E-waste Toolkit in Southeast Asia

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E-waste is one of the most pressing challenges of our time, yet it is often ignored in Southeast Asia. The “tsunami of e-waste” in the region has been putting our lives and our environment at risk. With the extensive use of electrical and electronic devices, we are also contributing to harming the environment and quickening climate change by producing and discarding e-waste. Youths are among the major users of electronic devices, and more often than not, hunger for upgraded and newer versions.

However, there is still a lack of sensitization on e-waste management issues in the Southeast Asia region. Why should not young people be pioneers in educating this challenge to the young public? Our FRE-E-WASTE project team, which took shape during our participation in the 2022 YSEALI Summit "Empowering Technology for a greener future" is firm in our belief that youths should take the lead in bringing to light this aspect of climate justice, to the best of our ability.

Implemented by a group of ASEAN environmental enthusiasts, STEP Forward Education and supported by the U.S. Department of State and the Young Southeast Asian Leaders Initiative (YSEALI), FRE-E-WASTE Project seeks to bring together a group of Southeast Asian environmental enthusiasts aged between 18 and 35 to connect and collaborate on e-waste issues in the region and eventually to create a toolkit about e-waste for the Southeast Asia region.

There were two major phases of the project. First, a two-day online workshop on the 3rd and 4th of September 2022, which brought together a group of 24 Southeast Asian environmental enthusiasts, who had been selected through an online application. The second phase of the project is toolkit completion. The workshop included a presentation and lively exchanges with our speaker, Dr. Chuck Chuan Ng, Assistant Professor of Environmental Science from Xiamen University, Malaysia. Second, participants were divided by four groups and created a toolkit based on the input from the workshop as well as their own research within one month, with the support of two editing volunteers as well as the project team. With a view to sensitizing the public to e-waste challenges, enormous efforts were made to render the toolkit reader-friendly while highlighting the relations between e-waste and climate change.

Since it is the first-of-its-kind community-created toolkit in the region and completed within a month, we seek your understanding of its limitations. It should be noted that English is the second, or third language of all the authors and editors, who contributed to the toolkit while working or studying full-time. The frameworks, practices as well as guidances in this toolkit, as a result, are far from exhaustive. We welcome your feedback and hope that you will share it with others!

We would like to express our gratitude to the U.S. Department of State and the Young Southeast Asian Leaders Initiative (YSEALI) for their financial support. Also, we appreciate and thank all participants from seven Southeast Asian countries for their active participation in the FRE-E-WASTE workshop, as well as their joint efforts to make the toolkit a reality. Finally, we would like to express our gratefulness to the two volunteers who lent their support to the editing team. We hope it will be a launching pad for our regional movement to raise awareness about e-waste management.

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Chapter 1: Introduction

Technology has been increasingly integrated into every nook and cranny into our daily existence. Electronic and electrical devices are more in demand as more people go digital. Nevertheless, their life spans have become shorter, which means they are born to die “young" to be replaced with new generations. In many cases, built-in obsolescence strategies of numerous tech companies, decline in prices and consumers’ desire to access cutting-edge products make it even more affordable to purchase a new device than repair an old one.

The generation of e-waste in Southeast Asia was reported to have increased by 63% in 2015 compared to 2010 (Honda et al., 2017). Both economic and demographic growth has contributed to the purchase and consumption of electronic devices in the region. In particular, the mobile phone subscription has skyrocketed from in 2010 to in 2018. The e-waste generation from mobile phones of Southeast Asian countries alone was valued at USD 2,019.06 million, higher than that of 27 developed countries in the European Union (EU) at USD 1,286.59 million. According to a study by Jumpstart Magazine (2021), waste transport in Southeast Asia increased by 171% between 2016 and 2018 when China closed its borders to foreign waste.

In 2021, ASEAN adopted the Framework for Circular Economy for the ASEAN Economic Community. However, rules and regulations on the management of e-waste on both national and regional levels have lagged behind. Improper management of e-waste often leads to the inability to substitute primary raw materials and subsequently causes greenhouse gas emissions from extraction. It is estimated that 57.4 million metric tons of e-waste was generated globally in 2021, among which only 17.4% of it is known to be collected and recycled in a standardized manner. Appropriate and adequate collection and recycling of e-waste is key to protect the environment and reduce climate emissions.

This toolkit, consisting of four main chapters, seeks to provide a reader-friendly overview of legal frameworks in 10 members of the Association of Southeast Asian Nations and Timor-Leste as well as guidance on how to handle e-waste on an individual level.

Chapter 1 deals with the concept of e-waste in the Southeast Asian contexts. Statistics on e-waste in Southeast Asia, as well as health issues related to e-waste consumption are also presented. Besides, chapter one also classifies e-waste based on its use, size and composition.

Chapter 2 centers upon the link between e-waste and climate change, namely the impact of e-waste on climate change. In addition, the potentials of proper e-waste management in mitigating climate change are also thoroughly discussed.

Chapter 3 delves into the status quo of e-waste treatment in Southeast Asia as well as the existing legal frameworks with regard to e-waste processing in Southeast Asian countries, as well as top-down and bottom-up efforts to improve e-waste management.

Chapter 4 is concerned with existing solutions to the e-waste predicaments in Southeast Asia. This chapter suggests actions that governments and producers can take to make treating e-waste part of its fight against climate change.

Chapter 2: What is E-waste?

2.1 *Definition*

Generally, e-waste is defined as electronic products that are unwanted, not working, and nearing or at the end of their "useful life" (Clark, 2022). In fact, there are other similar definitions of e-waste coined by various institutions in different Southeast Asian countries (Table 1).

Table 1: Definition of E-waste among different Southeast Asian Countries

Country	Definition of E-waste
 **Brunei**	Any discarded electrical and electronic devices or any other device powered by an electrical source (Department of Environment, Parks and Recreation, Ministry of Development, Brunei Darussalam, 2020).
 **Cambodia**	All equipment that is not used anymore but still in the whole figure or broken (not functional) or separating/recycling of electrical and electronic equipment (EEE) (Eduljee & Harrison, 2019).
 **Indonesia**	Electronic goods that are not functioning and not used anymore, originating from households, offices, commercial activities, and others (Eduljee & Harrison, 2019).
 **Lao PDR**	Toxic and hazardous waste whereby the government of Laos has issued the second notification No. 1855/PM dated on 17th November 2017 to ban the importation of E-waste.
 **Malaysia**	Scheduled waste under the code SW110 (First Schedule Environmental Quality (Scheduled Wastes) Regulations 2005).
 **Myanmar**	Items of all types of electrical and electronic equipment (EEE) and its parts that the owner has discarded as waste without the intention of reuse (Latt, n.d).
 **Philippines**	All waste of electrical and electronic equipment that contain hazardous components and is classified as a new class of miscellaneous with waste

Country	Definition of E-waste
	numbers M506 and 507 (Department of Environment and Natural Resources, Administrative Order No. 2013-22).
 **Singapore**	Like the definition as stipulated under the Basel Convention "A1180" (Eduljee & Harrison, 2019).
 **Thailand**	The product, electrical appliance and electronic device that is damaged or deteriorated and no longer be used or are needed (Pollution Control Department, Department of Industrial Works, 2021). Only some of the used electrical and electronic appliances have been categorized on Hazardous Substance Act B.E. 2535 (1992) and its amendment B.E. 2556 (2013).
 **Timor-Leste**	Among the recoverable waste definition, which covers all waste that is capable of being separated and whose transformation leads to a useful end (Article 7 of Decree-Law 2/2017) (The University of Melbourne, 2021).
 **Vietnam**	Also known as part of the hazardous waste whereby the hazardous waste management is uniformly applied to e-waste (Nguyen, 2020).

2.2 *General Classification of E-waste Products*

According to the study by Singh & Amin (2018), e-waste could be classified depending on its use such as:

1) *Large household appliances*: Refrigerators, dishwashers, electric cooking stoves and hot plates, clothes dryers, microwaves, electric fans, freezers, washing machines and air conditioners.

2) *Small household appliances*: Coffee machines, appliances for haircutting and drying, vacuum cleaners, toasters, grinders, tooth brushing and shaving.

3) *Information technology (IT) and telecommunications equipment*: Laptops, personal computers, notebooks, telephones, cell phones and printers.

4) *Consumer equipment*: Televisions, stereo recorders, audio amplifiers, video cameras, video recorders, radios and musical instruments.

5) *Lighting equipment*: High-intensity discharge lamps and fluorescent lamps.

6) *Electrical and electronic tools*: Drills, saws, sewing machines, soldering irons and equipment for turning, milling, grinding, drilling, making holes, folding, bending or similar processing of wood and metal.

7) *Medical devices*: Pulmonary ventilators, radiotherapy equipment, nuclear medicines and analyzers.

8) *Monitoring and control instruments*: Heating regulators, smoke detectors and thermostats.

9) *Automatic dispensers*: Hot or cold bottles, solid products, money and all appliances that automatically deliver various products.

10) *Toys, leisure equipment and sporting goods*: Electric trains or racing car sets, video games and sports equipment with electric elements.

2.3 *Composition of E-waste*

The composition of e-waste components generally contains high-value materials, hazardous materials, plastic, glass, ferrous metal, non-ferrous metal and other materials (Widyarsana et al., 2021). The materials of e-waste depend on the types and models of the electronic device, their manufacturers, the date of production and the age of the scrap (Abdelbasir et al., 2018).

Table 2: Composition based on different types of e-waste

Types of E- waste	Composition	References
Laptop, desktop	Aluminum (Al), copper (Cu), iron (Fe), Iron (Fe), magnesium (Mg), tin (Sn), lead (Pb), gold (Au), Neodymium (Nd), Dysprosium (Dy), glass, plastic, mercury (Hg), gallium (Ga), nickel (Ni) & etc.	Moraga et al. (2022), Mi & Dhawan (2021), Arshadi et al. (2019), Gupta et al. (2019), Eygen et al. (2016), Mundada et al. (2007)
Smartphone, tablet	Plastic, silver (Ag), copper (Cu), steel, lead (Pb), nickel (Ni), gold (Au), palladium (Pd), tin (Sn), epoxy, ceramics, silicon & etc.	Mi & Dhawan (2021), Gupta et al. (2019), Arshadi et al. (2019)

Types of E- waste	Composition	References
Television	Copper (Cu), tin (Sn), lead (Pb), ferrites, plastic, nickel (Ni), lead glass, iron (Fe) & etc.	Mi & Dhawan (2021), Gupta et al. (2019), Arshadi et al. (2019)
Radio	Iron (Fe), nickel (Ni), copper (Cu), aluminum (Al), plastic, ceramics, silicon (Si), selenium (Se), chromium (Cr), lead (Pb), zinc (Zn) & etc.	Islam & Huda (2020), Mundada et al. (2007)
Washing Machine	Iron (Fe), nickel (Ni), copper (Cu), aluminum (Al), plastic, chromium (Cr), lead (Pb), zinc (Zn) & etc.	Islam & Huda (2020), Mundada et al. (2007)
Air conditioner, refrigerator	Iron (Fe), nickel (Ni), copper (Cu), aluminum (Al), plastic, chromium (Cr), lead (Pb), zinc (Zn) & etc.	Islam & Huda (2020), Mundada et al. (2007)

E-waste is composed of different materials, which include hazardous constituents, high-value components and plastic. Figure 1 shows the percentage of e-waste components where the highest component is ferrous metal (31%) such as iron (Fe) and manganese (Mn) (Huang et al., 2019). Glass and plastic come next, with 27% of each. For the plastics, there are several types of plastic in e-waste, which include: high impact-resistant polystyrene (HIPS), polyvinyl chloride (PVC), brominated flame retardant (BFR), acrylonitrile butadiene styrene (ABS) and others. Each type of plastic has its characteristics, such as insulation properties, strength and flexibility. These types of plastics are commonly used for electronic equipment wire casing and body compartments (Wagner et al., 2019; Wu et al., 2020). Meanwhile, the commonly used materials in glass are borosilicate, soda-lime silicate and phosphates. Similar to plastic, the characteristic of each type of glass is different in terms of the properties (physical, chemical and optical) and application demand (Willsey, 2015). Other materials such as cement, ceramic and rubber comprise 8% of the overall e-waste composition (Akram et al., 2019).

