

Circular Value Chains of Electrical and Electronic Equipment in ASEAN

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Chapter 1

Circular Value Chains of Electrical and Electronic Equipment in ASEAN

1. Introduction

This study is a response to a request from the Association of Southeast Asian Nations (ASEAN) and Japan for the ASEAN–Japan Circular Economy Initiative. The focus is on addressing urgent issues related to electrical and electronic equipment (EEE) waste, which is one of the fastest-growing waste streams, and presenting policy recommendations for future collaboration on this matter between ASEAN Member States (AMS) and Japan.

This chapter provides overall information on the circular value chains of electrical and electronic equipment (EEE) in AMS and Japan. It investigates the current situation of EEE circular value chains in AMS through a literature review, analyses gaps in the value chains between AMS and Japan, and identifies challenges for AMS in improving their circular value chains for EEE.

In a circular economy, organisations maintain a circular flow of resources and recover, retain, and add value to these resources (Murakami, 2022). For that, it is necessary to recover, retain, and add to as much value per resource as possible; thus, it is important to consider not only functional value that consumers perceive by utilising the function of products but also the environmental value – a kind of value in context¹ – which consumers perceive by feel. For example, environmental value is observed when a consumer who wants to contribute to the circular economy uses a product made from recycled materials. Value in exchange must thus be considered, which comes from the concept of traditional economics, including functional value as well as value in context. Five categories for circular value chain activities are illustrated below, depending on the difference of value (Figure 1.1).

¹ Value in context is value that is perceived by consumers, depending on the dynamic context of producers and consumers.



Note: The sizes of arrows of value in context and functional value show the relative amount of value as a reference. For example, the value of washing machines – which denotes the willingness to pay for washing machines – is higher than that for motors. Consumers see more environmental value of reused products than recycled products because the loss of resources in reuse activities is less than that of recycling activities.

Source: Circular Economy Association, https://www.ce-association.org/en/resource/column/.

The first category of circular value chain activities – starting from the upstream –focusses on adding value through design and technology. It encompasses various manufacturing processes, such as raw materials, parts, and final goods production as well as sales and services activities. Businesses that produce refrigerators made from recycled materials is an example. The function to cool foods is added to refrigerators as value, and an environmental value is also proposed to consumers who want to contribute to achieving a sustainable society by utilising recycled materials.

The second category of circular value chain activities aims to retain value through efficient utilisation of products. This begins with sales and services activities, extends to consumers, and then returns the retained value of the products back to sales and services activities. Businesses that reuse and resell used refrigerators made from recycled materials is an example. In this case, the function of refrigerators – cooling foods – is repeatedly used by more than one consumer. An environmental value is also proposed to more than one consumer who wishes to contribute to achieving a sustainable society by reusing materials for their intended purpose.

The third category focusses on recovering the value of used products. It involves maximising the value of products through refurbishing, remanufacturing, and recycling. Businesses for the horizontal recycling of e-waste – in which e-waste is recycled into the same category products as originally intended for use – are examples. Metal scraps, such as copper, are collected from the e-waste and put into the manufacturing process of the same category of products, so the function as metal is recovered. This leads to a perceived environmental value to a consumer who wants to contribute to a sustainable society by utilising recycled materials without disposing of the materials.

The fourth category emphasises maintaining circulation to rebuild lost values, also referred to as 'cascade recycling' that minimises the loss of recycled materials. Businesses for cascade recycling recycle e-waste into lower-value products before it is discarded. As an example, plastics are collected from e-waste and are put into the manufacturing process of building materials; the function as plastics is not lost. However, cascade recycling is not necessarily recommended in a circular economy, as the proposed environmental value to a consumer is not high.

The fifth category of circular value chain activities provides comprehensive support for the expansion and transition to circular businesses. The activities of this category promote the above four categories of circular value chain activities and are conducted by businesses and other organisations. For example, industrial organisations can develop quality standards for recycled materials, information platform businesses can construct databases of information on the quality of various parts for reuse, and governments can establish legal systems to ensure the collection of used EEE and e-waste.

Promoting and strengthening circular value chain activities in the five categories above are crucial for developing circular value chains for EEE in ASEAN. This research specifically focusses on the activities from the collection of used EEE and e-waste to the input of raw materials to manufacturers, as the difference in these processes between AMS and other countries is significant. In this chapter, Japan is considered a model case for circular value chains of EEE. The circular value chain activities emphasised in this research include collection, dismantling and classification, reuse, repair, refurbishment, remanufacturing, recycling and downgrading (i.e. cascade recycling), and treatment (i.e. disposal and energy recovery).

For the purposes of this report:

(i) **Reuse.** According to the Basel Convention, reuse refers to the using again of a product, object, or

substance that is not waste, for the same purpose for which it was conceived, without the necessity of repair or refurbishment.²

- (ii) **Repair.** This refers to the fixing of a specified fault in an object or replacement of defective components to make the waste or product a fully functional product to be used for its originally intended purpose.³
- (iii) **Refurbishment**. Refurbishment refers to the modification of an object to increase or to restore performance and/or functionality or to meet applicable technical standards or regulatory requirements with the result of making a fully functional product to be used for a purpose that was originally intended.⁴
- (iv) Remanufacturing. This refers to a standardised industrial process that takes place within industrial or factory settings in which a core product or module – that has been sold, worn, or is no longer functional – is restored to same-as-new or better condition and performance.⁵
- (v) Recycling. Recycling refers to relevant operations that prevent waste disposal and allows material to re-enter the loop.⁶ In this research, allowing material to re-enter the other ecosystem loop – known as downgrading – is also included in recycling.

The choice of Japan as a model is based on its status as an exemplary case in establishing and enforcing legal systems, such as the Act on Recycling of Specified Kinds of Home Appliances and Act on Promotion of Recycling of Small Waste Electrical and Electronic Equipment.

In this research, the following definitions are used:

- (i) EEE. This refers to equipment that is dependent on electric currents or electromagnetic fields to work properly as well as equipment for its generation, transfer, and measurement. Televisions, refrigerators, washing machines, air conditioners, personal computers, mobile phones, and multifunction printers are the focus, because their circular value chains are well-established in Japan.
- (ii) **E-waste.** EEE becomes e-waste once it has been discarded by its owner as waste without the intent of reuse (STeP Initiative, 2014).
- (iii) **Used EEE.** This refers to used equipment for the purpose of reuse.
- (iv) **Second-hand goods.** These are goods that are reused, repaired, or refurbished.
- (v) **Second-hand shops.** These are shops that sell second-hand goods.

