Chapter 9

Design of E-waste Recycling Indicators in East Asia

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1. Introduction

Until this time, considerable research has been carried out on the issue of e-waste recycling performance in East Asia which has implemented the Extended Producer Responsibility (EPR) policies (Tasaki Tomohiro 2006; Chung 2008; Lihchyi Wen et al. 2009). Recently, many developing Asian countries have actively begun preparing the introduction of EPR-based policy to effectively tackle the current e-waste-related policy challenges.

However, most research does not pay sufficient attention to the fact that the definition of "recycling" and the actual implementation of recycling-related indicators differ substantially throughout East Asia. In consequence, this leads to the difficulty of elucidating substantial policy implications from the individual policy experiences of each of the advanced countries of East Asia.

In this paper, the authors present a brief review of the legal situation and compare the recycling-related indicators in East Asia, specifically Japan, Korea, and Taiwan. In section 2, the features of the e-waste recycling system designs in Japan, Korea, and Taiwan are provided. Section 3 compares e-waste recycling indicators which are designed to evaluate the recycling performance in their respective recycling systems. In addition, the issue of formulating domestic regulation is discussed in relation to the global reuse and recycling of e-waste as well. The authors hope that the result of this study will be used as reference material for countries which are interested to introduce EPR-based policies in order to manage e-waste more effectively.

2. System Designing on E-waste Recycling in East Asia

2.1 Japan

In Japan, municipalities demanded that e-waste discharged from households should be designated as “goods difficult to treat properly” (*Shori konnan butsu* in Japanese) in the 1970s. At that time most municipalities resorted to landfill treatment because they did not have sufficient facilities for proper e-waste recycling, which only caused the landfill situation to worsen.

In this context, Japan implemented the Law for Recycling Specified Home Appliances (RHA) as an EPR-based law for managing e-waste in 2001. Under the RHA, municipalities are no longer responsible for e-waste collection and recycling. In their place, manufacturers have come to play a major role in e-waste management in Japan. In this respect, Japan’s RHA is marked by the transfer of the responsibility for -waste from the municipalities to the manufacturers.

According to the RHA, consumers have to pay a fee for the transportation and recycling to the retailers and manufacturers respectively when they discharge e-waste such as TV sets (braun tube/ liquid crystal/ plasma), refrigerators (including freezers), air conditioners and washing machines. The recycling fee ranges from 1,700 yen (kindly provide also the equivalent in USD) (TV sets under 25 inches) to 3,600 yen (refrigerators). Retailers are obliged to take back e-waste upon the request of consumers. With the transportation fee paid by consumers, retailers should transport e-waste to the manufacturer-furnished collection sites. It is a violation of the RHA if retailers dispose of e-waste for which the recycling fee has been paid.

Under the provision of the RHA, manufacturers must recycle all e-waste transported to collection sites. However, manufacturers do not have any compulsory target

for e-waste collection. This can mean that Japan's manufacturers can fulfill their legal obligation by recycling only e-waste transported by retailers. In this regard, Japan's manufacturers do not have a strong incentive to increase the collection and recycling of e-waste. In addition, manufacturers should clear Recycling Standards Rates (RSR) which is required per unit level. These rates are: 50-55% for TV sets (50% for liquid crystal and plasma TV sets and 55% for Braun tube TV sets), 60% for refrigerators (freezers), 70% for air conditioners and 65% for washing machines on the basis of weight.

Based on its interpretation of the EPR principle, Japan places physical responsibility on manufacturers and financial responsibility on consumers separately for e-waste recycling. This reflects the fact that when it comes to the cost sharing, the mode of payment and ease of fee collection are essential elements to be considered (FLMS 2000).

2.2 Korea

Strongly influenced by the Organization for Economic Co-operation and Development (OECD)'s Government Manual on the implementation of EPR principle, Korea started implementing the EPR-based law by revising the Recycling Act of 2003. This act comprehensively regulates 18 items out in 7 categories including packaging and products, e-waste representing one category. In 2008, the Law on Resource Circulation of Waste of Electrical and Electronic Equipment and End of Life Vehicles (LEV) was enacted for e-waste and end of life vehicles considering both of them to be durable goods. There are 10 e-waste items covered under the LEV (TV sets, refrigerators, air conditioners, washing machines, personal computers, mobile phones,

audio equipment, printers, copy machines, and fax machines).