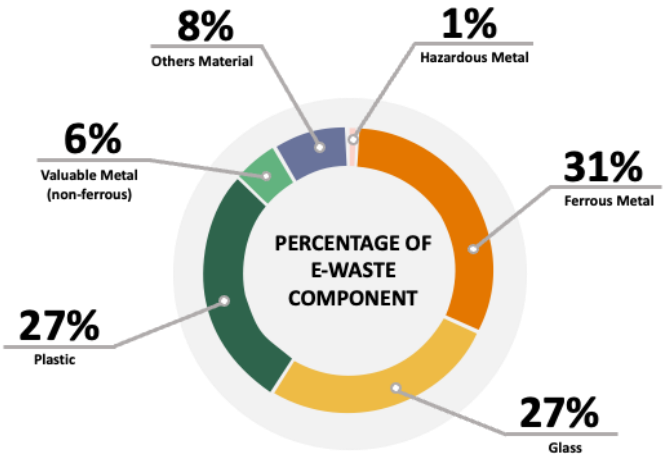

Figure 1: Composition of E-waste component (Widyarsana et al., 2021)

The main components in information and communications technology (ICT) equipment are valuable metals such as gold (Au), silver (Ag) and palladium (Pd) (Akram et al., 2019) and special metals such as indium, selenium, tellurium, tantalum, bismuth and antimony (Chancerel et al., 2009). However, it only contributes to 6% as the second lowest composition in e-waste. The lowest composition of e-waste is hazardous material (1%) whereby it often contains arsenic (As), cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb) and others (Akram et al., 2019). This hazardous material can be negatively harmful to both human health and the environment if not disposed of correctly.

2.4 *Perspectives towards E-waste in Southeast Asia*

Today, old electrical and electronic devices are constantly being replaced by newer versions, resulting in numerous electronic and electrical products. It is estimated that the informal sector contributed to 95% of e-waste recycling at the expense of health and the environment. Informal recycling is a new and expanded cost-effective recycling method for managing e-waste. In many developing countries, especially in Asia, emerging environmental management gaps, high demand for used electronic devices and the norm of selling e-waste to individual collectors have led to substantial amounts of informal recycling. E-waste is recognized as one of the fastest-growing solid waste streams in the world. However, most of the documented formal recycling rates for e-waste are incredibly low. The existing formal recyclers account for only a minuscule percentage of all e-waste generated in the developing countries due to e-waste supply chain constraints caused by informal e-waste collectors. The amount of e-waste disposed of in East and Southeast Asia has increased by almost two-thirds over the past decade. The amount generated, both overall and per capita is proliferating. E-waste generation is driven by the rising income and high demand for new gadgets and devices. Nevertheless, the average growth rate of e-waste is increasing in the developing countries and regions, especially in East and Southeast Asia, accounting for 63% over the last

seven years whereby a total of 12.3 million metric tons of e-waste has been recorded (United Nations University, 2016).

2.5 *General Effects of E-waste on Human Health*

E-waste may pose a negative influence on significant health issues such as changes in lung function, respiratory effects, reduced thyroid function and an increased risk of several chronic diseases later in life, such as cancer and cardiovascular disease (World Health Organization, 2021). There are six different groups of chemical substances which are commonly found in e-waste that could be harmful to human health:

a) *Brominated Flame Retardants (BFRs)*: It affects long-term health problems in pregnant women and memory function in children.

b) *Lead*: It causes serious disturbance in human reproductive systems.

c) *Cadmium:* It is associated with kidney disorders and bone disease for a long-term effect between 20 to 30 years.

d) *Mercury*: Highly vulnerable to affect the immune system, severe respiratory and kidney diseases. Besides, it also contains corrosive properties which may cause skin irritation.

e) *Hexavalent Chromium Compounds*: It is carcinogenic that may lead to the development of lung cancer and irritation in different human organs.

f) *Plastic compounds or Polyvinyl Chloride* (*PVC*) *cabling*: It may affect immune system disorders.

Chapter 3: E-waste and Climate Change

3.1 *Climate Change Background*

Climate change affects both the economy and people's way of living. Extreme weather events are occurring more frequently, sea levels increasing, and weather patterns changing. In 2020, GHG emissions were anticipated to fall by around 6% due to travel bans and economic slowdowns brought on by the global outburst of coronavirus 2019 (COVID-19), although this improvement is only temporary (United Nations, 2020; Kumar et al., 2022). With the rate of human induced GHG emissions, the pace of climate change has further exacerbated. Emissions are projected to rise when the global economy has recovered from the pandemic. Aiming to preserve lives and livelihoods, action must be taken immediately to tackle the threat of climate change. As part of the ASEAN Socio-Cultural Community Blueprint 2025, the Southeast Asia region will need to identify plans for climate change adaptation and to establish resiliency because ASEAN is one of the most highly vulnerable regions to climate change (ASEAN Socio-Cultural Community, 2016).

Improper management of e-waste has contributed to global climate change. The 2020 Global E-waste Monitor report claimed that if the components in e-waste are not recycled, they cannot substitute primary raw materials and reduce greenhouse gas emissions from extraction and refinement of primary raw materials (Forti et al., 2020). The discarded refrigerators and air-conditioners released 108 tons of carbon dioxide (CO_2) equivalents whereby the value of raw materials in global e-waste in 2019 was about USD 57 billion (Mendoza, 2022).

On average, each person will generate about 7.6 kg of e-waste in 2021, which is equivalent to a massive 57.4 million tons produced worldwide (Rosane, 2021). Hence, it is crucial to consider the effects of electronic goods on climate change. Every electrical or electronic device produced consists of a carbon footprint that contributes to human-induced global warming. From manufacturing a metric ton of laptops could potentially produce ten metric tons of CO_2 (Geneva Environment Network, 2022). When CO_2 is released over a device's lifespan is considered, it primarily occurs during the production process before consumers purchase the products. This makes lower carbon processes and inputs at the manufacturing stage (using recycled raw materials) and product lifespan key determinants of overall environmental impact. Using computers, notebooks, tablets, and smartphones add up to about 900 - 1100 Mt CO_2 emission. The production and transportation of the end devices are responsible for over 50% of their greenhouse gases (GHG) emissions, and this amount could rise (Bieser et al., 2020).

Rapid population growth and urbanization in developing countries are increasing greenhouse gas emissions from waste, especially methane (CH_4) from landfills as well as CH_4 and nitrous oxide (N_2O) from wastewater. CH_4 emissions from wastewater alone are expected to increase by almost 50% between 1990 and 2020, especially in the developing countries of Eastern and Southern Asia (US EPA, 2006). Besides, CH_4 from landfills has historically been the largest source of GHG emissions from the waste sector. In Southeast Asia alone, the CH_4 emissions from landfills tend to increase dramatically, approximately 200 Mt CO_2-eq per year (Bogner et al., 2008).

As a result, building climate resilience is one of the available options to mitigate the climate crisis. All actors should be considered, including the governments, civil societies, communities, businesses and other sectors to anticipate climate risks and hazards, and subsequently transform development pathways in the long run.

3.2 *Effects of E-waste on Climate Change*

The United Nations described a “tsunami of e-waste” because of the rapid expansion of digital society and consumer demand for digital products (ITU, 2022). Due to the non-recyclable “waste mountain” and potential harm to human health and the environment, the “tsunami of e-waste spreading out over the world” is becoming a significant threat to our planet (United Nations, 2015).

E-waste is significantly different from other artificial wastes physically and chemically. That is why the disposal of e-waste contributes significantly to the pollution of the atmosphere. Many studies have indicated that these various chemicals, when burned for disposal could damage the environment and humankind whereby the high condensed toxicity levels could lead to the possibility of health destruction to both humans and wildlife. A large amount of CO_2 is released by producing electronic devices. Approximately, 2.9 metric tons of carbon acid will be emitted by each ton of screen manufactured (Adams, 2018). In order to decrease the CO_2 emission, recycling is the recommended method, with 90% lower carbon emissions than the traditional disposal like burning (incineration) (Adams, 2018). However, various studies showed that only 20% of e-waste is resolved correctly, while the rest of the waste is inappropriately or informally disposed (Coalition 2019). Unfortunately, these informal recycling operations are mainly managed by the communities in the developing countries that are easily exposed to the toxins leaked from e-waste (Schwarzer et al., 2021).

The air is not the only one susceptible to pollution, but terrestrial and aquatic habitats are also heavily influenced as e-waste can leak harmful chemicals into the ground and water if dumped into the landfills. In the event of combustion, fumes release chemicals into the atmosphere and cause global warming. In addition, the fabrication of everything from our phones to laptops depends largely on rare elements and other materials that are extracted

from the earth which are also commonly the scarce resources that could directly impact on climate change.

As the population grows, the enormous demand for production is urgently required. More products are consumed, and more waste is released. As time went by, humans developed new technology as an excellent achievement for civilization. It is undeniable that digital innovations have created significant impacts on our lives. There are many great features such as telephone, camera, television, map, credit card and other physical items that are compacted into a smartphone. Nowadays, many modernized products are getting more convenient which leads to a reduction in the manufacture of other kinds of electronic and electrical products.

Nonetheless, recycling these types of products is getting harder. The most common way to recycle an electrical product is to dismantle and assemble its components into another one. In addition, the lightweight electrical products only have compressed components with glued parts making it difficult for recyclers to reuse them (Babbitt & Althaf, 2021).