EEE contains copper, aluminium, and other precious metals, but it also includes hazardous materials. For example, printed circuit board contains lead; refrigerators and air conditioners contain fluorocarbons; and televisions contain brominated flame retardants (Hosoda, 2003). Improper treatment of lead causes health damage due to direct exposure or indirect exposure through water or soil pollution. Improper treatment of fluorocarbons causes destruction of the ozone layer. Heating plastics containing brominated flame retardants emits dioxin. Therefore, establishing proper EEE

² UNEP, Reuse, UNEP Circularity Platform, <u>https://buildingcircularity.org/reuse/</u>

³ UNEP, Repair, UNEP Circularity Platform, <u>https://buildingcircularity.org/repair/</u>

⁴ UNEP, Refurbish, UNEP Circularity Platform, <u>https://buildingcircularity.org/refurbish/</u>

⁵ UNEP, Remanufacture, UNEP Circularity Platform, <u>https://buildingcircularity.org/remanufacture/</u>

⁶ UNEP, Recycle, UNEP Circularity Platform, <u>https://buildingcircularicty.org/recycle/</u>

circular value chains is an important health and environmental issue as well.

2. Japan's EEE Value Chain

In Japan, the structure of the circular value chain varies, depending on the product category of EEE. Devices such as televisions, refrigerators, washing machines, and air conditioners – which fall under the Home Appliance Recycling Act – are collected and treated according to that law (Figure 1.2). Smaller appliances, including computers and mobile phones, are collected and recycled under the Small Waste Electrical and Electronic Equipment Recycling Act (Figure 1.3). As a unique case, multifunction printers are collected, remanufactured, and recycled based on the voluntary contribution of companies, which conduct these efforts as a part of their business operations (Figure 1.4).



Figure 1.2. Circular Value Chain of Televisions, Refrigerators, Washing Machines, and Air Conditioners in Japan, 2020

UEEE = used electrical and electronic equipment. Source: METI (2023).



Figure 1.3. Circular Value Chain of Small Home Appliances in Japan, 2020

UEEE = used electrical and electronic equipment. Source: METI (2023).



Figure 1.4. Circular Value Chain of Multifunction Printers in Japan

Note: The example above is for the company Ricoh, which has the functions of a sales company, maintenance company, collection centre, product manufacturer, product recovery centre, recycling centre, and parts recovery centre.

Source: RICOH, Comet Circle [in Japanese], <u>https://jp.ricoh.com/sustainability/environment/management/policy/comet</u>

In Japan, the EEE circular value chain from collection to final disposal is relatively well established. EEE and e-waste are collected appropriately in accordance with the related laws. Its reuse is also well managed thanks to the activities of industrial associations. Most collected e-waste is delivered to licensed recyclers, who dismantle, classify, and sort e-waste and deliver metal scraps to domestic smelters. Domestic smelters recycle steel, copper, aluminium, and various precious metals. This capacity to treat copper and precious metals, however, can be improved.

2.1. Collection

2.1.1. Four Home Appliances

During the collection process, four home appliances – televisions, refrigerators, washing machines/dryers, and air conditioners – are collected from households by various entities, such as manufacturers, retailers, movers, construction scrappers, unwanted item collectors, second-hand shops, second-hand good dealers, municipalities, and scrappers.⁷ They are eventually delivered to home appliance recycling plants, which are managed by manufacturers or licensed recyclers (METI, 2023).

As manufacturers are obligated to recycle these used home appliances under the Home Appliance Recycling Act, designated collection places have been set up to ensure recycling. In 2020, about 55% of these used home appliances were collected by retailers, and they delivered about 97% of them to the designated collection places (METI, 2023).

Additionally, movers – who have licenses to treat waste based on the Act on Waste Management and Public Cleansing – are permitted to collect the four used home appliances when individuals are moving residences.⁸ When the appliances are left in buildings to be demolished, construction scrappers collect them also in compliance with the Act on Waste Management and Public Cleansing. In 2020, about 9% of the four used home appliances were collected by movers and about 6% were collected by construction scrappers, who then delivered them to designated collection places, licensed recyclers, or scrappers (METI, 2023).

Unwanted item collectors collect used EEE and e-waste from users other than manufacturers, retailers, movers, construction scrappers, scrappers, municipalities, second-hand shops, and second-hand good dealers, on trucks or at collection points prepared by the unwanted item collectors. Some unwanted item collectors may be illegal because they do not have licenses to treat waste based on the Act on Waste Management and Public Cleansing (METI, 2023). In 2020, about 16% of the four used home appliances were collected by unwanted item collectors and delivered to scrappers or exporters of second-hand goods.

Some of the four used home appliances are delivered from users to domestic second-hand shops and collected by second-hand good dealers who export the used EEE to other countries. In 2020, about 4% of used appliances were collected by domestic second-hand shops, and less than 2% of the appliances were collected by second-hand good dealers.

Municipalities collect the four used home appliances that retailers are not obligated to collect under

⁷ Before the Home Appliance Recycling Act in 2001, there was a trade-in custom regarding these home appliances (METI, 2022a).

⁸ Government of Japan METI, Appropriate Treatment of the Used Four Home Appliances by Movers [in Japanese], <u>https://www.meti.go.jp/policy/it_policy/kaden_recycle/shiryousyu/KadenRecycleInfoSession_Doc3.pdf</u>

the Home Appliance Recycling Act. For example, when users cannot identify where they bought a used appliance, they can ask the municipality to collect it. Municipalities also collect dumped appliances (METI, 2023). Municipalities deliver the collected appliances to designated collection places, licensed waste disposers, or disposal sites (METI, 2023). In 2020, less than 1% of the four used home appliances were collected by municipalities (METI, 2023).

Some e-waste is collected by scrappers via various entities such as retailers, movers, construction scrappers, unwanted item collectors, and second-hand good dealers. Scrappers are actors who treat e-waste as scraps.⁹ Some scrappers shred the e-waste, some collect metal scraps and sell them, and others store the e-waste in their yards. Scrappers deliver e-waste or metal scraps to domestic or foreign companies. In 2020, about 26% of the used four home appliances were collected by scrappers via other actors such as retailers, movers, construction scrappers, unwanted item collectors, and second-hand good dealers (METI, 2023).

2.1.2. Small Home Appliances

Used small home appliances covered by the Recycling of Small Waste Electrical and Electronic Equipment Act are collected by various entities such as municipalities, retailers, unwanted item collectors, second-hand good dealers, exporters, scrappers, and authorised recyclers (METI, 2023). The collected volume of used small home appliances by municipalities and authorised recyclers has increased, from 21,000 tonnes in 2012 to 100,000 tonnes in 2020 (METI, 2022b).

Municipalities are obligated to collect used small home appliances separately, and almost all municipalities try to do that.¹⁰ They collect the appliances at public facilities and retail shops with specific boxes, at various public events, or with other municipal waste. In 2020, about 43% of used small home appliances were collected by municipalities (METI, 2023).

Retailers are obligated to ensure the appropriate collection of used small home appliances as well. Some retailers receive used appliances at their shops or when they deliver their new products. In 2020, about 21% of used small home appliances were collected by retailers (METI, 2023).