Under the LEV, consumers can discharge e-waste by means of turning it for free to the dealers when they purchase a new home appliance. Manufacturers have a compulsory target for e-waste collection, which is calculated on the basis of a mandatory collection rate (MCR). MCR is announced by the Ministry of Environment (MOE) on an annual basis who considers current recycling performance, the amount of import and export, and the recycling capacity in Korea. In addition, the average weight of e-waste collected in the previous year (kg) and shipment of the target year (unit) are also taken into consideration to compute the exact amount of e-waste collection. A manufacturer's collection target is calculated by multiplication of MCR, the average weight of the e-waste, and the amount of shipment. In the event that the manufacturers do not meet the collection target, they are obliged to pay a recycling charge for the unfulfilled e-waste collection and surcharge in proportion to the unperformed collection target.

As for setting the target amount of collection by manufactures, the MOE promotes increasing e-waste collection under the LEV by announcing mid-to long-term goals in 2012. The goals in 2012 are from 1.7 times to 2.0 times higher than those of 2005. However, Korea's manufacturers do not have a compulsory target for e-waste recycling, which is significantly different than in Japan. In this respect, Korea's LEV puts higher value on increasing the amount of e-waste collected by manufacturers rather than the proper treatment of e-waste. For example, proper treatment of Chloro-Flouro-Carbon (CFC) in refrigerator was not required until 2009. In addition, manufacturers need to clear the Reuse and Recycling Rates (RRR) which correspond to the RSR of Japan. These rates are: 65% for TV sets and personal computers, 70% for refrigerators, audio equipments, and mobile phones, 75% for printers, copy machines, and

fax machines, and 80% for air conditioners and washing machines on the basis of weight.

In the meantime, municipalities dissimilar to those in Japan still collect and recycle considerable amounts of e-waste discharged by households. The e-waste in this case is treated as municipal wastes under the Waste Management Law (WML). However, because in reality most municipalities do not have facilities sufficient to properly treat e-waste, recovery of recyclable resources and proper treatment of e-waste are not guaranteed (Chung 2008).

2.3 Taiwan

In Taiwan, the EPR-based Waste Disposal Law (WDL) was enacted in 1998 against a background of environmental pollution caused by mixed metal scrappers in the 1980s. They burned non-metal parts or refined metals with hazardous chemicals to extract metals, which led to water and soil pollutions by heavy metals. Furthermore, burning mixed metals in the fields contaminated the air. In the late of 1980s, even though mixed metal scrappers were managed by limiting their locations to two areas, environmental pollution did not cease and incessantly repeated, which water pollution expanded to the neighboring sea (Terao 2008).

As a government-led recycling scheme to prevent environmental pollution, the Recycling Fund Management Committee (RFMC) was established on the basis of WDL. Under the RFMC system, manufacturers assume only financial responsibility for e-waste recycling. The specific amounts of the recycling fees are determined by the Fee Rate Reviewing Committee (FRRC), which is composed of representatives of government, academia, consumer groups, and manufacturers. The recycling fees, which are

managed by RFMC, are diverted as a subsidy to the commercial recycling companies which carry out proper recycling of e-waste. In order for them to obtain a subsidy, commercial recycling companies must be registered with the Environmental Protection Administration (EPA) and their recycling performances must also be monitored by a public auditing institute. These regulations signify that commercial recycling companies should compare the merits (obtaining subsidy) and demerits (taking environmental measures) when it comes to becoming registered recyclers under the RFMC system.

As for e-waste recycling, registered recyclers do not have any compulsory target for collection. However, it can be said that they have a target for e-waste recycling in that they are subsidized by the EPA only for the e-waste they recycle, which is quite different than in Korea. In addition, registered recyclers need to clear the Compulsory Recycling Rates (CRR) which is required per unit level. These rates are 70% for all covered items since 2007. Using the criteria of Japan or Korea, RFMC handles approximately 7 items. Unique to the policy of Taiwan, separate subsidies are set for each 5 parts of computers (main bodies, monitors, liquid crystal monitor, mother board, and note book computers), the purpose of which is to make sure they are treated properly.

In Taiwan, it is not common for consumers to discharge e-waste to the retailers or manufacturers because e-waste usually has some value. Registered recyclers normally purchase e-waste from collection firms which buy these items from households. In this respect, the recycling system of Taiwan does not pay attention to the collection and transportation stage but concentrates on the recycling stage which has a high probability of bringing about heavy environmental impact.