Another issue caused by the advancement of technology is the convenience of making people's lives easier has shortened the lifespan of many electronic devices. Consumers' desire to replace their old devices with the latest models of technology has escalated the wasteful number of electronic goods. Furthermore, globalization is one of the leading causes which is responsible for this rising trend of increasing consumer needs. These factors have raised the amount of e-waste dumped into the environment, making the problem worse over time.

3.3 *E-waste Management in Mitigating Climate Change*

Various strategies can be taken to strengthen our climate resilience by mitigating the environmental impacts of e-waste and valorizing the end-of-life electronic products into valuable commodities (e.g.: virgin material substitution) (Hoy et al., 2022). These restorative and regenerative approaches can create a circular economy in e-waste management.

E-waste in a circular economy has two core processes: (i) strengthening recycling and (ii) escalating economic values. Both functions are reciprocal in the circular economy, where rising economic values could enhance the chance of implementing proper electronic waste recycling. A circular economy allows immediate solutions to e-waste problems by expanding functional and material value. For instance, the electronics will be utilized, if possible, then professionally remanufactured for reuse or repair in which the valuable components will be selected and recycled (Odumuyiwa et al., 2021).

Industrial symbiosis is a strategy to realize the circular economy by which wastes, or by-products of an industry or industrial process become the raw materials for another. The concept originates from biology, where symbiosis represents “the association of individuals of different species in a relationship where there is a mutual benefit” (Schwarz & Steininger,

1997). As companies from different business sectors collectively contribute to the physical exchange of their by-products, materials can be used more sustainably. Song et al. (2017) demonstrated a case study example of the symbiotic relationship between an e-waste treatment center, a material recycler and a compound producer, which emphasized plastic reuse from electrical cables, leading to win-win scenarios for all the involved stakeholders.

Achieving a circular economy is an integral part of the sustainability agenda which contributes to the United Nations Sustainable Development Goals (SDGs). The SDGs are a series of universal goals produced to help combat global environmental, political, and economic challenges. A sustainable e-waste management system would contribute to achieving multiple targets of the SDGs.

Water resources are highly susceptible to heavy metal contamination due to the mistreatment of e-waste. For instance, rainfall washes the heavy metal in soil into nearby water sources and acidifies groundwater via leaching (Wu et al., 2015). Given that locals frequently use groundwater and ponds for irrigation and drinking, it is vital to consider the potential ecological danger of heavy metal pollution in the area of abandoned e-waste sites. The proper management of e-waste effectively eliminates the risk of hazardous chemicals leakage into the water, air and soil. This would prevent the contamination of clean water and protect the aquatic ecosystem, which is in line with SDG 3 (Good Health and Well-Being), SDG 6 (Clean Water and Sanitation) and SDG 14 (Life Below Water).

The realization of e-waste in SDGs links urban mining as part of SDG 11 (Sustainable Cities and Communities). Urban mining, as part of a circular economy, is a long process to recycle vast amounts of electronic waste in particular cities. The urban mining technique includes recovering raw materials from waste products, buildings and rubbish. This measure leads to the increase in the possibility of recycling, which decreases the demand for primary raw materials, reusing essential goods to reduce energy consumption and GHG emissions and other environmental impacts of extraction and processing (Ilham et al., 2022). Urban mining of e-waste contributes to hamper the pressure on natural resources through recovery of metals, metal oxides and alloys which will reduce air and water pollution from the leachates of the landfills (Ramanayaka et al., 2020).

Environmentally sound management of e-waste supports SDG 12 (Responsible Consumption and Production) as it would significantly minimize the production of e-waste through prevention, reduction, repair, recycling and reuse. With the rapid growth in the economy and population, it is crucial to promote sustainable production and consumption by raising awareness levels among consumers and producers of electrical and electronic equipment. Effective e-waste recovery, reuse and recycling can also contribute to SDG 13 (Climate Action) as it contributes considerably to a net climate benefit. Clarke et al. (2019) discussed the potential climate impacts of e-waste treatment where reusing is optimal, followed by recycling and finally landfilling. Their findings emphasize that future e-waste

policies should increase e-waste collection and recovery rates and promote reuse. Consequently, household e-waste ends up in informal facilities through various collection methods (e.g.: non-governmental organizations (NGOs), charitable organizations, door-to-door collectors or other recyclable buyers and junkyards). These collection methods often involve the unwanted poisonous and dangerous components that are likely burnt or disposed of illegally (Hassan & Shirazi, 2021).

As e-waste management is a global threat from pollutant production and treatment perspectives, international negotiation and collaborative measures are the only realistic way to alleviate its climate impacts. Therefore, all Southeast Asian countries must collectively develop measures (e.g.: development of formal waste inventory, health prevention strategies, knowledge gaps and awareness training) to offset the hazards of e-waste effectively.

Figure 2: The United Nations Sustainable Development Goals that are relevant to e-waste. Adapted from Baldé et al. (2017).

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Chapter 4: E-waste in Southeast Asia

4.1 *Current Status of E-waste Management in Southeast Asia*

The movement of e-waste in Southeast Asia has increased by 171% between 2016 and 2018 when China closed its borders to foreign waste, mostly from the western countries (Jain, 2020). As an alternative option for waste disposal, other Southeast Asian countries came second on the list of places to dispose of their unwanted e-waste (Fundafunda, 2021). Besides, plastics and other non-biodegradable materials made up a sizable portion of this too. Moreover, due to Southeast Asia's generally loose rules on garbage imports, e-waste continues to end up in illegal landfills.

4.2 *Existing E-waste Policies in Southeast Asia*

With the alarming threat of e-waste to the environment and human health, Southeast Asian countries adopted international policies and guidelines about e-waste management, and several countries have crafted their own as well. Table 3 below shows the existing laws about e-waste management in different Southeast Asian countries.

Table 3: Policies related to E-waste Management in different Southeast Asian Countries

Countries	Existing Laws and Regulations
Brunei	○ Hazardous Waste (Control of Export, Import and Transit) Order (2013).
Cambodia	○ Sub-decree on E-waste Management (2016).
Indonesia	○ Government Regulation 27 (2020) on Specific Waste Management that covered the e-waste reduction and handling for the producer, area administrator and local government (The Asian Network for Prevention of Illegal Transboundary Movement of Wastes, 2020). ○ Government Regulation 101 (2014) on Hazardous Waste Management to regulate e-waste management. ○ Ministry of Environment and Forestry Regulation on Municipal Electronic Waste Management Act 18 (2008) on solid waste management.

Countries	Existing Laws and Regulations
Laos	○ Environment Protection Law (2012) for the management of toxic and hazardous waste and its disposal; and prohibited importation of hazardous waste. ○ Decision on Industrial and Handicraft Waste Management (2012). ○ Ministerial Instruction on Hazardous Waste Management (2015) on the classification of hazardous waste based on Basel Convention definition.
Malaysia	○ Environmental Quality (Scheduled Wastes) Regulations (2005). ○ Guidelines for the Classification of Used Electrical and Electronic Equipment in Malaysia (2010).
Myanmar	○ E-waste management is administered through the Basel Convention but no specific legislative measures to regulate e-waste.
Philippines	○ Presidential Decree 1586 (1978) mandates the Environmental Management Bureau on establishing an Environmental Impact Statement System (EISS) as a pre-condition for any project which involves the location and development of waste treatment and disposal facilities in ecologically sensitive areas. ○ Toxic Substances and Hazardous and Nuclear Waste Control Act (1990) regulated to prohibit the entry of hazardous and nuclear wastes and their disposal. ○ Ecological Solid Waste Management Act (2000) aims to protect human health by establishing ecologically-sound methods for managing solid waste (including liquid, semi-solid, or contained gaseous material, electronic and food waste).
Singapore	○ Hazardous Waste (Control of Export, Import and Transit) Act (1997) and with the revised edition in 2020. ○ Environmental Protection and Management (Hazardous Substances) Act (1999) and with the revised edition in 2022.
Thailand	○ E-waste management is governed by the Local Administrative Organization under the Ministry of Interior. ○ Under consideration to ratify Basel Ban Amendment (Pollution Control Department and Department of Industrial Works, 2021).

Countries	Existing Laws and Regulations
	○ Hazardous Substance Act (1992) and its amendment in 2013 (Chareonsong, 2014). ○ Currently, still developing the draft Waste from Electrical and Electronic Equipment (WEEE) Integrated Management Action Plan B.E. 2565 – 2569 (2022 – 2026) (Enviliance, n.d.).
Timor-Leste (East Timor)	○ Decree Law No. 2 (2017) Urban Solid Waste Management System.
Vietnam	○ Circular 23 (2006) on hazardous waste ○ Law on Environmental Protection No. 55 (2014) ○ Decree No. 38 (2015) on the management of waste and scraps ○ Circular No. 36 (2015) on hazardous waste management ○ Prime Minister's Decision No. 50 (2013) on Prescribing Retrieval and Disposal of Discarded Products. ○ Decree No. 187 (2013) on the ban of import of e-waste. ○ Decision No. 16 (2015) on Retrieval and Disposal of Discarded Products.

4.3 *Best Practices on E-waste Management in Southeast Asian Countries*

1) **Indonesia**: The country has started dealing with e-waste problems by implementing several legal bases, commencing government-run projects and collaborating with various institutions such as United Nations Development Programme (UNDP) Indonesia. Besides, there is a vast economic potential of e-waste management in Indonesia which is estimated at about USD 1.8 billion and could reduce up to 1,400 tons of carbon emissions.

The Environmental Office of Jakarta launched a program for collecting e-waste. The project commenced by installing e-waste drop boxes and garbage banks at residential areas in Jakarta. Then, a commercial company will collect and sort it for e-waste processing. The process starts with dismantling, then the recyclable garbage will be recycled, while non-recyclable debris will be treated before being transported to the dumping site. Electronics recycling is encouraged in several informal industries as well. There is a lack of recycling services in the formal sector due to the environmental and health effects, which has contributed to this informal sector of e-waste recycling in Indonesia (Bahraini, 2022).

2) **Malaysia:** Sending electronic debris to a facility that is permitted to recycle it is a feasible approach to solve the e-waste problems in Malaysia (Cho, 2018). Numerous non-governmental linked projects have emerged to deal with the issue of e-waste management. One of them is the Senheng E-waste Recycling Program, which was designed to dispose of old appliances properly and safely in order to protect the environment for future generations. Customers may simply bring their non-bulky e-waste goods to any of the national Senheng (electrical and electronic appliances) shops and get rewarded with cash vouchers for their efforts.

To support the local communities, the Community Recycle for Charity (CRC) gathers and recycles goods, including electronics. This nonprofit organization has donated various items to several charitable organizations, by giving these outdated and useless electronic gadgets a second chance of existence. Along with providing a completely free pickup service, CRC has placed 400 bins throughout the Klang Valley region for simple item drop-off (Chan, 2022).