Unwanted item collectors collect small home appliances from users on trucks or at collection points organised by the unwanted item collectors. There are also a few cases in which they picked the used appliances from municipality collection points. In 2020, about 9% of used small home appliances were collected by unwanted item collectors (METI, 2023). Some unwanted item collectors are doing so illegally because they have no licenses to treat waste based on the Act on Waste Management and Public Cleansing (METI, 2023).

Some used small home appliances are also delivered to second-hand goods dealers and exporters through municipalities, retailers, unwanted item collectors, authorised recyclers, or other licensed recyclers. In 2020, about 15% of the used appliances were collected by second-hand good dealers and exporters. Second-hand good dealers and exporters deliver the collected appliances to second-hand shops in Japan or other countries. Few collected small appliances are delivered as scrap for recycling to scrappers in other countries.

⁹ Government of Japan, METI, Flow of Used Home Appliances [in Japanese], <u>https://www.env.go.jp/council/former2013/03haiki/y0311-20/mat08.pdf</u>

¹⁰ SWEEE, Collection Method [in Japanese], Collection Methods, <u>https://www.sweee.jp/recovery.html</u>

Authorised recyclers are licensed by the Ministry of Economy, Trade and Industry (METI) and Ministry of the Environment (MOE). Authorised recyclers meet the standards of environmentally sound treatment and capacity for valuable resource recovery. Some set up collection places, and some collect used appliances at users' houses. In 2020, less than 2% of used appliances were collected by authorised recyclers directly.

2.1.3. Multifunction Printers

Manufacturers generally collect used printers from users.

2.2. Reuse and Repair

While the ratios of reuse for the four home appliances and small appliances are not particularly high, industry associations – such as the Japan Reuse Affairs Association, Japan Reuse Organization, and Japan Containers and Packaging Recycling Association – have developed systems to promote appropriate reuse (METI, 2023).

Appropriate second-hand shops comply with regulations and ensure quality management. Such shops do not deliver the used EEE to illegal recycling places; they confirm the quality of a reused good before selling it and guarantee the quality during a certain period. The Japan Reuse Affairs Association and Japan Containers and Packaging Recycling Association have certified second-hand shops that comply with regulations and ensure quality management, while the Japan Reuse Organization has established a digital manifest system for tracking information on suppliers and buyers of reused products, covering the four home appliances (MOE, 2016). The system prevents a second-hand shop from buying and selling illegally obtained, used EEE – such as a stolen good – as well as delivering used EEE to illegal recycling places. These activities enable consumers to buy good-quality second-hand goods, which leads to promotion of reuse businesses.

2.3. Dismantling, Classification, Sorting, and Material Recycling

E-waste and used EEE are dismantled, classified, sorted, and recycled by licensed recyclers, which aim to achieve environmentally sound treatment and recovery of many valuable resources. Although there may be instances of illegal treatment of e-waste for the four home appliances and small appliances, those volumes are relatively small (METI, 2023).

For multifunction printers, non-reusable parts are crushed, sorted, and recycled into new multifunction printers.¹¹

As for the four home appliances covered by the Home Appliance Recycling Act, most are recycled by the home appliance recycling plants managed by the manufacturers or licensed recyclers. The plants dismantle, classify, and sort e-waste and recover metal scraps (i.e. copper, aluminium, and steel) and plastics as recyclable resources (METI, 2022a). About 92% of air conditioners, 72% of cathode-ray tube (CRT) televisions, 85% of liquid crystal display (LCD) televisions and plasma televisions, and 92% of refrigerators collected at designated collection places were recycled in 2022 (METI, 2022b). In 2022, about 100,000 tonnes of metal scraps were recycled (METI, 2022b). Residues are utilised for energy recovery or disposed of properly (METI, 2023). In addition, licensed recyclers treat fluorocarbons as required in the Home Appliance Recycling Act (METI, 2022b).

¹¹ RICOH, Collection, Reuse and Recycling of Used Products [in Japanese], <u>https://jp.ricoh.com/sustainability/environment/product/recycle/collect</u>

During the process of recycling the small home appliances covered by the Recycling of Small Waste Electrical and Electronic Equipment Act, authorised recyclers dismantle, classify, and sort e-waste; deliver metal scraps such as steel, aluminium, copper, brass, silver, gold, and palladium as recyclable materials to domestic smelters; and recover plastics for recycling or energy recovery (METI, 2022b). Reusable EEE is delivered as reused goods to second-hand good dealers. About 90% of e-waste collected by authorised recyclers is reused, recycled, or utilised as fuel. In 2021, authorised recyclers treated about 100,000 tonnes of used small home appliances, and about 52,000 tonnes of metal scraps were delivered to domestic smelters and recycled. Authorised recyclers also manage hazardous parts such as batteries, fluorescent lamps, and fluorocarbons properly as well.¹²

However, the recycling rate of municipalities is lower than that of authorised recyclers. In 2018, the municipalities treated about 150,000 tonnes of used small home appliances, and about 37,000 tonnes of metal scraps were delivered to domestic smelters and recycled.

2.4. Remanufacturing and Refurbishment

Used multifunction printers from business sectors are remanufactured in Japan. Manufacturers collect used printers, dismantle them, and separate reusable parts for the remanufacturing processes. To promote remanufacturing, the manufacturers of multifunction printers have developed their own take-back system, unique technology for remanufacturing, standards for distinguishing parts that can be used for remanufacturing, and standards for quality and safety assurance. Some used multifunction printers are refurbished according to in-house quality standards and sold as refurbished products.¹³

2.5. Disposal and Energy Recovery

The collection rates of the four home appliances and collection volume of small home appliances have increased since enforcement of the associated acts. Home appliance recycling plants and authorised recyclers have achieved high recycling rates of used EEE and use of residues as fuel. However, about 30% of used small appliances still ended up in landfills with municipal waste in 2020 (METI, 2023). During such a process of disposal, e-waste is landfilled directly, landfilled after incineration, landfilled after crashing, or landfilled after melting (METI, 2023).

For multifunction printers, non-recyclable residue is utilised as fuel or disposed in final disposal sites.¹⁴

3. ASEAN Electrical and Electronic Equipment Value Chain

In AMS, used EEE and e-waste generated from households or industries are collected, reused, repaired, refurbished, recycled, or disposed of by various actors. Actors are classified into licensed actors and informal actors. Licensed actors are collectors or recyclers permitted to collect or to treat e-waste by each country's laws related to hazardous waste. Meanwhile, informal actors collect EEE and e-waste without licenses to treat hazardous waste (Figure 1.5). In AMS, EEE and e-waste are not collected nor treated separately by product category as in Japan, and low-value EEE that does not contain valuable materials is disposed of without recycling.

