

## **Mitigating Hazards by Better Designing a Recycling Program: Lessons Learned from South Korea**

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*As an effort of mitigating hazards, pro-environmental programs have been vigorously activated with regard to solid waste recycling. It is beneficial for both the environment and resource saving, but implementation and enforcement are hard to achieve voluntarily. The South Korean Government first implemented the Deposit Refund System (DRS) and later the Extended Producer Responsibility Program (EPR) to reduce waste and encourage recycling in South Korea. Under the DRS, producers would pay for recycling the wastes of the products. The government then repealed the DRS and implemented the EPR program. Under this program, the producers recycle as much as the Ministry of Environment determines or pay a penalty for an excessive amount of the waste. In the broader perspective of disaster management, such policy programs can mitigate environmental hazards. This paper compares those two programs that facilitated the level of recycling, focusing on how such programs regulate producers and how they were operated from the perspective of implementation and enforcement.*

Keywords: hazard mitigation, pro-environmental program, solid waste recycling

### **Introduction**

Environmental degradation can be linked to various types of disaster (ISDR, 2004; Shaw, 2006). Unsustainable use of resources can intensify the frequency of hazards such as floods and droughts and may have negative effects on the natural environment and human life (Lee and Rambo, 1996). For instance, deforestation can lead to irregular precipitation, soil erosion, deterioration of water quality, and reduction of agricultural products. Such negative environmental consequences heighten the vulnerability of populations reliant upon agricultural products and worsen poverty (Blaikie et al., 2004). In addition, by-products of resource use can be sources of hazards, and inadequate treatment of wastes may intensify the risk of natural disasters (Tran & Shaw, 2007). Inadvertent disposal of wastes has high potential to pollute the environment and threaten surrounding communities. If the wastes contain toxic materials, inadequate disposal of

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the wastes may contaminate the environment and may have an adverse impact on human health (Needhidasan, Samuel, & Chidambaram, 2014).

Environmental protection is an important element in disaster reduction actions (Renaud, 2006; Milleti, 1999). The importance of government intervention for environmental protection has been stressed for reducing the frequency and magnitude of the potential disasters (McEntire, 2011). As an effort of mitigating hazards, pro-environmental programs have been vigorously activated regarding to solid waste recycling. Recycling programs are recognized as one of the important means to reduce environmental hazards (Castell, Clift, & Francae, 2004). Resource conservation and waste treatment – the two main goals of recycling – are critical for mitigating environmental degradation and the risk of disasters. Recycling programs may reduce the adverse impacts of exploitation of natural environments like the negative consequence of deforestation. In addition, recycling programs may mitigate environmental hazards that are generated from an inadequate disposal of wastes. Considering that many non-recycled wastes are disposed of through landfill or incineration, recycling reduces the risk of pollution from the waste disposal that may damage human health and environment (U.S. EPA, 2012). Recycling helps reduce the use of fossil fuels to burn non-recycled waste material, decrease the release of toxins from incineration, and eliminate of the need for additional landfills. Thus, when examined from the perspective of disaster management, recycling programs can be a critical means to mitigate environmental hazards.

Recycling programs are beneficial for both the environment and resource saving, but implementation and enforcement are hard to achieve voluntarily. In order to efficiently manage recycling, governments induce manufacturers to participate in recycling programs. Businesses do not voluntarily undertake environmental protection initiatives due to externality cost (Lee, 2001); therefore, governments design such waste recycling programs to mitigate hazards and conserve resources.

In 1993, the Ministry of Environment (ME) in South Korea launched the Deposit Refund Systems (DRS) to encourage recycling. However, in 2003, the government repealed the DRS and implemented the Extended Producer Responsibility (EPR) program. Both recycling programs required manufacturers to take responsibility for recycling and to improve their recycling performance, but the DRS had some problems in actual operation.

Studies of the DRS program indicate that the program had several problems in terms of economic incentives and manageability. First, the program did not motivate the producers to improve their recycling performance. Second, the government could not adjust the deposit rate to effectively manage recycling (Choi, 1992; Kim, 1993; Nam 1994; Jung 1995; Yu 1997; Park 1999; Yang 2003). Studies of the EPR program indicate that the EPR program is more pro-environmental and effective than the DRS (Seol 1999; Oh 2002; Park 2003; Nam 2004). Further, some studies provide suggestions to make the EPR operate more effectively (Yun 2003; Jung 2003; Kim 2004; Seo 2005; Hong 2006).

Although both programs force manufacturers to recycle manufactured products and to improve their recycling efforts, the range of items in the EPR regulation is broader than that of the DRS along with the difference of systematic operation (See Table A1). This paper compares how those two programs facilitated the level of recycling, focusing on how these programs regulate producers with and how they operated from the perspective of implementation and enforcement.

**Table A1: The items under EPR (Environmental White Paper)**

Existing Items Under DRS	Package	Paper package, Metal Container, Glass bottle, PET
	Product	Electrical and Electronics Product(4kinds), Tire(3kinds), Lubricant, Battery(2kinds), Fluorescent Light
New Items Under EPR	Package	Cellular Phone, Audio, Computer/ Printer, Copy machine, Fax machine, Fluorescent light (2004, reintroduction)
	Product	Plastic Package(Foods, Medicine, Drink, Detergent, Cosmet- ics, etc), Expanded Polystyrene(EPS)

### **Theoretical Background**

Waste is any scrap material, effluent, or other unwanted surplus and includes any substances which have been broken, worn out, contaminated, or otherwise spoiled (UK’s Environmental Protection Act 1990). Regarding the necessity of waste recycling program, D’Amico and Juback (1990) stressed that “we aren’t yet in a waste crisis, but one is clearly on horizon”. Waste management is collecting, transporting, processing, recycling, or disposing of waste. Governments frequently use product charges, user charges, and subsidies as policy instruments for waste management. In addition to these instruments, programs, such as the Deposit Refund System and the Extended Responsibility Systems, are applied to waste management. This paper focuses on the two applied recycling programs that the South Korean government adopted to promoting waste reduction and resource conservation.