On the other hand, Thanam Industry, which was founded more than 35 years ago, is a registered supplier of waste management and recycling solutions that take both scrap metals and e-waste. The business sources, gathers, processes, weighs and recycles waste products in accordance with all applicable environmental regulations and local regulatory agencies (Chan, 2022).

ERTH is a different initiative that runs in Malaysia. By delivering free pickups at the clients' doorsteps, they provide one of the most practical e-waste recycling services in Malaysia. The honor-winning business guarantees quick and easy payment the same day by cash, bank transfer and e-wallets. In addition, clients may choose their safe data deletion service, which uses top-notch software and procedures, if they are worried about the data that may still be on outdated devices like smartphones and tablets (Chan, 2022).

3) **Philippines**: Mintal Resource Collectors Association, under PHINLA Global Program and sponsored by German Cooperation and World Vision has helped in collecting the electronic waste in the community such as broken television, cellphone, and computer monitor and afterwards, they sell it to local manufacturers or recycling facilities. This

kind of collectors is different from the residual waste collectors and food waste collectors.

The unsung heroes of championing zero waste communities.
(Photo source: Fidel D. Pasco Jr., Barangay Mintal, Davao City, Philippines)

A member of the association segregates and collects what can still be recycled and sold from the electronic waste collected. (Photo source: Randy Catubag Irog, MiRCA President, Barangay Mintal, Davao City, Philippines)

A project on the growth of the recycling sector was launched in the Philippines by the Department of Environment and Natural Resources (DENR) and the National Solid Waste Management Commission (NSWMC) in partnership with the Department of Trade and Industry-Board of Investment (DTI-BOI), with additional expertise from the Japan International Cooperation Agency (JICA). The Cell Phone Waste Collection and Recycling Pilot Project, which started in September 2007, aimed to apply the knowledge gained in the project. By installing 20 collection bins in three designated areas, the initiative aims to designate drop-off stations for collecting faulty mobile phones and components in Metro Manila's malls and other public places. The government agencies like DENR and DTI, mobile phone manufacturers (Alcatel, LG Electronics, Nokia, Samsung, and Sony Ericsson), network service providers (Globe Tech Communication and Sun Cellular), selected mall owners,

transport and storage facilities (HMR Envirocycle Philippines) and JICA signed the Memorandum of Understanding (MoU) which solidified their participation and cooperation on the project. A technical working group (TWG) comprising partners was formed to give technical contributions for project execution (Arora, 2008).

As a part of Globe Telecom's sustainability program, a project named “The E-Waste Zero Bin” was established. The initiative gathered about 343,000 kg of e-waste in 2019, increasing the total number of e-waste garnered to more than 1.2 million kg since its inception in 2014. To promote the appropriate disposal of electronic or battery-operated gadgets, as well as information technology equipment and accessories that are no longer operating or desirable, Globe has set up over 100 electronic trash (e-waste) collection facilities around the Philippines (BMPlus, 2021).

Sample bin of the E-waste Zero Program of Globe Telecom in their Market Taguig Branch (Lopez, 2021)

On 5th June 2021, PLDT Inc., Smart Communications Inc., and Department of Environment and Natural Resources-Environment Management Bureau (DENR-EMB) Region 3 signed an agreement together with DENR-accredited provider JMR Trade & Transport Services (JMR) for an innovation program aimed at the proper collection, transportation, disposal and recycling of electronic and hazardous waste from cell sites and other locations. The #SmartPlanet phone recycling device program employs electronic sensors to send out Smart e-load in return for discarded phones, computers, device accessories, chargers and tablets (SMART Public Affairs, 2021).

Display of the #SmartPlanet Phone Recycling Bin which send out smart e-load for every donation of e-waste (Smart Public Affairs, 2021)

Envirocycle Philippines, a full-service recycling firm certified by the Department of Environment and Natural Resources, manages e-waste for other large-scale companies as well as smaller groups. Envirocycle Philippines Inc. accepts various recyclable materials such as polyethylene terephthalate (PET) bottles, glass, plastic containers, industrial sacks, cardboard and papers (Ramos, 2019).

Envirocycle Inc. Treatment, Storage and Disposal (TSD) facility accredited by DENR located at Silangan Industrial Park Canlubang, Calamba, Laguna, Philippines (Envirocycle HMR Group Affiliate, n.d.)

The E-waste Project, a three year-long program developed from the joint efforts of the University of the Philippines' (UP) Diliman, Manila, and Los Banos schools, seeks to create awareness on the hazard posed by the rising amount of illegally dumped electronic gadgets. Additionally, week-long drives are set up in selected months when individuals are invited to bring e-waste contributions from their homes to the UP Diliman campus such as computer motherboards, flash drives, television, computer monitors and others (Ramos, 2019).

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A drop off booth located Muni Market, Capitol Commons, Ortigas for the collection of e-wastes from interested individuals (The E-waste Project, 2017)

Globe Telecom Inc., the United Nations Industrial Development Organization (UNIDO), the Department of Environment and Natural Resources (DENR), Integrated Recycling Industries, Inc., EcoWaste Coalition and the local government unit of Dampalit have collaborated through the Global Environmental Facility (GEF) to transform the Materials Recovery Facility (MRF) of Barangay Dampalit in Malabon City into a Treatment, Storage, and Disposal (TSD) Community-based Facility for electronic waste. The said TSD facility is the second community-based facility and a massive breakthrough for e-waste recycling in the Philippines, particularly for Barangay Dampalit's waste management system as it improves the well-being of recyclers and their families and the entire community due to the dismantling and segregation were done in an appropriate e-waste facility where workforce are equipped with proper handling knowledge. With the installation of the TSD facility, informal e-waste pickers will be appropriately trained to address concerns about informal e-waste processing and the threats it poses to both the environment and human health. They will now have enough resources to kick start the facility's operations as well as the tools to properly collect and transport e-waste products thanks to Globe's assistance. The facility expects to handle at least 15,000 glass video displays from computers and television sets from its collection. Globe will also collaborate on a public awareness effort to emphasize the necessity of appropriate e-waste disposal. Since 2014, the TSD has been a component of Globe's E-waste Zero initiative, which encourages the safe and ethical management of e-waste (Punto, 2022).

A truck for e-waste collection has been turnover during the inauguration of the TSD Facility at Brgy. Dampalit was attended by Globe, DENR, UNIDO and EcoWaste Coalition (Punto, 2022).

The Department of Environment and Natural Resources-Environmental Management Bureau (DENR-EMB) and the United Nations Industrial Development Organization (UNIDO) presented the marker for the Philippines' first e-waste storage facility, situated in Bagong Silang, Caloocan City on 1st March 2019. Informal waste recyclers embraced their community's safe e-waste management initiative, reiterating their shared desire for everybody to have a good and safe recycling-based living. To store collected e-waste (mainly old and broken television sets), the e-waste storage facility will be staffed by skilled workers with the ranks of local informal recyclers. Collected e-waste will subsequently be sent to the Laguna-based Integrated Recycling Industries (IRI). This firm specializes in the recovery and recycling of valuable elements from e-waste (Sta. Rosa, 2019).

The Department of Environment and Natural Resources (DENR), in partnership with the United Nations Industrial Development Organization (UNIDO) established initiatives such as the "Safe PCB and E-waste Management Project" apart from installing e-waste facilities. The collaboration of national government and commercial companies aims to showcase the best available techniques and best environmental practices (BAT/BEP) in the long-term treatment of e-waste (Argosino, 2022).

A forum has been conducted to Bagong Silang in Caloocan City in July 2019, regarding "Safe PCB and E-waste Management Project" for awareness regarding the proper dismantling of e-waste (EcoWaste Coalition, 2019)

SM Supermalls established its Electronic Waste Collection (EWC) program, which was sponsored by SM Cyberzone and the SM Cares Program on Environment. This corporate social responsibility (CSR) and sustainability project invites mall consumers, communities, and people to bring their old electronics and other e-waste for appropriate disposal by authorized hazardous waste collection partners. Old or damaged mobile phones, mobile phone chargers, power cables, commercial batteries, earphones/earbuds, calculators, printer ink and toner cartridges, tiny devices and computer wire are examples of acceptable electronic trash (SM Cares Press releases, 2021).

SM Malls in Bulacan put up an e-waste collection booth for their sustainability program called "SM Electronic Waste Collection Program" (Environmental News, 2021).

4) **Thailand:** “Thai’s Say No to E-waste” program aims to educate Thai people about improper disposal of e-waste by collaborating with various partners such as universities, government and private sectors to set up e-waste returning points, acknowledge the recycling process and to track the amount of collected e-waste (Advance Info Service Company Limited, 2020). Subsequently, the e-waste blockchain is a continuous project from the "Thai’s Say No to E-waste" program that helps to track who returned the e-waste in each station, then calculate the carbon credit from the clean development mechanism and exchange this credit with the developed countries in the carbon market.

5) **Vietnam**: There are currently 15 firms licensed to handle e-waste nationwide, with daily capacity ranging from 0.25 to 30 tons per day. Only three of these businesses (Hoa Binh Treatment and Recycling of Industrial Waste Joint-stock Company, Viet Xanh Environmental and The Commercial and Service Green Environment from Hai Duong Province) may be regarded as the licensed handlers to treat e-waste (Hai et al., 2019).

Aside from that, another company (Viet Nam Recycles) oversees another special e-waste project operation. As part of the project, all stages of the e-waste treatment process are completed in facilities inside Vietnam as it represents a novel method for recycling e-waste. Safe made resources from e-waste are recovered through recycling processes that comply with the Law on Environmental Protection Amendments. Mobile devices, tablets, laptops, central processing unit (CPUs), liquid crystal display (LCD) and cathode ray tube (CRT) screens, printing devices, facsimile and scan devices, photocopiers, and electrical components associated with information technology are the main items recovered by Vietnam Recycles (Khang, 2022).

Chapter 5: Recommendations on E-waste Management (Do's and Don'ts)

To manage e-waste effectively on a broader scale, all users must be responsible for doing their part to maximize benefits and minimize the negative impacts it has on the environment. Hence, this chapter provides a general idea of what users should do and not do to address the e-waste problem whereby in this section, the users were classified into three major groups: (i) *Government*, (ii) *Producers* and (iii) C*onsumers*.

5.1 *Governments*

Some nations have varying electronic recycling legislation, while others do not. Some nations partner with private organizations to operate on a nationwide collection system. At the same time, others force manufacturers to reach minimum recycling goals depending on sales volume. All governments may help to construct a more robust e-waste recycling infrastructure by establishing targets and developing financing schemes for collection systems and recycling plants, which would be crucial in reducing e-waste. In addition, it might provide a tax credit or refund to businesses that recycle their electronic waste and prevent its export to underdeveloped nations (Cho, 2018).

A list of recommendations is suggested below to the governments to lessen e-waste issues:

1) **Apply strict implementation of existing e-waste management laws and to develop strategic plans for effective e-waste management.** Domestic regulations need to be strengthened and strictly implemented; strict punishments and fines must be incorporated to ensure both producers and consumers are liable for their e-waste management.