¹² Government of Japan, MOE, Capacity of Domestic Smelters of Non-Ferrous Metals [in Japanese], <u>https://www.env.go.jp/recycle/yugai/conf/conf27-03/H280107_08.pdf</u>)

¹³ RICOH, Regeneration Machine [in Japanese], <u>https://www.ricoh.co.jp/mfp/rc/</u>

¹⁴ RICOH, Comet Circle [in Japanese], <u>https://jp.ricoh.com/sustainability/environment/management/policy/comet</u>





EEE = electrical and electronic equipment, NGO = non-governmental organisation, OEM = original equipment manufacturer.

Note: The flows that are applicable to five or more countries are shown in red. The flows that are applicable to at least one country are shown in black. Industry includes the office of private companies and public organisations and the factories of EEE. Source: Authors.

3.1. Collection

In AMS, a lot of EEE and e-waste are collected by informal collectors (UNODC, 2022). Informal collectors deliver it to informal recyclers. In many cases, environmental considerations are lacking, even for some small recycling companies.

In at least five AMS, informal collectors – including waste pickers, scavengers, door-to-door collectors, and junk shops – collect e-waste from households and deliver it to informal recyclers. For example, in Cambodia, waste pickers collect e-waste from public trash bins (ASEAN-Korea Economic Cooperation Fund, 2020). In Indonesia, scavengers pick up e-waste from municipal waste collection points and deliver it to informal recyclers (METI, 2020). In Malaysia, door-to-door collectors visit households and collect EEE and e-waste, and then bring it to informal recyclers such as junk shops (METI, 2019). In the Philippines, junk shops collect e-waste from households directly and treat it themselves or deliver it to other junk shops (METI, 2019). In Thailand, door-to-door collectors buy e-waste from households, or scavengers pick up discarded e-waste (METI, 2020). In Viet Nam, door-to-door collectors visit households,

Used EEE is collected by second-hand shops directly or through other collectors such as door-to-door collectors in at least five AMS.¹⁵ In Cambodia, about 80% of collected used EEE and e-waste are delivered to second-hand shops or repair and recycle shops; these are resold to households after repair (ASEAN-Korea Economic Cooperation Fund, 2020). About 50% of used EEE is reused in Thailand (Jiaranaikhajorn, 2013).

In at least five AMS, e-waste is collected by municipal waste collectors, which is mixed with municipal waste. It is disposed with municipal waste at final disposal sites. However, in Indonesia, scavengers do pick e-waste from municipal waste collection points (Utomo, 2021).

In Malaysia, Singapore, and Viet Nam, e-waste is collected from households and industries by licensed collectors. In Singapore, Alba E-Waste has collection points where e-waste is collected; it then delivers it to licensed recyclers based on Singapore's Resource Sustainability Act. In Malaysia, Ministry of Environment and Water-registered collection centres collect e-waste and deliver it to recyclers that have SW110 licenses. In Viet Nam, companies collect e-waste and deliver to licensed recyclers based on Prime Minister Decision No. 16/2015/QD-TTg, stipulating the take-back and recycling of discarded products to reduce the volume of e-waste discharged into the environment.

Some manufacturers have established their own take-back systems as well. HP, Dell, and Toshiba have take-back systems for computers, and Nokia has one for mobile phones in Indonesia; HP, Dell, Apple, and Toshiba have take-back systems for computers, and Nokia has one for mobile phones in Malaysia; and Nokia and TES-AMM have take-back systems for mobile phones, and Toshiba Lighting and Phillips have take-back systems for lighting equipment in Thailand (ASEAN-Korea Economic Cooperation Fund, 2020).

In addition, non-governmental organizations (NGOs) and charity organisations collect EEE for donation in Malaysia and Singapore. For example, the National Volunteer and Philanthropy Centre in Singapore maintains an online list of charity organisations that accept such donations. Brunei Darussalam's Department of Environment, Parks and Recreation also collects e-waste from government offices.

¹⁵ Information on the second-hand shops was not found for Brunei Darussalam, Lao People's Democratic Republic (Lao PDR), and Singapore.

3.2. Reuse and Repair

Used EEE is generally reused via second-hand shops in Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Thailand, and Viet Nam. Second-hand shops resell used EEE directly or after repair. Second-hand shops receive used EEE directly from households or from importers; they also import e-waste as used EEE (Kojima, 2014). Indeed, Europe, East Asia, and North America are primary exporters of uncontrolled used EEE and e-waste, but South-East Asia has no capacity for treating it (Baldé et al., 2022). Second-hand and new EEE are not distinguished by six-digit Harmonized System (HS) codes, and only a few countries distinguish between used and new EEE (Terazono and Yoshida, 2012).

Trade statistics of Japan divide second-hand goods from new goods. In 2022, Japan exported secondhand air conditioners to Cambodia, Myanmar, and Viet Nam (Figure 1.6); second-hand refrigerators to Cambodia, Myanmar, and the Philippines (Figure 1.7); second-hand CRT monitors to the Philippines, Thailand, and Viet Nam (Figure 1.8); and second-hand LCD televisions to Malaysia, Myanmar, and Thailand (Figure 1.9).



Figure 1.6. Exports of Second-Hand Air Conditioners from Japan to ASEAN, 2022

Note: Some units were exported to Indonesia, Lao People's Democratic Republic, Malaysia, Philippines, Singapore, and Thailand as well. Source: Authors.



Figure 1.7. Exports of Second-Hand Refrigerators from Japan to ASEAN, 2022

Note: Some units were exported to Thailand as well. Source: Authors.



Figure 1.8. Exports of Second-Hand CRT Monitors from Japan to ASEAN, 2022

Note: Some units were exported to Brunei Darussalam, Cambodia, China, Hong Kong, and Indonesia as well. Source: Authors.



Figure 1.9. Exports of Second-Hand LCD Televisions from Japan to ASEAN, 2022

Note: Some units were exported to China, Indonesia, Singapore, and Viet Nam. Source: Authors.

Although some used EEE was imported into AMS for reuse, it was instead improperly recycled (Kojima, 2014). Second-hand shops also sell non-reusable products (i.e. e-waste) imported as used EEE (Terazono, 2015). Junk shops sometimes burn cables to collect copper and dump the residues in their backyards.

3.3. Dismantling, Classification, Sorting, and Material Recycling

In at least five AMS, e-waste is dismantled, classified, and recycled by informal recyclers such as junk shops or licensed recyclers. They generally dismantle e-waste and classify it into valuable parts, metal scraps, and plastic scraps, and then sell these to foreign or domestic recyclers or smelters. Sometimes e-waste or metal scraps are crushed and sorted to collect precious metals.

In Malaysia, informal recyclers dismantle e-waste manually and classify it into printed circuit board, plastic scraps, and metal scraps (i.e. copper, aluminium, steel, cable, and copper coil), and such valuable resources are then sold to domestic or foreign scrap dealers or smelters (METI, 2019). In Myanmar, informal recyclers dismantle EEE manually and classify it into various parts (i.e. metal frames, power supplies, printed circuit board, and plastics) (ASEAN-Korea Economic Cooperation Fund, 2020). Some informal recyclers there have introduced shredder machines for crushing and sorting e-waste (ASEAN-Korea Economic Cooperation Fund, 2020). In Viet Nam, recycling villages dismantle EEE manually, and classify printed circuit board, metal scraps, plastic scraps, and some valuable parts. Metal scraps are sold to domestic or foreign smelters, other recycling villages, or exporters (METI, 2019). Some recycling villages melt and cast metals from e-waste (Honda, Khetriwal, Kuehr, 2016). No masks or safety gear are used in these recycling villages (Honda, Khetriwal, Kuehr, 2016).