2.4 Summary

Japan, Korea, and Taiwan, have enacted EPR-based policies to effectively manage e-waste by considering their own policy backgrounds. Historic policy of differences and region-specific problems have caused them to establish characteristic e-waste recycling systems, differing particularly in which items are covered and how to set indicators for recycling performance.

Firstly, with regards to coverage: 4 items are managed in Japan, 10 in Korea, and about 7 in Taiwan by their respective EPR-based laws. However, it is quite hard to determine the exact number of covered items because these three systems utilize different ways of counting the items (Table 1).

As for TV sets, there are three types which are explicitly provisioned for as one of the covered items in Japan, and accordingly for all of them the respective RSR is required. In contrast, Korea's LEV does not specify types of TV sets. This can be understood from Korea's quantification-centered approach to imposing compulsory collection targets on manufacturers for the management of e-waste recycling. Only CRT and liquid crystal TV sets are included in Taiwan's RFMC system.

A variety of approaches to managing used computers are employed in these three systems. In Japan, used computers are regulated by the Law for the Promotion of Effectiveness in the Utilization of Resources (PUR), which collection and recycling system were developed by manufacturers themselves. Under PUR, retailers do not have any responsibility to take back used computers from consumers. In Japan, it is rare for retailers to deliver a new computer to the purchaser's home. This is also a major reason why specific waste home appliances and waste computers are managed by separate laws. In Korea, personal computers accounts for one of 10 covered items. By comparison, as

the authors mentioned in the former section, computers management is divided into 5 parts in Taiwan. Additionally, liquid crystal monitors and computer keyboards were added in 2007.

Unlike TV sets and computers, audio equipment, mobile phones, copy machines, and fax machines are controlled only under the LEV in Korea. Printers are commonly covered items in Korea and Taiwan. Electric fans were new items included in 2007 under the RFMC system in Taiwan.

Table1　Covered Items under the EPR-based Policy in Japan, Korea, and Taiwan

		Japan	Korea	Taiwan
TV sets	Braun tube	○	○ (TV sets)	○
	Liquid crystal	○		○
	Plasma	○		×
Refrigerators	Refrigerator	○	○	○
	Freezer	○	×	×
Air conditioners		○	○	○
Washing machines	Washing machines	○	○ (only for household)	○
	Clothing dryer	○	×	×
Computers	Main body	Managed by Law for the Promotion of Effectiveness Utilization of Resources	PCs (including monitors and keyboards)	○
	CRT Monitor			○
	Liquid crystal monitor			○
	Notebook			○
	Mother board			○
Audio equipments		×	○(excluding portable)	×
Mobile phones		×	○(including battery and charger)	×
Copy machines		×	○	×
Printers		×	○	○
Fax machines		×	○	×
Electric fans		×	×	○
Total		4 items	10 items	About 7 items

Secondly, it has been pointed out that there are significant differences in the details of recycling indicators in these three systems (Table 2). Japan and Taiwan have in common that they put much emphasis on quantitative recycling targets when it comes to e-waste collection. However, they place manufacturers and registered recyclers respectively as the main actors in e-waste management. In contrast, Korea sets collection targets as the main policy goal, which should be cleared by manufacturers.

As for qualitative recycling indicators, all three systems set up their own indicator to evaluate the quality of e-waste recycling. However, full attention should be paid to the fact that the details of quality-side recycling targets in the respective systems indicate substantially different things. Grasping the similarities and differences between recycling indicators is essential because they may be a decisive clue in comprehending the fundamental aspects of the e-waste recycling system in East Asia. The authors provide the details of the respective qualitative recycling indicators in the next section.

Table2　Details of Recycling Indicators in East Asia

	Recycling Indicators		
	Collection target	Recycling target	
	Quantity	Quantity	Quality
Japan	×	? (Manufacturers)	? (Manufacturers)
Korea	? (Manufacturers)	×	? (Manufacturers)
Taiwan	×	? (Registered recyclers)	? (Registered recyclers)

Source: Compiled by the authors

3. Comparison of Recycling Indicators in East Asia

3.1 Japan

3.1.1 Recycling Standards Rates in Practice

As mentioned in the former section, Japan has adopted the RSR as the indicator with which to evaluate qualitatively the recycling of e-waste. As a supplement indicator to RSR, RSR etc. was also laid down in the RHA. While RSR only includes material recycling, RSR etc. is a more comprehensive indicator in that it includes material recycling and thermal recovery. In reality, clearing the RSR is a stricter standard than RSR etc. in terms of e-waste recycling because the same degree of recycling is required for each of them. The concrete rates for the RSR and RSR etc. for the 4 covered items are illustrated in the Table 3.