2) **Invest in e-waste management technological innovations and advancements.** The governments should invest and assist businesses to invest in high-quality recycling techniques. Reusing and recycling e-waste without causing pollution or harm to human health or the environment is required to decarbonize the economy and safeguard the nations.

3) **Encourage eco-friendly designs.** Should encourage designers, firms, and suppliers to develop socially and ecologically responsible electrical and electronic products that satisfy the needs of both regulators and consumers as well as to minimize negative social and environmental consequences. The governments should safeguard consumers by tightening and extending the product lifetime guarantees and mandating manufacturers to label products with information regarding their durability and ease of repair. Everyone should have the right to have their belongings repaired (Environmental Audit Committee, 2020).

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4) **Provide treatment facilities and collection sites and services for e-waste.** E-waste management necessitates by establishing appropriate collection, treatment and disposal systems. Most developed nations have enacted treaties, directives and legislations designed to promote the correct collection, treatment and recycling of electronic trash as well as the safe disposal of the components that cannot be recycled. These initiatives include the Reduce, Reuse and Recycle (3R's) campaign, the Extended Producer Responsibility (EPR) program, product stewardship and advance recycling fund (ARF) projects (Mmereki et al., 2016).

5) **Engage with environmental conservation organizations to develop holistic e-waste management solutions.** The pollution caused by e-waste is a significant problem and addressing this issue with one entity alone will not resolve it. The governments must collaborate to develop ways to reduce the amount of e-waste produced. It may be helpful to cooperate closely with various environmental organizations, institutions, and many others.

6) **Strengthen domestic recycling by providing relevant information, education, and communication campaigns.** Inform individuals of the significance of e-waste recycling. It can begin with committing to bring any electronic item we no longer need or want to a recycling center rather than throwing it away or storing it in a desk drawer. Communicating this message to our family members, friends, neighbors, and co-workers is necessary, but it is equally crucial to reach out to our future leaders (Balsara, 2020).

7) **Minimize hazardous e-waste exports and strengthen capacity in underdeveloped nations.** Emerging nations must take limiting measures on importing harmful electronic trash. Responsible parties should be held accountable for their illegal operations and receive legal sanctions.

8) **Establish a designated agency for e-waste management.** To ensure the correct disposal method of e-waste be the utmost priority and should not be neglected. The governments must establish a designated agency and manpower to manage e-waste in the country. Employees and technical personnel in the relevant field must have the necessary skills and knowledge in order to manage e-waste effectively (US EPA, 2021).

5.2 *Producers*

Producers are one of the most critical stakeholders in producing e-waste and are duty-bound to take action to mitigate the amount of e-waste in the region. “Producers” include but are not limited to companies or businesses that manufacture or import regulated products such as ICT-related products, batteries, solar or other electrical devices for supply on the local market needs.

To ensure reducing e-waste in the region, the producers are also important to be aware of the following Do’s and Don'ts during the process of to design and manufacture a product.

Producers Do’s

1) **Manufacture a lifetime warranty product.** Companies and businesses should focus more on the product's life cycle and maintain decent quality. They should manufacture or produce electrical and electronic products that can be upgraded to extend product life.

2) **Manufacture products that can be reused after the expiry date.** Companies and businesses should produce more electrical and electronic products that can be reused even if they are expired.

3) **Focus on energy-efficient products.** Companies and businesses should manufacture electrical and electronic products that are equipped with high energy-efficiency when they are used in order to reduce energy usage.

4) **Reduce plastic and recourse to eco-friendly packaging.** Companies and businesses should ensure to include fewer packaging materials (limit plastics usage) and/or use recyclable packaging for all electrical and electronic products.

5) **Manufacture products that use recycled materials.** Instead of using single used plastic, producers should focus more on recyclable products like iron, copper or glass which can be recycled after they are damaged or expired.

6) **Facilitate comprehensive product usage guidelines.** Producers are responsible to specify clear policies and guidelines about extended producers’ responsibility (EPR) for all the electrical and electronic products through their whole life cycle.

7) **Develop programs to encourage the public to recycle e-waste.** All producers should educate their users or customers by developing relevant awareness activities to encourage the public to recycle e-waste.

8) **Provide sufficient e-waste collection facilities.** Producers should provide a variety of e-waste collection avenues for e-waste recycling (e.g.: e-waste receptacles in public areas, scheduled collection drives, ad-hoc doorstep collection services, etc.).

9) **Put in place appropriate e-waste tracking systems.** Producers should collaborate with other regional stakeholders and establish a reliable data management system to track and report to the national e-waste agency on the total amount of e-waste collected for treatment and disposal.

10) **Provide e-waste recycling reports regularly.** Producers are responsible for tracking the amount of e-waste recycling from their products. Producers are encouraged to provide quarterly recycling reports on the flow of regulated e-waste, including the number of materials prepared for reuse or repurposing.

Producers Don'ts

1) **Overuse of plastic in the products.** Producers should not use too much of the single-use plastic in their products to ensure low production cost.

2) **Concern about the collection rate.** Producers should not concern solely on the total collection and recycling rates, but instead should highlight the importance of waste minimization and education awareness to the consumers.

3) **Less encouragement for consumers to recycle.** There is a lack of initiatives from producers to encourage consumers to dispose of appropriate electrical and electronic devices at its end-of-life stage.

4) **Lack of product tracking and monitoring procedures.** Many producers do not provide product tracking and monitoring in the after-sales service causing a lack of data collection system for producing e-waste and unwanted products in the market.

5) **Providing insufficient awareness about e-waste in the workplace.** Most companies and businesses do not provide sufficient awareness and training to their employees and workers in the workplace about appropriate e-waste management.

6) **Focus on quantity more than quality.** Producers often emphasize on the number of products rather than the quality, which can affect the overall product's ability and make it easy to break in a short time which may eventually cause the rise of e-waste.

5.3 *Consumers*

Consumers can be individuals or groups who purchase or use electrical and electronic devices solely for personal uses, not for production or resale. In the sales distribution chain, they are the final consumers.

Consumers Do's

1) **Be a smart consumer.** Consumers need to be wise to opt for eco-friendly products and should conduct a simple comparison among different products before purchasing.

2) **Consider carefully before buying new products.** Consumers should always try to ask themselves whether "Is it vital to buy a new one only to satisfy our momentary lust?"

3) **Use the product's handbook or manual wisely.** Consumers should read the products contents properly to understand the basic product functionality and disposal method.

4) **Demand for product warranty and servicing.** Consumers should visit the product servicing centers for any defective and/or malfunctioning device instead of discarding them straightaway. Besides, it is dangerous if consumers try to repair the product themselves without proper guidance.

5) **Educate children at a very young age.** Adults and parents should educate the children and the younger generation about the importance of proper e-waste management at home.

6) **Maintain what we have.** To extend products' lifespan, consumers should keep good care of the products and avoid overusing them.

7) **Reuse and recycle as much as possible.** Consumers should reuse and recycle their unwanted products as it can significantly help to reduce the generation of e-waste.

Consumers Don'ts

1) **Dispose electrical and electronic devices into general bins carelessly.** Consumers should be considerate to dispose of the unwanted e-waste through the appropriate collection facilities. It may take a long time to decompose and potentially release hazardous pollutants into the environment should it be disposed of incorrectly to the landfill.

2) **Burn e-waste products.** Consumers should not try to burn the e-waste at home as the incomplete combustion of e-waste will emit many toxic pollutants into the environment such as dioxins, furan, carbon monoxide and a significant amount of particulate matter.

Chapter 6: Conclusions

E-waste is one of the most harmful yet least understood waste. Definitions of e-waste vary from country to country, but it turns out that e-waste is quite similarly conceptualized across the region. Furthermore, they are made of recoverable and recyclable materials. For example, in Brunei, e-waste is defined as any discarded electrical and electronic devices, whereas in Singapore, legal frameworks on e-waste conform to international law, specifically Basel Convention "A1180" definition. Across all the Southeast Asian countries, plastics and other non-biodegradable materials make up a large percentage of e-waste.

By and large, it has been shown that Southeast Asia's e-waste management rules remain vague. E-waste often ends up in illegal landfills due to Southeast Asia's generally loose rules on garbage imports. As discussed in chapter 2, over the past ten years, the amount of electronic scrap has skyrocketed, whereby recycling, and burning of these materials have become popular. The disposal of e-waste has been partly responsible for the contamination of the atmosphere. The air is not the only victim. Terrestrial and aquatic habitats are also heavily polluted because e-waste can leak harmful chemicals into the groundwater if dumped into the landfills. Due to the increased health risks including kidney damage, bronchitis, and Wilson's disease brought on by the inappropriate disposal of hazardous materials from electronic scrap and combustion, there is a growing need for efficient e-waste management policies.

Many countries' rising per capita incomes have encouraged consumers to frequently and ambitiously upgrade their purchases. Young generations switch out old technology for newer models of computers, telephones, and other gadgets. Over the past ten years, the amount of electronic scrap has skyrocketed, and burning of these materials have become rampant.

As of 2022, most Southeast Asian countries do not have specific laws and regulations regarding e-waste. In general terms, legal stipulations on e-waste are part of the law on environmental protection and/or hazardous waste management regulations. For instance, in Vietnam, e-waste regulation is covered by the law on environmental protection and hazardous waste management regulation. It should be noted, however, that Southeast Asian countries have made continuous efforts to improve e-waste management, albeit to a varying extent. On 1st November 2021, Vietnam Recycles began applying a new list of products to collect, focusing on collecting mobile phones, tablets, CPUs and laptops, LCD and CRT screens, printing machines, facsimile and scan machines, photocopiers and electronic parts related to information technology. The changes are intended to align with amendments to the Environmental Protection Law. Some nations partner with private organizations to operate a nationwide collection system, while others force manufacturers to reach minimum recycling goals depending on sales volume.

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E-waste is managed with the proper recycling strategies; it can be economically viable and create a circular economy. E-waste in the region is recycled both informally and formally. E-waste in a circular economy has two core processes: strengthening recycling and escalating economic values. For instance, the electronics will be utilized, if possible, then professionally remanufactured for reuse or repair. Their valuable components will be selected and recycled. According to the latest research report by Spherical as Insights & Consulting, the Global E-waste Management Market Size was valued at USD 52.13 billion in 2021. With the rapid growth in the economy and population, it is crucial to promote sustainable production and consumption by raising awareness levels among both consumers and producers in electrical and electronic equipment. Effective e-waste management policies that cover recovery, reuse and recycling of electronic devices are bound to contribute to a net climate benefit.