EEE contains valuable metals, but it also includes hazardous materials. Printed circuit board contain lead, refrigerators and air conditioners contain fluorocarbons, and televisions contain brominated flame retardants (Hosoda, 2003). The informal sector does not usually have technologies and

knowledge for environmentally sound treatment, causing environmental pollution and health damage (Table 1.1).

Table 1.1. Examples of Environmental Pollution and Health Damage due to Improper Recycling in
ASEAN

Country	Example
Cambodia	There is no mandate on wearing safety gear during dismantling processes, which has led to several accidents. Free discharge of toxic gases into the atmosphere from equipment results in health and environmental hazards. Residues are burned in dumpsites or disposed of in public places, causing extreme ground, water, and air pollution.
Indonesia	Environmental contamination happened in Pesarean Village, Adiwerna District, and Tegal Regency. [Pesarean Village] has a few metal businesses that smelter aluminium, lead, copper, zinc, and batteries, causing heaps of metal waste. In 2011, the consequences of a provincial example test showed that more than 46 individuals had high lead levels.
Thailand	Most informal e-waste recyclers do not use personal protective equipment when dealing with lead, cadmium, mercury, and other dangerous toxins. Insomnia, muscle atrophy, weakness, and headaches are often reported. 72.46% of people in the community where e-waste recycling occurred were concerned about their health, and the health of 31.02% of people in those communities was adversely affected.
Viet Nam	Most e-waste is manually recycled in 90 villages, which use manual techniques to sort, pre- process, melt, and cast metals from e-waste. Masks or safety gear while treating e-waste with chemicals are not used.

Sources: Honda, Khetriwal, Kuehr (2016); Decharata, Kiddee (2020); Shad, Ling, Karim (2020).

In at least five AMS, some e-waste – at least e-waste from industries – is dismantled, classified, and recycled by licensed recyclers. In Thailand, 81,220 tonnes of e-waste were treated by formal recyclers and 235,715 by informal recyclers in 2018 (ASEAN-Korea Economic Cooperation Fund, 2020). In Brunei Darussalam, Indonesia, the Philippines, and Thailand, licensed facilities dismantle e-waste and classify it into valuable parts, metal scraps, and plastic scraps, and sell them to foreign or domestic recyclers or smelters. In Malaysia, Viet Nam, and Singapore, licensed facilities smelt precious metals. For example, in Malaysia, licensed recyclers are categorised into full-recovery facilities and partial-recovery facilities based on regulations. Partial-recovery facilities dismantle e-waste; classify it into printed circuit board, metal scraps, and plastic scraps; and dispose of residues in the proper manner (METI, 2019). Some crush printed circuit board and sort metals and plastics (METI, 2019). Full-recovery facilities smelt precious metals such as gold, silver, and platinum with wet or dry smelting methods as well (METI, 2019).

The Ministry of Industry and Commerce and Ministry of Natural Resources and Environment inspect and ensure that pollution standards are met at recycling facilities in the Lao People's Democratic Republic (Lao PDR). As a result, only three factories have proper pollution treatment systems, with eight only partially meeting the criteria (ASEAN-Korea Economic Cooperation Fund, 2020).

AMS export copper scraps to China, Japan, and Korea (Figure 1.10; aluminium scraps to China and Korea (Figure 1.11); and precious metal scraps to Japan and Korea (Figure 1.12). Additionally, some AMS export e-waste to Europe, Japan, and Korea based on the Basel Convention (Figure 1.13).



Figure 1.10. Exports of Copper Scraps from ASEAN, 2021

ASEAN = Association of Southeast Asian Nations, HS = Harmonized System, Lao PDR = Lao People's Democratic Republic.

Note: This figure is based on the data applicable to HS code 7404 (copper; waste and scrap), so it includes the volume of the scraps that are not from used electrical and electronic equipment/e-waste.

Source: UN, UN Comtrade Database, https://comtradeplus.un.org/ (accessed 30 June 2023).



Figure 1.11. Exports of Aluminium Scraps from ASEAN, 2021

ASEAN = Association of Southeast Asian Nations, HS = Harmonized System, Lao PDR = Lao People's Democratic Republic.

Note: This figure is based on the data applicable to HS code 7602 (i.e. aluminium, waste, and scrap), so it includes the volume of the scraps that are not from used electrical and electronic equipment/e-waste.

Source: UN, UN Comtrade Database, <u>https://comtradeplus.un.org/</u> (accessed 30 June 2023).



Figure 1.12. Exports of Precious Metal Scraps from ASEAN, 2021

ASEAN = Association of Southeast Asian Nations, HS = Harmonized System, Lao PDR = Lao People's Democratic Republic.

Note: This figure is based on the data applicable to HS code 7112 (i.e. waste and scrap of precious metal or of metal clad with precious metal; other waste and scrap containing precious metal compounds, of a kind used principally for the recovery of precious metal), so it includes the volume of the scraps that are not from used electrical and electronic equipment/e-waste.

Source: UN, UN Comtrade Database, <u>https://comtradeplus.un.org/</u> (accessed 30 June 2023).



Figure 1.13. Export of E-Waste from ASEAN, Based on the Basel Convention, 2021

Note: E-waste includes batteries and printed circuit board in this figure. Other ASEAN Member States did not report exports of e-waste in 2021.

Source: Basel Convention, Basel Convention National Reports – Year 2021, https://www.basel.int/Countries/NationalReporting/NationalReports/BC2021Reports/tabid/9379/Default.aspx The capacity of smelting non-ferrous metal is poor in AMS. Indeed, secondary production of highly recyclable metals, such as aluminium and copper, accounts for only 2.5% and less than 1.0% of total refined consumption in the ASEAN region, respectively, significantly below global rates (IISD, 2023). In contrast, Japan has good capacity for treatment of secondary raw materials, such as precious metal scraps and e-waste like printed circuit board; this figure measured 375,000 tonnes with a surplus capacity of 51,000 tonnes in 2014.¹⁶

3.4. Remanufacturing and Refurbishment

Remanufacturing of used EEE is rarely found in Indonesia, Malaysia, and Singapore. Remanufactured products are rarely sold in Singapore and Indonesia (Kamigaki, Matsumoto, Yun, 2017). Most used products cannot be collected in developing countries, an obstacle to remanufacturing activities (Kamigaki, Matsumoto, Yun, 2017). However, the refurbishment of multifunction printers by manufacturers does occur in Singapore and Indonesia, and the refurbishment of information and communications technology equipment is found in Malaysia (Centre for Remanufacturing and Reuse, 2015).

