants in the solid waste stream. In addition, e-waste needs to be handled properly in order to conserve resources because they contain valuable recyclable materials. The valuable spare parts of more selective types of electronic equipment will generate revenue for the organization.

Therefore, the implications of these findings are that the awareness creation program needs to be facilitated by the households rather than the GSD personnel and higher government officials. Besides, proper measures should be taken during the purchase and utilization of electronic equipment as well as during the storing, transportation, and disposal of the e-waste. It is evident that owing to the lack or absence of management system to handle e-waste, the majority of the consumers might lack awareness about what to do with the non-functional, obsolete, and irreparable electronic waste generated. As a result, there will be either prolonged storage or disposal of electronic waste with other types of domestic or municipal waste.

The result of this study can help not only for improving the e-waste management practices in Addis Ababa and other urban areas of Ethiopia, but it also serves as a first-hand information for other cities of the developing countries. Undeniably, the improper disposal practice of e-waste considerably affects both the environment and human health. Therefore, awareness creation programs and activities are among the pillars of electronic waste management to reduce these impacts. Fundamental achievement of proper waste management, consequently, is the availability of information and consultation and participation of government authorities and responsible stakeholders to create public awareness through designing communication tools for awareness enhancement and implementation of training needs on the issue of environmentally sound management of electronic wastes.

Based on the findings achieved from the study, it is highly recommendable to work on some of the e-waste-management-related activities. First and foremost, systematic training including seminars will be useful for the GSD personnel, regional and local authorities, and other actors involved to disseminate information especially on the relevance of managing e-waste in a sound manner. Then, the technical solutions (maintenances and assembly) and financing mechanisms for the fulfillment of e-waste management and recycling facilities. Finally, there should be promotion and awareness creation programs toward e-waste and its management

through Mass-medias, such as televisions, magazines, newspapers, journals, radios, and pamphlets.

## REFERENCES


Adediran YA & Abdulkarim, A. (2012). Challenges of Electronic Waste Management in Nigeria. International Journal of Advances in Engineering & Technology (IJAET), 4 (1), 640–648.

Arora, R. (2008). A survey on Electronic waste management in Coimbatore www.ijest.info/docs/IJEST11-03-03-114.pdf. (Accessed in March, 2015)

Askari, A. & Ghadimzadeh, A. (2014). Electronic Waste Management: Towards an Appropriate Policy. European Journal of Business and Management. 6 (1).

Baldé, C.P., Forti V., Gray, V., Kuehr, R., Stegmann,P. (2017). The Global E-waste Monitor – 2017. United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna.

Baldé, C.P., Wang, F., Kuehr R. & Huisman, J. (2015). The global e-waste monitor – 2014, United Nations University, IAS – SCYCLE, Bonn, Germany.

Borthakur, A. & Sinha, K. (2013). Electronic Waste Management in India: A stakeholder's Perspectives. Electronic Green Journal 1(36).

Chibunna, J.B., Siwar, C., Ara Begum, R. & Fariz, M.A. (2012). The Challenges of E-Waste Management among Institutions: A Case Study of UKM. Elsevier.

Circulate, (2017). The Source for Latest News and Insight on the Circular Economy. Eliminating the Concept of Electronic Waste.

Feras Y, Fraige, Laila A, Al-khatib, Hani M, Alnawafleh, Mohammad K, Dweirj & Paul A, Langston. (2012). Waste Electric and Electronic Equipment in Jordan: Willingness and Generation rates. Journal of Environmental Planning and Management, 55(2), 161–175.

Geethan, K., Vasantha, A., Jose, S., Manikandan, V.K., Muthuswamy, V., & Jude, S.L. (2012). Assessment of Electronic Waste Inventory and Management Model, International Journal of Applied Environmental Sciences, 7(1), 77–92

Gudeta, H.B., Akhila, S., Nair, & M.I. Zuberi, (2015). Electronic Waste Generation and Its Management in Bole and Akaki Kaliti Sub Cities of Addis Ababa Ethiopia. International Journal of Environmental Sciences 4 (2), 46–51.

Kiddee, P., Naidu, R., & Wong, M.H. (2013). Electronic Waste Management Approaches: An overview. Waste Management, 33(5), 1237–1250.

Lundgren, K. (2012). The Global Impact of E-Waste: Addressing the Challenge, International Labor Office, Programme on Safety and Health at Work and the Environment (Safe Work), Sectoral Activities Department, Geneva: ILO.

MICT (2013). Strategy for Electronic Waste Management UNDP, Republic of Uganda.

NCHEWM (2013). Environment Observer. Society for Environment Education Research and Management (SEERM). Proceedings of National Conference on Hazardous e-Waste Management. Vol 17.

Oomman, U.P. (2014). A Survey of Consumer Behaviour towards E- Waste Management in the City of Mumbai. International Journal of Research in Applied, Natural and Social Sciences 2 (8), 1–10.

Otieno, I. & Omwenga, E. (2015). E-Waste Management in Kenya: Challenges and Opportunities. Journal of Emerging Trends in Computing and Information Sciences. 6(12).

Samarakoon, M.B. (2014). A Review of Electrical and Electronic Waste Management in Sri Lanka. International Conference on Chemical, Civil and Environmental Engineering. Singapore.

Sinha, K.D., Kraeuchi, P. & Schawninger, M. (2005). A Comparison of Electronic Waste Recycling in Switzerland and in India. Environmental Impact Assessment Review, 25(5), 492–504.

Sivaramanan, S. (2013). E-Waste Management, Disposal and Its Impacts on the Environment. Universal Journal of Environmental Research and Technology, 3(5), 531–537.

Sotelo, S.C., Benitez, S.O., Victorica, K.V., Soto, N.S., Cueto, R.G., Gonzalez, P.T., & Virgen, Q.A. (2016). Electronic Waste in Mexico – Challenges for Sustainable Management.

Tengku-Hamzah, T.A.A. (2011). Durham E-Thesis Making Sense of Environmental Governance. A study of E-waste in Malaysia, Durham Theses, Durham University. http://www.etheses.dur.ac.uk/670/1/TAATengkuHamzah.pdf (Accessed in June, 2015).

Theodros, G. (2010). Assessment of Electronic Waste Management: Case Study of Some TVET Colleges in Addis Ababa. A Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Masters of Arts in Development Studies.

Townsend, T.G. (2011). Environmental Issues and Management Strategies for Electronic and Electrical Equipment. Journal of the Air and Waste Management Association. Volume 61: pp. 587–610. DOI:10.3155/1047-3289.61.6.587.

Tyagi, N., Baberwal, S.K., & Passi, N. (2015). E-Waste: Challenges and its Management. Journal of Undergraduate Research and Innovation, 1(3) 108–114.

United Nation University (2013). E-waste Management Project Launched in Ethiopia.

Veit, H.M. & Moura, B.A. (2015). Electronic Waste: Topics in Mining, Metallurgy and Materials Engineering.

Yale School of Forestry & Environmental Studies, (2012). https://e360.yale.edu/digest/africa...produce...e-waste.../3378/

Yu, J., Williams, E., Ju, M., & Yang, Y. (2010). Forecasting global generation of obsolete personal computers. Environmental science & technology. 44(9), 3232–3237.