Governments can enhance their investments in e-waste management through technological advancements, as well as providing treatment facilities, collection sites and e-waste services. The governments may help to construct a more robust e-waste recycling infrastructure by establishing targets and developing financing schemes for collection systems and recycling plants, which would be crucial in reducing e-waste. In addition, producers of electronic devices, who are responsible for taking actions to reduce the amount of e-waste in the region, should pay heed to during all phases of production. Electronic products that contain less plastic and can be reused beyond their shell life are particularly desirable. Lastly, consumers are encouraged to buy “green” electrical and electronic devices when possible and inform themselves where to deal with e-waste in the first place.

References

Abdelbasir, S. M., El-Sheltawy, C. T., & Abdo, D. M. (2018). Green Processes for Electronic Waste Recycling: A Review. *Journal of Sustainable Metallurgy*, 4(2), 295–311. https://link.springer.com/article/10.1007/s40831-018-0175-3

Adams, R. (2018). E-waste and How to Reduce It. A Climate Institution Publication. Retrieved from https://climate.org/e-waste-and-how-to-reduce-it/#:~:text=E%2Dwaste%20disposal%20contributes%20to,metals%20accumulate%20in%20the%20air.

Advanced Info Service Public Company Limited. (2020, December 16). AIS upgrades "Thais say no to e-waste" program to National Agenda Partners Ministry of Natural Resources and the environment. *AIS*. Retrieved October 8, 2022, from https://sustainability.ais.co.th/en/update/news/180/ais-upgrades-thais-say-no-to-e-waste-program-to-national-agenda-partners-ministry-of-natural-resources-and-the-environment#:~:text=The%20goal%20was%20to%20raise,the%20convenience%20of%20the%20public.

Akram, R., Natasha, Fahad, S., Hashmi, M. Z., Wahid, A., Adnan, M., Mubeen, M., Khan, N., Rehmani, M. I. A., Awais, M., Abbas, M., Shahzad, K., Ahmad, S., Hammad, H. M., & Nasim, W. (2019). Trends of electronic waste pollution and its impact on the global environment and ecosystem. *Environmental Science and Pollution Research*, 26(17), 16923-16938. Springer Link. https://link.springer.com/article/10.1007/s11356-019-04998-2

Arellano Law Foundation. (n.d.). P.D. No. 1586. The lawphil project. Retrieved September 13, 2022, from https://lawphil.net/statutes/presdecs/pd1978/pd_1586_1978.html

Argosino, F. (2022, April 6). How to manage E-waste: Bring to a treatment, storage, and disposal facility. *Manila Bulletin*. Retrieved September 13, 2022, from https://mb.com.ph/2022/04/06/how-to-manage-e-waste-bring-to-a-treatment-storage-and-disposal-facility/

Arora, R. (2008, April). Best practices for e-waste management in developing nations. *Europe Aid Co-operation Office*, 1-24. Retrieved September 13, 2022, from https://www.environxchange.com/images/article/139/best%20prac.pdf

ASEAN Socio-Cultural Community. (2016). *ASEAN Socio-Cultural Community Blueprint 2025*. ASEAN Secretariat

Arshadi, M., Yaghmaei, S., & Mousavi, S. M. A. (2019, December 10*).* Optimal electronic waste combination for maximal recovery of Cu-Ni-Fe by Acidithiobacillus ferrooxidans. *Journal of Cleaner Production*, 240, 118077. Science Direct. https://doi.org/10.1016/j.jclepro.2019.118077

ASEAN-Korea Economic Cooperation Fund. (2022). Guideline Handbook for E-Waste Management within ASEAN and Korea. Retrieved from https://www.oie.go.th/assets/portals/1/files/industrial_article/Guideline%20Handb

ook%20for%20E-Waste%20Management%20within%20ASEAN%20and%20Korea.pdf.

Babbitt, C., & Althaf, S. (2021). Consumer electronics have changed a lot in 20 years – systems for managing e-waste aren't keeping up. The Conversation. Retrieved from. https://theconversation.com/consumer-electronics-have-changed-a-lot-in-20-years-systems-for-managing-e-waste-arent-keeping-up-147972

Bahraini, A. (2022, March 17). How electronic waste is managed in Indonesia. *Waste4Change*. Retrieved October 9, 2022, from https://waste4change.com/blog/how-electronic-waste-is-managed-in-indonesia/

Baldé, C. P., Forti, V., Gray, V., Kuehr, R., & Stegmann, P. (2017). The global e-waste monitor 2017: Quantities, flows and resources. United Nations University, International Telecommunication Union, and International Solid Waste Association. http://collections.unu.edu/eserv/unu:6341/GEM_2017-R.pdf

Balsara, F. (2022). How to design environmentally sustainable electronics. NeuronicWorks. Retrieved September 22, 2022, from https://neuronicworks.com/blog/environmentally-sustainable-design/

Bieser, J. et al. (2020). Climate protection through digital technologies. Bitkom e.V.

BMPlus. (2021, January 5). Globe sets up over 100 e-waste collection points nationwide. *BusinessMirror*. Retrieved September 13, 2022, from https://businessmirror.com.ph/2021/01/05/globe-sets-up-over-100-e-waste-collection-points-nationwide/

Bogner, J., Pipatti, R., Hashimoto, S., Diaz, C., Mareckova, K., Diaz, L., ... & Gregory, R. (2008). Mitigation of global greenhouse gas emissions from waste: conclusions and strategies from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. Working Group III (Mitigation). *Waste Management & Research, 26(1)*, 11-32. https://doi.org/10.1177/0734242X07088433

Chan, A. (2022, July 26). Got some old unwanted electronic devices and items? get your e-waste recycled at these places. *Shopee Blog*. Retrieved October 9, 2022, from https://shopee.com.my/blog/e-waste-recycling-malaysia/#CRC_Community_Recycle_for_Charity

Chancerel, P., Meskers, C., Hagelüken, C., & Rotter, V.S. (2009). Assessment of Precious Metal Flows During Preprocessing of Waste Electrical and Electronic Equipment. *Journal of Industrial Ecology*, 13

Chareonsong, P. (2014). E-Waste Management in Thailand. Presentation, Hanoi, Vietnam. Retrieved October 9, 2022, from https://19january2017snapshot.epa.gov/sites/production/files/2014-08/documents/thailand_country_presentation.pdf

Chatterbuzz. (2019, April 4). Simple ideas on how to reduce e-waste. Great Lakes Electronics. Retrieved September 22, 2022, from https://www.ewaste1.com/how-to-reduce-e-waste/

Clark, J. (2022). What is E-waste? Definition and Why It's Important. Great Lakes Electronics. Retrieved September 25, 2022, from https://www.ewaste1.com/what-is-e-waste/.

Clarke, C., Williams, I. D., & Turner, D. A. (2019). Evaluating the carbon footprint of WEEE management in the UK. *Resources, Conservation and Recycling*, 141, 465-473. https://doi.org/10.1016/j.resconrec.2018.10.003

Cho, R. (2018, August 27). What Can We Do About the Growing E-waste Problem? State of the Planet. Retrieved October 2, 2022, from https://news.climate.columbia.edu/2018/08/27/growing-e-waste-problem/

Coalition, E. W. (2019). A new circular vision for electronics: Time for a global reboot. World Economic Forum.

Costoff, D. (n.d.). E-Waste: Producers Vs Consumers. ECOLOGICA. Retrieved September 22, 2022, from https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1626780535.pdf

Daum, K., Stoler, J., & Grant, R. J. (2017). Toward a more sustainable trajectory for e-waste policy: a review of a decade of e-waste research in Accra, Ghana. *International journal of environmental research and public health, 14(2)*, 135. https://doi.org/10.3390/ijerph14020135

Department of Environment, the Jakarta Provincial Government. (2022). Picking Up E-Waste. Retrieved from https://lingkunganhidup.jakarta.go.id/layanan_kami/e_waste

Department of Environment, Parks and Recreation, Ministry of Development, Brunei Darussalam (2020). E-WASTE MANAGEMENT IN BRUNEI DARUSSALAM. Royal Society of Chemistry. Bioie.oie.go.th. (2020). Retrieved 25 September 2022, from http://bioie.oie.go.th/oieqrcode/uploadFile/oie621360278_1622728335.pdf.

Earth 911. (2021b, July 16). E-Waste: What Happens When We Fail To Recycle Electronics *Earth911*. Retrieved September 22, 2022, from https://earth911.com/eco-tech/e-waste-why-you-should-recycle-electronics/

Ecological Solid Waste Management Act of *2000*. Republic act no. 9003. Official Gazette of the Republic of the Philippines. (2001, January 26). Retrieved September 13, 2022, from https://www.officialgazette.gov.ph/2001/01/26/republic-act-no-9003-s-2001/

EcoWaste Coalition. (2020). Barangay bagong silang in caloocan city makes stride in safe e-waste management. *EcoWaste Coalition*. Retrieved September 13, 2022, from http://ecowastecoalition.blogspot.com/2020/12/barangay-bagong-silang-in-caloocan-city.html.

EcoWaste Coalition. (2019). Caloocan barangay gears up for safe e-waste management. *EcoWaste Coalition*. Retrieved September 13, 2022, from http://ecowastecoalition.blogspot.com/2019/07/caloocan-barangay-gears-up-for-safe-e.html.

Eduljee, G. H., & Harrison, R. M. (Eds.). (2019). *Electronic Waste Management*. Royal Society of Chemistry.

Environmental Audit Committee - MPs on the House of Commons (2020, November 26). How do we solve our electronic waste problem? Retrieved September 22, 2022, from https://houseofcommons.shorthandstories.com/environmental-audit-e-waste/index.html

Environmental Management Bureau (n.d.). Mandates and Functions. GOV.PH. Retrieved September 13, 2022, from https://emb.gov.ph/mandates-functions/

Environmental News. (2021). Sm Malls Introduce E-Waste Collection Program in Bulacan. *Green Party of the Philippines*. Retrieved September 13, 2022, from https://www.greenparty.ph/sm-malls-introduce-e-waste-collection-program-in-bulacan/

Extended producer responsibility (EPR) system for E-waste management system. *National Environment Agency*. (n.d.). Retrieved September 22, 2022, from https://www.nea.gov.sg/our-services/waste-management/3r-programmes-and-resources/e-waste-management/extended-producer-responsibility-(epr)-system-for-e-waste-management-system#:~:text=The%20regulated%20e%2Dwaste%20management%20system%20is%20based%20on%20the,reach%20end%2Dof%2Dlife.

Enviliance (n.d.). Thailand, draft WEEE Action plan 2022 – 2026: Enviliance Asia, *Enviliacne Asia.* Retrieved October 13, 2022, from https://enviliance.com/regions/southeast-asia/th/th-waste/th-weee.