3.5. Disposal and Energy Recovery

In Brunei Darussalam, Cambodia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, and Thailand, e-waste from households is disposed of in final disposal sites mixed with municipal waste.¹⁷ In Brunei Darussalam, e-waste is collected as ordinary municipal waste by local garbage collectors and delivered to final disposal sites such as Sungai Paku Landfill. In Malaysia, waste separation at the source is not common, so all types of municipal waste are collected in a single bin, and then this mixed waste is disposed of at landfill sites (Chow, 2017). In Myanmar, a lot of hazardous waste is sent to landfills due to lack of proper systems and methods to separate such waste (Thien et al., 2020). These circumstances are overwhelming the capacity of final disposal sites, and valuable resources such as such as copper, aluminium, and precious metals are lost. In Indonesia, scavengers pick e-waste from municipal waste collection points, so e-waste rarely flows into final disposal sites (Utomo, 2021).

In Cambodia, Indonesia, Myanmar, Philippines, Thailand, and Viet Nam, residues from e-waste are dumped or burned by informal recyclers. For example, in the Philippines, junk shops burn cables to collect copper and dump residues in their backyards. In Thailand, formal recyclers sometimes sell residues of e-waste to cement companies as fuel.

¹⁶ Government of Japan, MOE, Capacity of Domestic Smelters of Non-Ferrous Metals [in Japanese], <u>https://www.env.go.jp/recycle/yugai/conf/conf27-03/H280107_08.pdf</u>

¹⁷ Related information in Viet Nam is not found in this research.

Table 1.2. Processes and Actors of the Electrical and Electronic Equipment Circular Value Chain inASEAN

Country	Processes	Actors and Activities
Brunei Darussalam	Collection	 E-waste from households is collected by formal recycling companies (permitted by Ministry of Health) or formal municipal waste collectors. In addition, some NGOs have take-back initiatives. E-waste from government offices is collected by Department of Environment, Parks and Recreation.
	Reuse and repair	 Reuse, repair, and refurbishment were not found in the reviewed documents.
	Dismantling, classification, sorting, and material recycling	• E-waste collected by formal recycling companies is dismantled, crushed, and sorted. Valuable resources are exported according to the Basel Convention. Much e-waste may be disposed of at landfills, such as Sungai Paku Landfill.
	Remanufacturing and refurbishment	Remanufacturing was not found in the reviewed documents.
	Disposal and energy recovery	 Many households disregard e-waste and treat it as ordinary domestic waste. It is collected by local garbage collectors and sent to Sungai Paku Landfill.
Cambodia	Collection	 Used EEE and e-waste from households are collected with municipal waste and can be picked up by informal collectors, such as waste pickers, from public trash bins. Informal recyclers have their own systems for the collection and transport of e-waste. A few formal companies, such as EcoBatt-Energy Cambodia, have started to collect used EEE and e-waste, including batteries from households and industries.
		 About 85% of collected used EEE and e-waste are from households. These also come from offices, repair and dismantle shops, or importers.
	Reuse and repair	 80% of collected used EEE and e-waste are delivered to second- hand shops or repair and recycle shops. These are resold to households after repair. Residues generated are landfilled with municipal waste or burned.
	Dismantling, classification, sorting, and material recycling	• E-waste is treated by informal recyclers. Informal recyclers dismantle e-waste and recover and sell the recyclable parts to scrap dealers. The recyclable parts are exported to China, Thailand, and Viet Nam. Residues are disposed of at municipal dumps or burned.

Country	Processes	Actors and Activities
	Remanufacturing and refurbishment	Remanufacturing was not found in the reviewed documents.
	Disposal and energy recovery	 Valuable waste components are collected and exported, often from open dump sites, whereas non-valuable waste is disposed of in landfills.
Indonesia	Collection	• Used EEE and e-waste from households are stored at home, given to family or friends, or collected by formal or informal collectors.
		• E-waste is collected at formal collection points or waste banks (i.e. municipality-registered collection centres where people exchange valuable waste and money) and then delivered to B3- licensed facilities. Alternatively, some used EEE is collected by second-hand shops or repair or refurbish shops and then resold. Some e-waste is also collected with municipal waste at collection points for municipal waste. Some global companies have take-back initiatives as well.
		 E-waste is collected by junk shops, which treat used EEE as waste, without licenses. E-waste stored at collection points for municipal waste is picked up by scavengers.
		• E-waste from industries is collected by formal collectors and delivered to licensed facilities.
	Reuse and repair	 Used EEE and e-waste delivered from households to second- hand shops are resold to households or delivered to junk shops that recycle them. Before resale, used EEE is repaired or refurbished if necessary.
	Dismantling,	E-waste is recycled by formal and informal recyclers.
	classification, sorting, and material recycling	• E-waste collected from industries and at collection points and waste banks are treated by formal recyclers, which are licensed facilities. Formal recyclers dismantle, crush, and sort the e-waste. They recover and sell metal scraps to domestic or foreign smelters. They also recover plastic scraps and deliver them to domestic or foreign organisations.
		 Informal recyclers, such as junk shops or organisations entrusted by junk shops, recover precious metals and plastics. Unusable parts are dumped.
	Remanufacturing and refurbishment	 Remanufactured products are rarely provided in Singapore and Indonesia.
	Disposal and energy	The Ministry of Environment and Forestry admits that Indonesia
	recovery	still does not have an e-waste final disposal site. Most may be picked by informal collectors from municipal waste.
Lao PDR	Collection	Informal workers collect recyclable materials.

Country	Processes	Actors and Activities
		• E-waste from industries may be collected by formal collectors.
	Reuse and repair	• Reuse, repair, and refurbishment were not found in the reviewed documents.
	Dismantling,	E-waste is treated by formal and informal recyclers.
	classification, sorting, and material recycling	 Formal recyclers dismantle e-waste manually and classify and recover metal scraps and plastic scraps. Some formal recyclers melt printed circuit board.
		Treatment by informal recyclers is not clear.
	Remanufacturing and refurbishment	Remanufacturing was not found in the reviewed documents.
	Disposal and energy recovery	Mixed waste is disposed of in open-loop landfills.
Malaysia	Collection	• Used EEE and e-waste from households are collected by formal and informal collectors.
		• E-waste is collected at collection centres of e-waste listed by the Department of Environment and delivered to licensed facilities. Alternatively, some is collected by second-hand shops or repair or refurbishment shops and then resold. Some e-waste is collected with municipal waste and delivered to disposal sites. NGOs and charity organisations also collect used EEE and donate it.
		• E-waste is collected by informal collectors, such as door-to-door collectors and junk shops, which dismantle e-waste.
		 E-waste from industries is collected by formal collectors and delivered to licensed facilities.
	Reuse and repair	 Much used EEE is collected by door-to-door collectors, street collectors, and municipal waste collectors and delivered to repair, retail, or second-hand shops. It is resold to households as second-hand or repaired goods.
	Dismantling, classification, sorting, and material recycling	• E-waste is treated by formal and informal recyclers. Formal recyclers are classified into full-recovery facilities and partial-recovery facilities.
		 Partial-recovery facilities dismantle e-waste and classify and recover printed circuit board, metal scraps, and plastic scraps. Some facilities crush printed circuit board and sort metals and plastics. Residue is disposed of in the proper manner.
		 Full-recovery facilities dismantle e-waste and classify and recover printed circuit board, metal scraps, and plastic scraps. Some facilities crush printed circuit board and sort metals and plastics. These also smelt precious metals with wet or dry smelting methods. Residues are disposed of in the proper