Since April of 2009, new targets of RSR and RSR etc. have been imposed on manufacturers. This is a reflection of improvement in recycling technology and the increasing amount of waste plastic recycled against the price hike of resources at the global level (AEHA 2009). The main change is a new target ratio for TV sets (liquid crystal and plasma). As for the Braun tube type of TV set, no increase in the RSR and RSR etc. is apparent, which is affected by decreasing demand for recycled glass cullet from TV sets and technological difficulties in directing it toward other usage. For the remaining 3 items with the exception of TVs, higher target in RSR and RSR etc. than before April 2009 are required.

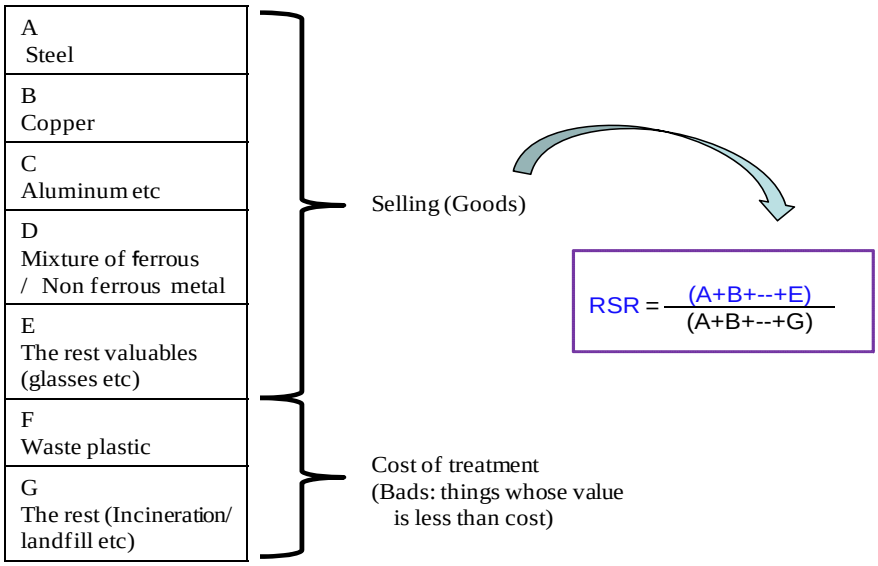
Table 3 The Target Ratio of Recycling Standards Rates and Recycling Standards Rates etc. in Japan

		Before April. 2009		After April. 2009	
		Recycling Standards Rates	Recycling Standards Rates etc.	Recycling Standards Rates	Recycling Standards Rates etc.
TV sets	Braun tube	55%	55%	55%	55%
	Liquid crystal/ Plasma	–	-	50%	50%
Refrigerators	Refrigerators	50%	50%	60%	60%
	Freezers				
Air conditioners		60%	60%	70%	70%
Washing machines		50%	50%	65%	65%

However, regarding the issue of recognition of RSR and RSR etc., special attention should be paid to the definition of RSR. On the basis of the Waste Treatment Law (WTL), only recycled materials being sold or taken back free of charge are counted as being legally recycled in Japan. The RSR in practice is provided in case of TV sets. However this does not reflect the real recycling situation but shows imaginary situation for the purpose of comprehension and speculation.

According to figure 1, TV sets are basically composed of 7 parts (A to G) including steel, copper, and so on. In Japan, aluminum and nonferrous metal etc (A to E) are usually traded at a profit. However, in the case of waste plastic and the rest (F and G), it is common that the manufacturers pay treatment fees to the recyclers for final treatment. This is not recognized as recycling by definition under the RHA. Consequently, RSR can be expressed as the amount of parts sold or taken back for nothing divided by the total weight of the TV sets. In 2008, the RSR for TV sets was reported to be 89%, which is far higher than what was legally required. However, the glass occupies more than 60% of the total weight, which means that the trade relation concerning CRT glass is the most influential factor by which to decide the RSR for TV sets.

Figure 1 The RSR in Japan in Practice (TV sets)



Source: Compiled by the authors

3.1.2. Issues Related to the Recognition of Recycling Standards Rates

Regarding the recognition of RSR, there are several issues in connection with international recycling and reuse to be reviewed. This topic is worth looking at in detail as it pertains to the design of domestic regulation in harmony with current global reuse and recycling situation.