Eygen, E. V., Meester, S. D., Tran, H. P., & Dewulf, J. (2016, February). Resource savings by urban mining: The case of desktop and laptop computers in Belgium. *Resources, Conservation and Recycling*, 107, 53-64. Science Direct. https://doi.org/10.1016/j.resconrec.2015.10.032

Forti, V. (2020). Global electronic waste up 21% in five years, and recycling isn't keeping up. *The Conversation*. Retrieved from https://theconversation.com/global-electronic-waste-up-21-in-five-years-and-recycling-isnt-keeping-up-141997

Forti, V., Baldé, C. P., Kuehr, R., & Bel, G. (2020). The global e-waste monitor 2020. *Quantities, flows, and the circular economy potential*, 1-119.

Fundafunda, J. (2021, September 9). A close look at Southeast Asia's e-waste crisis. *Jumpstart Magazine*. Retrieved September 20, 2022, from https://www.jumpstartmag.com/a-close-look-at-southeast-asias-e-waste-crisis/

Garcia, G. (2022, May 15). Davao City Waste-to-energy project to fuel climate change, groups, warn. *Philstar.com*. Retrieved September 13, 2022, from https://www.philstar.com/headlines/climate-and-environment/2022/05/15/2181288/davao-city-waste-energy-project-fuel-climate-change-groups-warn

Garcia, G. (2022). Mountain of trash at the New Carmen dumpsite. *Philstar Global*. Retrieved September 13, 2022, from https://www.philstar.com/headlines/climate-and-environment/2022/05/15/2181288/davao-city-waste-energy-project-fuel-climate-change-groups-warn.

Geneva Environment Network. (2022). The Growing Environmental Risks of E-Waste. Retrieved from https://www.genevaenvironmentnetwork.org/resources/updates/the-growing-environmental-risks-of-e-waste

Geronimo R. Sañez, G. (2010). E-Waste Management in the Philippines. *Gec.jp*. Retrieved 25 September 2022, from http://gec.jp/gec/jp/Activities/ietc/fy2010/e-waste/ew_1-7.pdf.

Gupta, A., Datta, P., Bansal, M., & Singh, J. (2019). Electronic waste in India. 2019 2nd International Conference on Power Energy, Environment, and Intelligent Control (PEEIC), (552-555). https://ieeexplore.ieee.org/document/8976833.

Hai, H. T., Hung, H. V., & Quang, N. D. (2019, July 10). An overview of electronic waste recycling in Vietnam. *Văn phòng sản xuất và tiêu dùng bền vững. Consumption and Production*. Retrieved October 8, 2022, from https://scp.gov.vn/tin-tuc/t11235/an-overview-of-electronic-waste-recycling-in-vietnam.html

Hassan, E. I., & Shirazi, N. S. (2021). Electronic and Electrical Waste Management: Malaysia and Sweden Experiences. *In Islamic Finance and Circular Economy* (pp. 321-335). Springer, Singapore. https://doi.org/10.1007/978-981-16-6061-0_16

Honda, S., Khetriwal, D. S., & Kuehr, R. (2017). Regional E-waste monitor: East and Southeast Asia, United Nations University ViE—SCYCLE, Bonn, Germany.

Hoy, Z. X., Woon, K. S., Chin, W. C., Hashim, H., & Van Fan, Y. (2022). Forecasting heterogeneous municipal solid waste generation via Bayesian-optimised neural network with ensemble learning for improved generalisation. *Computers & Chemical Engineering, 166*, 107946. https://doi.org/10.1016/j.compchemeng.2022.107946

Huang, J. B., Luo, Y. M., & Feng, C. (2019). An overview of carbon dioxide emissions from China's ferrous metal industry: 1991-2030. *Resource Policy, 62*, 541-549. Science Direct. https://doi.org/10.1016/j.resourpol.2018.10.010

Ilham, I., Ginting, S., Ritonga, S. H., & Aslam, I. N. (2022). Potensi Penerapan Urban Mining dari E-Waste Berbasis Ekonomi Sirkular dalam Pembangunan Berkelanjutan di Bukittinggi. *Jurnal Himasapta, 7(1)*, 11-16. https://doi.org/10.20527/jhs.v7i1.5337

IPEN. (2020, October 8). Thailand passes strict ban on the importation of electronic waste. *IPEN*. Retrieved October 8, 2022, from https://ipen.org/news/thailand-passes-strict-ban-importation-electronic-waste

Islam, M. T., & Huda, N. (2020). Assessing the recycling potential of “unregulated” e-waste in Australia. *Resources, Conservation and Recycling, 152*, 104526. Science Direct. https://doi.org/10.1016/j.resconrec.2019.104526

ITU. (2022). ITU’s work to combat e-waste. *The International Telecommunication Union*. Retrieved from https://www.itu.int/en/action/environment-and-climate-change/Pages/ewaste.aspx

Jain, A. (2020). Trash trade wars: Southeast Asia's problem with the world's waste. *Council on Foreign Relations*. Retrieved October 8, 2022, from https://www.cfr.org/in-brief/trash-trade-wars-southeast-asias-problem-worlds-waste

Jumpstart Magazine. (2021, May 20). *A close look at Southeast Asia's e-waste crisis*. Retrieved September 20, 2022, from https://www.jumpstartmag.com/a-close-look-at-southeast-asias-e-waste-crisis/

Khang, T. (2022, July 8). Electronics manufacturers 'forget' to recall or recycle used products. *VietNamNet News*. Retrieved October 8, 2022, from https://vietnamnet.vn/en/electronics-manufacturers-forget-to-recall-or-recycle-used-products-2046660.html

Kumar, A., Singh, P., Raizada, P., & Hussain, C. M. (2022). Impact of COVID-19 on greenhouse gases emissions: A critical review. *Science of The Total Environment*, *806*, 150349.

Latt, H. (n.d.). E-Waste Management in Myanmar. *Bioie.oie.go.th*. Retrieved September 25 2022, from http://bioie.oie.go.th/oieqrcode/uploadFile/oie621360278_529468350.pdf.

Lopez, A. M. N. (2021). E-Waste Zero by Globe. Facebook. photograph, Taguig City. Retrieved September 13, 2022, from https://www.facebook.com/groups/buhayzerowaste/posts/1835174843316846/

Marconi, M., Gregori, F., Germani, M., Papetti, A., & Favi, C. (2018). An approach to favor industrial symbiosis: The case of waste electrical and electronic equipment. *Procedia Manufacturing, 21*, 502-509. https://doi.org/10.1016/j.promfg.2018.02.150

Mendoza, N. (2022). Global e-waste is up 21% in 5 years, causing serious environmental harm. *Tech Republic*. Retrieved from https://www.techrepublic.com/article/global-e-waste-is-up-21-in-5-years-causing-serious-environmental-harm/

Mi, S., & Dhawan, N. (2021, June). Characterization and Evaluation of Recycling Potential for Discarded Laptops. *Mining, Metallurgy & Exploration, 38*, 2117-2131. ScienceDirect. https://doi.org/10.1007/s42461-021-00446-3

Mmereki, D., Li, B., Baldwin, A., & Hong, L. (2016). The Generation, Composition, Collection, Treatment and Disposal System, and Impact of E-Waste. In (Ed.), *E-Waste in Transition* Retrieved September 22, 2022, From Pollution to Resource. IntechOpen. https://doi.org/10.5772/61332

Moraga, G., Huysveld, S., Meester, S. D., & Dewulf, J. (2022, March). Resource efficiency indicators to assess circular economy strategies: A case study on four materials in laptops. *Resources, Conservation and Recycling, 178*, 106099. Sciencedirect. https://doi.org/10.1016/j.resconrec.2021.106099

Mundada, M. N., Kumar, S., & Shekdar, A. V. (2007). E-waste: a new challenge for waste management in India. *International Journal of Environmental Studies, 61(3)*, 265-279. https://doi.org/10.1080/00207230420001760 60

Nguyen, N. (2020). COUNTRY REPORT ON E-WASTE OF VIET NAM (p. 6). Bangkok. Retrieved from http://bioie.oie.go.th/oieqrcode/uploadFile/oie621360278_1459684422.pdf

Odumuyiwa, V., Adelopo, A., & Nubi, A. (2021). Circular economy in Africa: examples and opportunities, Electronics and E-Waste. *Ellen Macarthur Foundation*. Retrieved from https://emf.thirdlight.com/link/z1fp0exz31i0-gpg8bm/@/#id=0

OIE. (n.d). E-waste management in Lao PDR. Bioie.oie.go.th. Retrieved September 25 2022, from http://bioie.oie.go.th/oieqrcode/uploadFile/oie621360278_1158308537.pdf

Padillo, M. M. (2020, January 21). Environmental groups call for stricter waste segregation policy in Davao City. *Business World Online*. Retrieved September 13, 2022, from https://www.bworldonline.com/the-nation/2020/01/21/274477/environmental-groups-call-for-stricter-waste-segregation-policy-in-davao-city/

Pollution Control Department and Department of Industrial Works. (2021). Thailand E-Waste and Plastic Waste Management. Bangkok. Retrieved October 9, 2022, from https://www.oie.go.th/assets/portals/1/files/industrial_article/Guideline%20Handbook%20for%20E-Waste%20Management%20within%20ASEAN%20and%20Korea.pdf

Punto. (2022, March 25). New e-waste facility in Malabon to protect communities from hazardous effects of improper e-waste handling. *Punto! Central Luzon*. Retrieved September 13, 2022, from https://punto.com.ph/new-e-waste-facility-in-malabon-to-protect-communities-from-hazardous-effects-of-improper-e-waste-handling/

Punto. (2022). Turnover truck for e-waste collection in Brgy. Dampalit. *Punto! Central Luzon*. Retrieved September 13, 2022, from https://punto.com.ph/new-e-waste-facility-in-malabon-to-protect-communities-from-hazardous-effects-of-improper-e-waste-handling/

Ramanayaka, S., Keerthanan, S., & Vithanage, M. (2020). Urban mining of E-waste: Treasure hunting for precious nanometals. *In Handbook of Electronic Waste Management* (pp. 19-54). Butterworth-Heinemann. https://doi.org/10.1016/B978-0-12-817030-4.00023-1

Ramos, N. B. (2019, April 11). 5 places for your used electronics disposal. *Globe Ph*. Retrieved September 13, 2022, from https://www.globe.com.ph/go/technology/article/donate-used-electronics.html

Rosane, O. (2021). This year's e-waste to outweigh Great Wall of China. *World Economic Forum*. Retrieved from https://www.weforum.org/agenda/2021/10/2021-years-e-waste-outweigh-great-wall-of-china/

Schwarz, E. J., & Steininger, K. W. (1997). Implementing nature's lesson: the industrial recycling network enhancing regional development. *Journal of cleaner production*, 5(1-2), 47-56. https://doi.org/10.1016/S0959-6526(97)00009-7

Schwarzer, S., Peduzzi, P., & UNEP/GRID-Geneva. (2021). The growing footprint of digitalisation. *Foresight Brief, 27*, pp. 3-6. https://wedocs.unep.org/bitstream/handle/20.500.11822/37439/FB027.pdf

Singh, Yash & Amin, Nida. (2018). Assessing the Challenges and Issues of Electronic Waste Management for Cities in Developing Countries. 10.13140/RG.2.2.21714.86728.