Country	Processes	Actors and Activities
		 manner. Informal recyclers, such as junk shops, dismantle e-waste manually and recover printed circuit board, plastic scraps, and metal scraps. Such valuable resources are for domestic or foreign scrap dealers or smelters.
	Remanufacturing and refurbishment	Refurbishment of ICT equipment by original equipment manufacturers occurs.
	Disposal and energy recovery	 Waste separation at the source is not a common practice, which leads to the collection of all types of municipal solid waste in a single bin, then disposed of at landfills. Some e-waste also seems to be disposed of at landfills.
Myanmar	Collection	 There is an active informal sector with an established network for the collection of used EEE and e-waste and recycling, repair, refurbishment, and parts harvesting. Some e-waste from industries is collected by formal collectors
	Reuse and repair	 such as Dowa Eco-System. There is an active informal sector with an established network for collection of used EEE and e-waste and their recycling, repair, refurbishment, and parts harvesting.
	Dismantling, classification, sorting, and material recycling	 E-waste is treated by informal recyclers, which dismantle e- waste manually and recover various parts (metal frames, power supplies, printed circuit board, and plastics). Some informal recyclers have introduced shredder machines. Open burning of cables is conducted to recover copper. After recovering reusable components and recyclable materials, residues are disposed of with solid waste, burned by owners, or discarded in dumpsites or landfills.
	Remanufacturing and refurbishment	Remanufacturing was not found in the reviewed documents.
	Disposal and energy recovery	• Almost all townships lack proper systems and methods to deal with such waste separately, with much of it ultimately sent to landfills or openly burned.
Philippines	Collection	 Used EEE and e-waste from households is delivered to junk shops. Some is collected by second-hand shops and then resold. E-waste from industries is generally collected by formal collectors and delivered to licensed facilities.
	Reuse and repair	 At households, schools, and small companies, second-hand goods are re-used. Used EEE and e-waste collected from households are delivered to second-hand shops or junk shops that recycle e-waste. Used EEE delivered to second-hand shops are resold to households.

Country	Processes	Actors and Activities
	Dismantling, classification, sorting, and material recycling	 E-waste is treated by formal and informal recyclers. Formal recyclers (licensed as TSD facilities) dismantle e-waste and classify and recover metal scraps, printed circuit board, and plastic scraps. They are sold in or out of the country. Printed circuit board is sometimes crushed and sorted. Residues are delivered to final disposal sites.
		• Informal recyclers, such as mid- or large junk shops, dismantle e- waste and classify it into valuable materials and non-valuable materials. Valuable materials are sold to other formal recyclers or exporters. Non-valuable materials are disposed of. Junk shops burn cables to collect copper and dump residues in their yards.
	Remanufacturing and refurbishment	Remanufacturing was not found in the reviewed documents.
	Disposal and energy recovery	• After being stored for a maximum of 3 years, 80% of e-waste is assumed to be landfilled since e-waste recycling is new, and facilities that handle e-waste are limited.
Singapore	Collection	 Used EEE and e-waste are collected at some collection points and delivered to licensed collectors (e.g. Alba E-Waste Smart Recycling) or <i>karang guni</i>, a kind of informal sector.
	Reuse and repair	• Reuse, repair, and refurbishment were not found in the reviewed documents.
	Dismantling, classification, sorting, and material recycling	 E-waste collected by Alba E-Waste Smart Recycling is classified and delivered to licensed recyclers for material recycling. Intermediate technologies can extract other precious metals besides gold and copper from e-waste.
	Remanufacturing and refurbishment	Remanufactured products are rarely sold.
	Disposal and energy recovery	• E-waste that is thrown away, including all precious metals that it contains, are incinerated and landfilled at Semakau Landfill.
Thailand	Collection	 Used EEE and e-waste from households are stored at home, passed on to family or friends, or collected by both formal and informal collectors.
		• Used EEE and e-waste are collected by formal collection companies such as Wongpanit and delivered to licensed facilities. Alternatively, some is collected by second-hand shops or repair or refurbishment shops and then resold. Some e-waste is collected with municipal waste.
		• E-waste is collected by door-to-door collectors or junk shops that treat used EEE as waste without licenses.
		 E-waste from industries is collected by formal collectors and subsequently delivered to licensed facilities.

Country	Processes	Actors and Activities
	Reuse and repair	 50% of used EEE is sold to second-hand shops or recycling facilities. In the shops, it may be repaired. Used EEE that cannot be repaired is sold to formal or informal recyclers.
	Dismantling, classification, sorting, and material recycling	 E-waste is treated by formal and informal recyclers. Formal recyclers (licensed under the Factory Act) dismantle e-waste and classify and recover printed circuit board, metal scraps, and plastic scraps. Such valuable resources are sold in or out of the country. Residues are sometimes sold to cement companies as fuel. Informal recyclers, such as junk shops, dismantle e-waste manually and recover metal scraps, printed circuit board, plastic scraps, and other parts (e.g. cables and motors). Residues are landfilled or burned.
	Remanufacturing and refurbishment	 Remanufacturing was not found in the reviewed documents. Some bazardous waste is disposed of at managed landfills.
	recovery	• Some nazaruous waste is disposed of at managed landnins.
Viet Nam	Collection	 E-waste from households is collected by both formal and informal collectors. E-waste is collected by formal municipal collection companies with municipal waste. Some e-waste is collected by second-hand shops and then resold. E-waste is collected by door-to-door collectors. E-waste from industries is collected by formal collectors and delivered to licensed facilities.
	Reuse and repair	 Some used EEE and e-waste collected from households are delivered to recycling villages or repair shops. Used EEE delivered to repair shops is resold to the second-hand market.
	Dismantling, classification, sorting, and material recycling	 E-waste is treated by formal and informal recyclers. E-waste collected from industries is delivered to licensed recyclers, which dismantle it and classify and recover printed circuit board, metal scraps, and plastic scraps. Some recyclers crush printed circuit board and sort metals and plastics, while others recover precious metals through chemical methods. E-waste collected from households is delivered to recycling villages. Some dismantle e-waste manually and recover printed circuit board, metal scraps, plastic scraps, and some valuable parts. Metal scraps are sold to domestic or foreign smelters, other recycling villages, or exporters. Plastic scraps are sold to domestic or foreign surfaces.