The first issue pertains to reuse. Under the RHA in Japan, domestic reuse of e-waste as secondhand goods is not included in the RSR. This does not mean that reuse of e-waste is illegal in Japan. RHA only regulates recycling by manufacturers. Manufacturers are not allowed to reuse e-waste as a means of clearing RSR. In addition, reuse of e-waste as parts is included in the RSR.

The second issue is related to export. When e-waste is exported as secondhand goods it is not included in the RSR. As the authors mentioned before, manufacturers must recycle all the e-waste that consumers have paid a recycling fee for. It is also illeg-

al for manufacturers to export e-waste to be sold by retailers as secondary goods. When e-waste parts are exported for reuse, they are actually included in the RSR. The RHA does not have a specific stipulation on this issue. It has not yet been reported that manufacturers have exported the parts of e-waste on their own behalf for reuse. However, it is undeniable that the portion of e-waste sold by manufacturers is exported for reuse in the long run.

The third issue concerns with the management of hazardous e-waste substances. A variety of hazardous substances are evident in e-waste (IGES 2009). In relation to global warming, CFCs are noteworthy substances that immediate measure should be taken at the global level. In Japan, CFCs exist as refrigerant in air conditioners, refrigerators and freezers which should be collected and destroyed. Furthermore, CFCs in the insulator of refrigerators and freezers should also be collected and destroyed. The RHA does not prohibit the reuse of CFCs as goods; however, Japan's manufacturers destroy all the CFCs transported to them.

3.2 Korea

3.2.1 Reuse and Recycle Rates in Practice

As a qualitative indicator for e-waste recycling, RRR has been adopted in Korea. RRR was revised in 2006. Compared with RSR of Japan, RRR is defined as a comprehensive term which includes thermal as well as material recovery. As for the specific target rate for e-waste, in contrast to Japan, there is no explicit stipulation about the liquid crystal/ plasma types of TV sets in Korea. While the lowest rate of RRR is required for TV sets and personal computers, 80% of RRR is imposed on air conditioners and washing machines. Three items such as copy machines, printers, and fax machines have

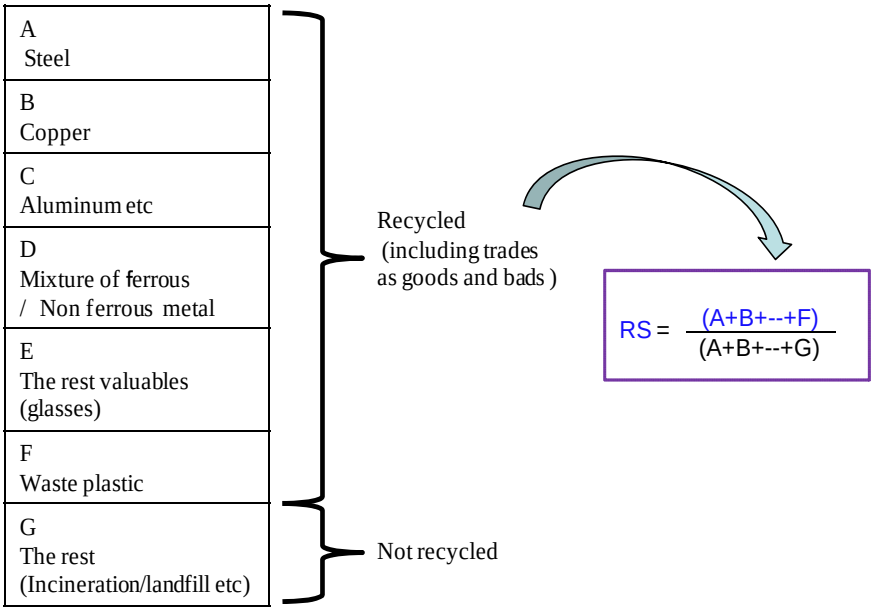
been listed on covered items since 2006.