Smart Public Affairs. (2021, June 10). DENR backs PLDT and Smart's e-waste disposal programs. *Smart Communications, Inc*. Retrieved September 13, 2022, from https://smart.com.ph/About/newsroom/full-news/2021/06/10/denr-backs-pldt-and-smart-s-e-waste-disposal-programs

Smart Public Affairs. (2021). The #SmartPlanet phone recycling bin uses electronic sensors to send out Smart e-load in exchange for used phones, chargers, and tablets. *Smart Communications, Inc*. Retrieved September 13, 2022, from https://smart.com.ph/About/newsroom/full-news/2021/06/10/denr-backs-pldt-and-smart-s-e-waste-disposal-programs.

SM Cares Press releases. (2021, February 18). SM Supermalls Rolls Out SM Electronic Waste Collection Program. *SM Cares*. Retrieved September 13, 2022, from https://www.smsupermalls.com/smcares/press-releases/sm-supermalls-rolls-out-sm-electronic-waste-collection-program/

Sta. Rosa, A. J. (2019, March 7). DENR-EMB, UNIDO unveiled the first e-waste storage facility in the country. *Department of Environment and Natural Resources-Environmental Management Bureau*. Retrieved September 13, 2022, from https://emb.gov.ph/wp-content/uploads/2019/03/DENR-EMB-UNIDO-UNVEILED-THE-FIRST-E-WASTE-STORAGE-FACILITY-IN-THE-COUNTRY.pdf

Sullivan, D. (n.d.). What Are the Main Parts of a Radio? *Techwalla*. Retrieved September 17, 2022, from https://www.techwalla.com/articles/what-are-the-main-parts-of-a-radi

Sustainability at Harvard. (2021, April 12). 6 ways to minimize your e-waste. Retrieved September 22, 2022, from https://green.harvard.edu/tools-resources/how/6-ways-minimize-your-e-waste

The Asian Network for Prevention of Illegal Transboundary Movement of Wastes. (2020). Workshops. *Workshops | Asian Network*. Retrieved September 3, 2022, from https://www.env.go.jp/en/recycle/asian_net/Annual_Workshops/Ws2020.html

The E-Waste Project. (2017). #TEPxMuniMarket. *Facebook*. Retrieved September 13, 2022, from https://www.facebook.com/theewasteproject/photos/1437918152927736/

The University of Melbourne. (2020). Assessment of Legislative Frameworks Governing Waste Management in Timor-Leste (pp. 10 - 20). Australia: Secretariat of the Pacific Regional Environment Programme. Retrieved from https://library.sprep.org/sites/default/files/2021-03/waste-legislation-Timor-Leste.pdf

Toxic Substances and Hazardous and Nuclear Wastes Control Act of *1990*. Republic act no. 6969. Official Gazette of the Republic of the Philippines. (1990, October 26). Retrieved September 13, 2022, from https://www.officialgazette.gov.ph/1990/10/26/republic-act-no-6969/

United Nations. (2015). UN environment chief warns of 'tsunami' of e-waste at conference on chemical treaties. *United Nations*. Retrieved from https://www.un.org/sustainabledevelopment/blog/2015/05/un-environment-chief-warns-of-tsunami-of-e-waste-at-conference-on-chemical-treaties/

United Nations. (2020). Fall in COVID-linked carbon emissions won't halt climate change—UN weather agency chief. *UN News*. Retrieved from https://news.un.org/en/story/2020/04/1062332

US EPA. (2021, November 2). Cleaning Up Electronic Waste (E-Waste). United States Environmental Protection Agency. Retrieved September 22, 2022, from https://www.epa.gov/international-cooperation/cleaning-electronic-waste-e-waste

US EPA. (2006). Global anthropogenic non-CO2 greenhouse gas emissions: 1990-2020. Office of Atmospheric Programs, Climate Change Division.

United Nations University. (2016). E-Waste in East and South-East Asia Jumps 63% in Five Years - United Nations University. Retrieved April 9, 2022, from https://unu.edu/media-relations/releases/e-waste-in-east-and-south-east-asia-jumps-63-percent-in-five-years.html

Wagner, F., Peeters, J. R., Keyzer, J. d., Janssens, K., Duflou, J. R., & Dewulf, W. (2019). Towards a more circular economy for WEEE plastics – Part A: Development of innovative recycling strategies. *Waste Management, 100*, 269-277. Science Direct. https://doi.org/10.1016/j.wasman.2019.09.026

Wasil, W. (2018). 'Dump your e-waste with us, save the environment' - The Scoop. *The Scoop*. Retrieved September 25 2022, from https://thescoop.co/2018/12/11/dump-your-e-waste-with-us-save-the-environment/

Widyarsana, W., Supramono, D. S., Tambunan, S. A., & Mulyadi, A. A. (2021). Identification of electronic waste (e-waste) generation from the household and non-household sectors in Indonesia and its sustainable management system. *Research Square*, 1-14. https://doi.org/10.21203/rs.3.rs-391423/v1

Willsey, A. (2015, July 14). 3 Common Glass Types: Properties and Applications. *Kopp Glass*. Retrieved September 17, 2022, from https://www.koppglass.com/blog/3-common-glass-types-properties-and-applications

World Health Organization. (2021, June 15). Soaring e-waste affects the health of millions of children, who warns. *World Health Organization*. Retrieved October 9, 2022, from https://www.who.int/news/item/15-06-2021-soaring-e-waste-affects-the-health-of-millions-of-children-who-warns

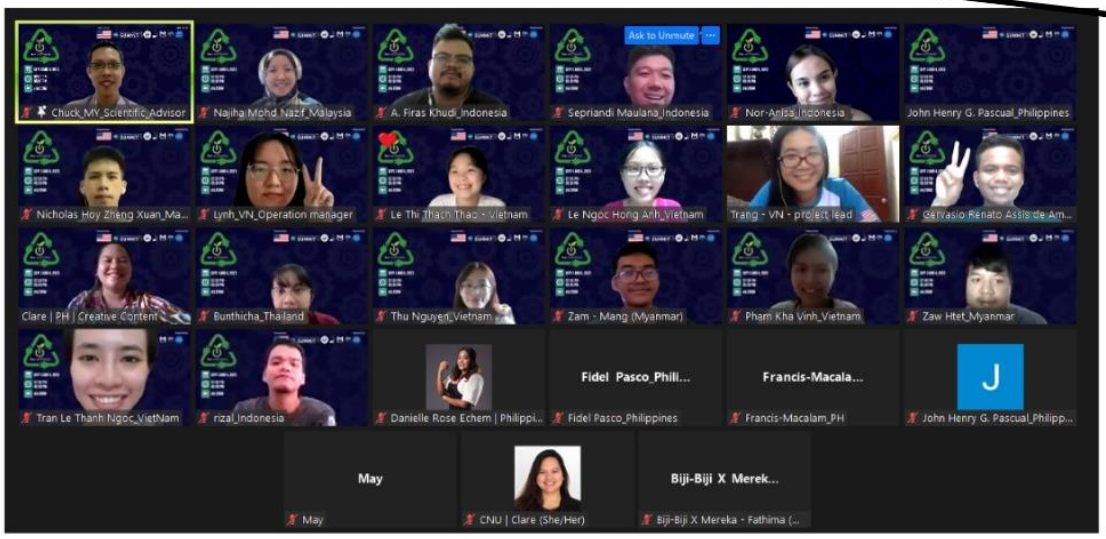
Wu, Q., Leung, J. Y., Geng, X., Chen, S., Huang, X., Li, H., ... & Lu, Y. (2015). Heavy metal contamination of soil and water in the vicinity of an abandoned e-waste recycling site: implications for dissemination of heavy metals. *Science of the Total Environment, 506*, 217-225. https://doi.org/10.1016/j.scitotenv.2014.10.121

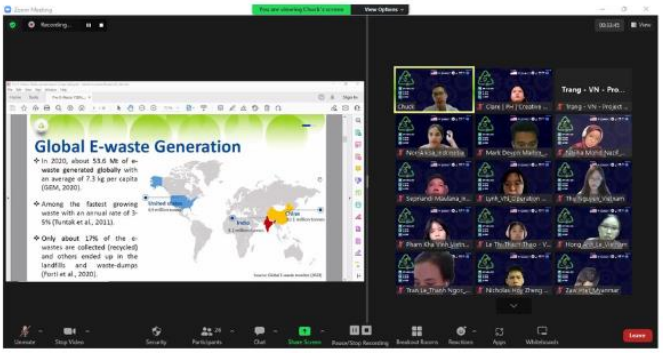
Wu, X., Li, J., Yao, L., & Xu, Z. (2020). Auto-sorting commonly recovered plastics from waste household appliances and electronics using near-infrared spectroscopy. *Journal of Cleaner Production, 246*, 118732. https://doi.org/10.1016/j.jclepro.2019.118732

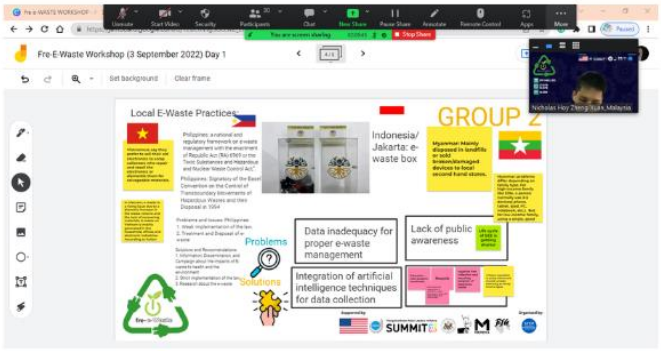
Zeng, X., Mathews, J. A., & Li, J. (2018). Urban mining of e-waste is becoming more cost-effective than virgin mining. *Environmental science & technology, 52(8)*, 4835-4841. https://doi.org/10.1021/acs.est.7b04909

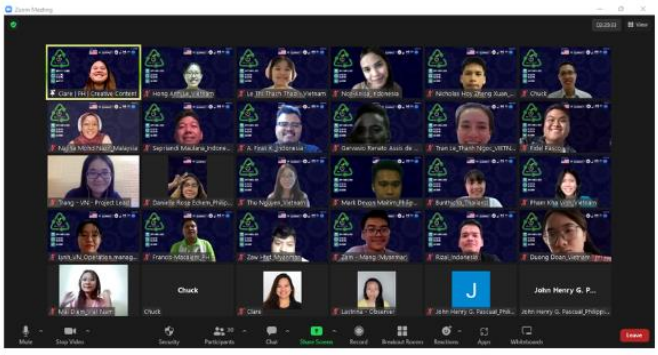
SNAPHOTS DURING THE WORKSHOP

SEPT 3 AND 4, 2022 **Online via ZOOM**









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