Country	Processes	Actors and Activities
	Remanufacturing and refurbishment	Remanufacturing was not found in the reviewed documents.
	Disposal and energy recovery	Residues are sometimes burned in the recycling villages.

EEE = electrical and electronic equipment, ICT = information and communications technology, NGO = non-governmental organisation.

Sources: Idris, Shams, and Yusof (2023); ASEAN-Korea Economic Cooperation Fund (2020); JICA (2019); METI (2019, 2020); Kamigaki, Matsumoto, and Yun (2017); Utomo (2021); Global Green Growth Institute (2018); Noudeng, Nguyen, Tran (2022); Centre for Remanufacturing and Reuse (2015); Chow (2017); OECD (2020); Ronald et al. (2018); Jiaranaikhajorn (2013); Alba E-Waste Singapore, <u>https://alba-ewaste.sg/</u>

4. Gaps in the EEE Circular Value Chains between Japan and ASEAN

In this section, gaps in the EEE circular value chains between Japan and ASEAN are described. Based on the results of the gap analysis, challenges for ASEAN in improving its EEE circular value chain are identified.

4.1. Gap 1: Poorly Managed Reuse Activities

In Japan, reuse activities are well managed by industry associations; in contrast, such activities are not found in AMS. Moreover, used EEE is imported into AMS as reused goods but is often improperly recycled instead. Second-hand shops sell non-reusable products and remove parts for junk shops, which then treat them in an improper manner. It is thus crucial to prevent the improper import of e-waste into AMS; importers and administrative agencies should also invoke the standards provided under the Basel Convention for distinguishing used EEE and e-waste. Additionally, second-hand shops must comply with regulations on the treatment of hazardous waste so that environmental pollution and health damage due to improper treatment of e-waste is avoided. Other challenges for well-managed reuse activities include:

- (i) establishment of certification system of excellent second-hand shops that comply with regulations and ensure quality management of reused goods; and
- (ii) establishment of a traceability system of reused products, which prevents a second-hand shop from buying and selling illegally obtained used EEE such as stolen goods and from delivering it to illegal recyclers.

4.2. Gap 2: Few Formal Collectors and Recyclers

In Japan, most e-waste – especially televisions, refrigerators, washing machines/dryers, air conditioners, and multifunction printers – are collected and recycled by licensed, well-managed collectors or recyclers. There, licensed recyclers have been able to receive more e-waste and achieve environmentally sound treatment and recovery of many valuable resources. In the ASEAN region, however, few licensed collectors and recyclers are active. For example, in Indonesia, Malaysia, the Philippines, Thailand, and Viet Nam, licensed collectors or recyclers only manage e-waste from industries and a limited amount of e-waste from households.

Governments in ASEAN struggle to regulate unlicensed collectors and recyclers and thus cannot make them comply with environmental and safety standards, leading to risks of environmental pollution and health damage. It is imperative to promote the participation of licensed collectors and recyclers and to formalise informal collectors and recyclers. Several barriers impede the participation of licensed collectors and recyclers, including

- (i) difficulty in collecting e-waste from households due to the lack of collection systems,
- (ii) lack of technologies and equipment for e-waste processing, and
- (iii) high costs associated with environmentally sound e-waste collection and treatment.

4.3. Gap 3: Mixed Waste

In Japan, televisions, refrigerators, washing machines/dryers, and air conditioners are not mixed with municipal waste. About 70% is collected and delivered to designated collection places set up by manufacturers. In AMS, however, e-waste from households is collected along with municipal waste and disposed of in the same final disposal sites. Sometimes, scavengers pick e-waste from municipal waste collection points. The same occurs for valuable EEE, while less valuable EEE may also end up in final disposal sites. Problems in AMS thus include

- (i) a lack of dedicated entities and infrastructure (i.e. collection points) for collecting e-waste from households,
- (ii) lack of incentives for consumers to deliver e-waste to collection points, and
- (iii) lack of consumer awareness and knowledge about the correct disposal of e-waste.

4.4. Gap 4: Low Capacity of Metal Scrap Recyclers

Japan has the capacity to recycle metal scraps, especially scraps containing copper and precious metals. In contrast, AMS have limited capacities. Metal scraps recovered from e-waste through dismantling, classification, and sorting are exported to other countries, particularly China, Japan, and Korea, where they are smelted.

From the viewpoint of the stable treatment of e-waste and stable supply of recycled resources, domestic recycling of metal scraps should be increased in all AMS. As global e-waste generation is predicted to increase (Baldé et al., 2017), AMS must expand their e-waste recycling capacities by ensuring the export of metal scraps for recycling while concurrently enhancing domestic capacities. This requires international cooperation and/or collaboration with countries capable of smelting these metals, involving both the public and private sectors.

4.5. Gap 5: Lack of Remanufacturing Activities

Remanufacturing of used multifunction printers is a well-established practice in Japan, yet remanufacturing of used EEE is uncommon in AMS. In general, remanufacturing is preferred over recycling and disposal, because remanufacturing generates more added value and fewer residues than recycling and disposal (OECD, 2020). In AMS, e-waste tends to be recycled, even when remanufacturing is possible. Hence, promoting the remanufacturing of used EEE should be prioritised before the recycling process. Potential barriers to remanufacturing in AMS include

- (i) lack of efficient collection and take-back systems linked to manufacturers;
- (ii) lack of access to technologies, know-how, and information needed to distinguish parts suitable for remanufacturing;
- (iii) lack of standards for quality and safety assurance; and
- (iv) lack of necessary infrastructure (e.g. production lines) in factories.

Considering policies and legal systems to address these barriers should be prioritised, taking into account good practices in advanced countries. Legal systems for ensuring collection linked to manufacturers should be established; national laws and standards of quality and safety assurance for remanufactured goods should be drafted in alignment with international rules and standards; and national strategies and roadmaps, including research and development, for promoting remanufacturing should be developed. Each EEE manufacturer should promote their own take-back systems, research and development for remanufacturing, in-house standards for quality and safety assurance, and investment in necessary infrastructure.

5. Conclusion

In this chapter, the gaps between AMS and Japan's EEE circular value chains were explored. Five gaps in ASEAN are identified: (i) poorly managed reuse activities, (ii) low presence of formal collectors and recyclers, (iii) mixed waste, (iv) low capacity of metal scrap recycling, and (v) lack of remanufacturing activities (Figure 1.14).



Figure 1.14. Gaps in the ASEAN Electric and Electronic Equipment Circular Value Chain

NGO = non-governmental organisation, OEM = original equipment manufacturer, UEEE = used electrical and electronic equipment. Note: The flows that are applicable to five or more countries are shown in red. The flows that are applicable to at least one country are shown in black. Industry includes private companies, public organisations, and factories. Source: Authors.

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