Table 4. The Target Ratio of Reuse and Recycling Rates in Korea

		Before2006	After2006
TV sets		55%	65%
Refrigerators		60%	70%
Air conditioners		70%	80%
Washing machines		70%	80%
PCs	Lap top	55%	65%
	Note book		
Audio equipment		60%	70%
Mobile phone		60%	70%
Copy machines		65% (Before 2008)	75% (After 2008)
Printers			
Fax machines			

As for the recognition of RRR, there are significant differences between Korea and Japan. Korea's RRR weighs heavily on the state of the recyclable resources, not the financial relation between the discharger and recipient. According to figure 2, 6 (A to F) of 7 categories are recycled on the basis of Korea's definition of recycling. What is most notably different in Japan is that, waste plastics (F) are additionally counted as recycling. Roughly speaking, all types of treatment except incineration and landfill are considered to be recycled. Consequently, RRR can be expressed as the amount of recycled e-waste divided by the total weight of TV sets. In 2005, it was reported by manufacturers that about 98% of TV sets are recycled. This may indicate that only 2% of the TV sets are treated by means of incineration or landfill. Wooden covers are typically the part of the TV set that are disposed to landfill.

Figure 2. The RRR in Korea in Practice (TV sets)



Source: Compiled by the authors

3.2.2 Issues Related to the Recognition of Reuse and Recycle Rates

With the recycling standard in Japan, Korea's e-waste recycling system is reviewed. The first issue pertains to reuse. Under the LEV in Korea, domestic reuse of e-waste as secondhand goods is not included in the RRR. The LEV does not address reuse of e-waste. In addition, reuse of e-waste as parts is explicitly included in the RSR as the title of the indicator implies.

The second issue is related to export. When e-waste is exported as secondhand goods it is not included in the RRR, with the exception of personal computers. It is not an easy task to collect personal computer e-waste directly from households even under the implementation of take-back. The MOE announced a governmental notice related to the collection situation of used personal computers so that the export of used personal computers for reuse could be recognized as a part of manufacturers' recycling performance. In 2009, manufacturers still fulfill their legal obligations by contracting with the

commercial recycling companies. Manufacturers provide subsidies to these recyclers relative to the amounts of used personal computer collected.

By contrast, Korea takes considerably different positions on e-waste export for recycling. As the author mentioned in the previous section, it is illegal for Japanese manufacturers to export e-waste for recycling. However, in Korea under the monitoring of proper treatment by manufacturers, the export of all covered items for recycling has been accepted as a means of accomplishing collection targets since 2007. Submission of related documents to prove proper treatment in the importing countries is necessary to assure the monitoring process. In addition, when the parts of e-waste are exported for reuse they are also included in the RRR.

The third issue is regarding the management of hazardous e-waste substances. In Korea, under the LEV, CFCs as refrigerant in air conditioners and refrigerators are to be collected. However, no stipulation is established after the collection. Most of collected CFCs are actually reused as refrigerant for cars. Furthermore, in reality, CFCs in the insulator of refrigerators are not collected at all.

3.3 Taiwan

3.3.1 Compulsory Recycling Rates in Practice

Taiwan introduced CRR as a qualitative recycling indicator under the RFMC system. The rates of CRR for each covered item are illustrated in Table 5. In 2007, there was a revision of CRR for covered items. Since that year, 70% of CRR has been required for all items across the board. As for TV sets and washing machines, higher CRR are imposed on registered recyclers. During that time, CRR for refrigerators and air conditioners decreased. According to high-ranking governmental officials, 70% has

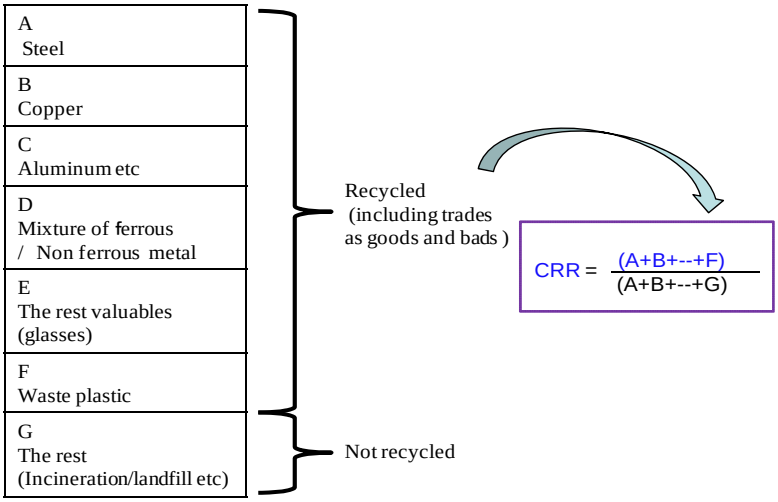
been the real average recycling rate in the current years in Taiwan.

Table 5 The Target Ratio of Compulsory Recycling Rates in Taiwan

		Before Feb.2007	After Feb. 2007
TV sets	Braun tube	60%	70%
	Liquid crystal/ Plasma	N/S	
Refrigerators		80%	70%
Air conditioners		80%	70%
Washing machines		60%	70%
PCs	Note book	N/S	70%
	The rest		
Audio equipment			70%
Electric fan			70%

As for the recognition of CRR, a standard similar to that of Korea is applied. However, there is a significant difference regarding the international reuse and recycling issue (details in the following section). According to figure 3, 6 (A to F) of 7 categories are recycled according to Taiwan's definition of recycling. In consequence, CRR can be expressed as the amount of e-waste recycled divided by the total weight of the TV sets. In Taiwan, e-waste control is divided in two groups: household appliances and it (?) objects. It has been found that the CRR for used household appliances and it (?) objects reached 71% and 86% respectively in 2007 (Ya-Yun 2009). If recalculated according to the Korean standard, they both increase to 87% and 86% respectively, which are slightly lower than those found in Korea. This difference comes from their disparate attitudes toward the export issue between Taiwan and Korea. The details are presented in the next section.

Figure 3. The CRR in Taiwan in Practice (TV sets)



Source: Compiled by the authors

3.3.2 Issues Related to the Recognition of Compulsory Recycling Rates 0.5

Taiwan, compared to Japan and Korea, has the most rigid attitude about the international reuse and recycling issue in relation to what is recognized as recycling. The first issue pertains to reuse. Under the RFMC system, domestic reuse of e-waste as secondhand goods is not included in the CRR, nor is reuse of e-waste as parts. This does not mean that it is illegal to reuse or sell e-waste as parts, as long as the recycling carried out is of higher quality than what is stipulated by CRR.

The second issue is related to export. When e-waste is exported as secondhand goods it is not included in the CRR. Export of e-waste as parts for reuse is not included in the CRR. Taiwan's cautiousness toward what they recognize as recycling can be understood against the policy background of the RFMC system. As the authors mentioned in the previous section, serious environmental pollution in the 1980s greatly served to drive policy designed to thoroughly monitor recycling activity.

The third issue concerns with the management of hazardous e-waste substances.

Under the WDA (Waste Disposal Act), CFCs as refrigerant in air conditioners and refrigerators need to be collected and destroyed. If CFCs are not properly treated, the registered recyclers cannot receive subsidies for their recycling performance. However, as in Korea, no stipulation is made regarding CFCs in the insulator.

3.4 Summary

In this section, the authors review the definition of recycling and the actual recycling indicators and practice in East Asia. Table 6 illustrates mandatory rates and revisions of the recycling indicators in Japan, Korea, and Taiwan. Overall, the Korea's mandatory rates are the highest out of these three systems; however, this does not necessarily indicate that the highest quality of e-waste recycling is carried out in Korea. This is primarily because reuse and recycling as secondary goods or parts are comprehensively recognized as performances of recycling in Korea.

Between Japan and Taiwan, it is quite difficult to conclude which standard is stricter than the other when it comes to the management of qualitative recycling. Special attention should be given when discussing the target rate of recycling in connection with the quality of recycling in East Asia. Furthermore, it has also been confirmed that the difference in target rates of recycling in East Asia come from differences in their definitions of recycling and their attitude toward international reuse and recycling.

Table 6 The Target Rate of Recycling in East Asia

<table>
<tr><th colspan="2" rowspan="2"></th><th colspan="3">Japan</th><th colspan="2">Korea</th><th colspan="2">Taiwan</th></tr>
<tr><th>Before April. 2009</th><th colspan="2">After April. 2009</th><th>Before 2006</th><th>After 2006</th><th>Before Feb.2007</th><th>After Feb.2007</th></tr>
<tr><td rowspan="2">TV sets</td><td>Braun tube</td><td>55%</td><td colspan="2">55%</td><td>55%</td><td>65%</td><td>60%</td><td>70%</td></tr>
<tr><td>Liquid crystal/ Plasma</td><td>–</td><td colspan="2">50%</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Refrigerators</td><td>50%</td><td colspan="2">60%</td><td>60%</td><td>70%</td><td>80%</td><td>70%</td></tr>
<tr><td colspan="2">Air conditioners</td><td>60%</td><td colspan="2">70%</td><td>70%</td><td>80%</td><td>80%</td><td>70%</td></tr>
<tr><td colspan="2">Washing machines</td><td>50%</td><td colspan="2">65%</td><td>70%</td><td>80%</td><td>60%</td><td>70%</td></tr>
<tr><td rowspan="4">Computers</td><td>Note book</td><td>20%</td><td rowspan="4">Voluntary (Since 2003)</td><td rowspan="2">55%</td><td rowspan="2">65%</td><td rowspan="5">N/S</td><td rowspan="3">70%</td></tr>
<tr><td>Desk top</td><td>50%</td></tr>
<tr><td>Liquid crystal</td><td>55%</td><td></td><td></td></tr>
<tr><td>Braun tube</td><td>55%</td><td></td><td></td></tr>
<tr><td colspan="2">Audio equipments</td><td rowspan="5" colspan="3">N/S</td><td>60%</td><td>70%</td><td>70%</td></tr>
<tr><td colspan="2">Mobile phones</td><td>60%</td><td>70%</td><td rowspan="3">N/S</td></tr>
<tr><td colspan="2">Copy machines</td><td rowspan="3">65% (Before 2008)</td><td rowspan="3">75% (After 2008)</td></tr>
<tr><td colspan="2">Printers</td></tr>
<tr><td colspan="2">Fax machines</td></tr>
<tr><td colspan="2">Electric fans</td><td colspan="3">N/S</td><td>70%</td></tr>
</table>

Note: N/S signifies no stipulation

Differences between the three systems' recognition of domestic and international reuse and recycling are illustrated in Table 7. They are identical in that domestic reuse of e-waste as a secondary good is not recognized as recycling. While reuse of e-waste for parts is regarded as recycling in Japan and Korea, it is not recognized as such in Taiwan.

As for the relationship between reuse and recycling recognition, Taiwan takes the most rigid stance on the issue of reuse. Regarding the management of hazardous waste, it can be pointed out that Korea's insufficient treatment of CFCs is a challenging policy issue that Korea should tackle.

Table 7 The International Reuse/ Recycling and Recognition as Recycling in East Asia

		Japan	Korea		Taiwan
Covered Items		4	9	1 (PCs)	7
(Domestic) Reuse	Secondary good	Not included	Not included	Not included	Not included
	Parts	Included	Included	Included	Not included
Export	Secondary good	Not included	Not included	Included	Not included
	Parts	Unclear	Unclear	Unclear	Not included
Management of hazardous substance	CFCs as a Refrigerant	Regulated (CFCs in air conditioners, refrigerators and freezers should be collected and crushed.	Regulated (CFCs in air conditioners, and refrigerators should be collected) However, no stipulation after collection		Regulated (CFCs in air conditioners and refrigerators should be collected and crushed)
	CFCs in a Insulator	Regulated (CFCs in refrigerators and freezers should be collected and crushed)	Unregulated		Unregulated

Source: Compiled by the authors

4. Conclusion

This paper presents the current legal situation on e-waste recycling and the actual recycling indicators applied in Japan, Korea, and Taiwan. The following are implications elucidated by the authors' analysis.

Japan, Korea, and Taiwan began to conduct EPR-based policies around 2000 to establish more efficient e-waste systems. A few parameters for evaluating e-waste recycling performance were also introduced; however many component parts of these parameters differed remarkably.

As a quantitative recycling indicator, Japan and Taiwan focus on the recycling target, whereas Korea is centered on the collection target. Unlike in Japan and Korea, registered recyclers are designated in Taiwan as the main actor for attaining the target.

With regards to qualitative recycling indicators, all three systems have their own recycling indicator; however, the details of their calculation methods are significantly different. In particular, they take individualized approaches to the issues of reuse, export and hazardous waste, which are shaped in accord with existing historical policy backgrounds.

Specifically, domestic reuse of e-waste as second hand goods is not counted as recycling performance in any of three systems. They differ in that the reuse of e-waste as parts is counted as recycling performance in Japan and Korea. However, it is not regarded as such in Taiwan. As for used computers which are the most actively reused at the global level, export of used computers for reuse is exceptionally evident in Korea. As for the proper treatment of CFCs, Japan takes the strictest position toward collection and destruction. However, CFCs in the insulator are not mandated for in Korea and Taiwan.

It is hard to judge which of these three systems is superior to the others. However, what should be clarified first when it comes to the design and revision of e-waste recycling indicators is that the definite relationship with recognition issue as recycling and the global reuse and recycling aspects should be established. This is the first step to realizing a more sustainable e-waste recycling system.

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