#### *The Concept of the Deposit Refund Systems (DRS)*

Basically, the concept of the DRS derived from an effort to increase reusing, recycling, and safely disposing of waste with a product charge (the deposit) and a subsidy for recycling or properly disposing waste (the refund). This approach requires that consumers or producers to pay a fee for items, which would otherwise be dumped (Calcott & Walls, 2005). The combination of recycling subsidies and output taxes is often called a deposit-refund, and it encourages producers and consumers to recycle more and deter illegal dumping (Dinan, 1993; Sigman, 1995; Fullerton & Kinmanan, 1995; Palmer & Walls, 1997; Calcott & Walls, 2005). Grounded on the idea of the “polluter pays principle”, Arthur C. Pigou contends taxation of polluters so that the polluters internalize the negative externality associated with the activity. However, it is difficult to impose a direct tax on polluters; thus, the DRS was devised. The DRS imposes a tax on the economic actors based on purchase or production and then is refunded on products recycled. Consequently, the amount of tax levied is equivalent to the quantity of product not recycled. Also, the system can be implemented with or without government involvement (Georgakellos, 2007).

Deposit Refund Systems operate in either both the following ways. First, consumer prices of items include a tax for targeted polluting items that is refunded when the items are returned.

**Table A2: The criteria for the deposit and refund rate (The Environment White Paper)**

Item	Kind & Volume	Rate of the deposit per a unit(2001)
Eating& drinking medicine, butane	<b>Paper package</b>	
	Under 250 ml	0.8 won
	Over 250 ml	1.5 won
	<b>Metal Container</b>	
	Combined with cap	2.5 won
	Separated from cap	7 won
	Butane gas container	7 won
	Cosmetic container (metal bowl with spray)	8 won
	Cosmetic container(other metal container)	5 won
	Pesticide container(under 500 ml)	7 won
	Pesticide container (over 500 ml)	16 won
	<b>Glass bottle</b>	
	under 100 ml(medicine)	3 won
under 350 ml	4 won	
Over 350 ml	9 won	
<b>PET</b>		
Under 500 ml	5 won	
over 500 ml~ under 1500 ml	7 won	
over 1500 ml	9 won	
<b>Battery</b>	Mercury battery	120won
	Silver oxide cell	75won
<b>Tire</b>	Large size	450 won
	Medium·small size	130 won
	two wheeled size	50won
<b>Lubricant(ℓ)</b>	Lubricant	25 won
<b>Electrical &amp; Electronics</b> (kg)	Television	100 won
	Washing machine	100 won
	Air conditioner	100 won
	Refrigerator	140 won
<b>Fluorescent light</b> (unit)	Fluorescent light	88 won

Second, manufacturers pay an environmental tax for the whole product and the tax is refunded based on their recycling records. This paper discusses the DRS that was adopted in South Korea.

### *DRS in South Korea*

A statute, the Promotion of Resources, Saving, and Reutilization (PRSR), introduced DRS to South Korea. This program aimed to improve recycling performance. In this program, manufacturers were taxed for manufactured products, which are potential wastes. Manufacturers reported prior-year production records at the end of each February. Based on these records, the local government determined how much money manufacturers must primarily pay. The government multiplied the material that the manufacturer produced during the prior year by the deposit rate per unit (See TableA2). The manufacturers paid the deposit to the government. The manufacturers complied with regulations by recycling, consigning the work to recyclers, or by joining a producer responsibility organization (PRO). PROs are intermediary organizations that perform recycling on behalf of producers under the DRS and the ERS, and this type of organization manages records of the recycling performance of the producers, who pay for these services. Manufacturers requested refunds from the government based on how much they recycled. The government made refunds their deposits based on their documentation.

### *The Concept of Extended Producer Responsibility (EPR)*

EPRs extend the producers' responsibility through the product's life cycle, including take-back, recovery, and disposal (Tojo, 2001). It is defined as "a policy principle to promote total life cycle environmental improvements of product systems by extending the responsibilities of the manufacturer of products to various parts of the entire life cycle of products, and especially to the take-back, recycling and final disposal of products" (Lindhqvist, 2000). The motivation for ERPs as legislative policy was to address problems with products dumped in the environment (Spicer & Johnson, 2004). EPR programs assign different responsibilities to producers (Lindhqvist, 2000). The first is liability. Liability holds producers accountable for the environmental damage their products cause. The second is economic responsibility. Economic responsibility holds manufacturers accountable for all or part of the cost of collection, recycling, and final disposal. The third is physical responsibility. Physical responsibility characterizes how manufacturers manage their products. The fourth is ownership. Ownership requires manufacturers to retain the ownership of their products and environmental problems caused by their products. The fifth is informative responsibility. Informative responsibility requires manufacturers to supply information on the environmental impacts of their products.

EPRs have three institutional forms. First, producers can voluntarily dispose of waste. Second, producers can negotiate contracts with governments to decrease the emission of toxins, dispose of waste, and improve product design. Third, governments can impose requirements on manufacturers (Lindhqvist, 2000). The EPR adopted in South Korea imposed requirements on manufacturers.

### *EPR in Korea*

South Korea adopted an EPR program after terminating the DRS in 2003. Under the EPR, the Ministry of the Environment (ME) imposed mandatory recycling goals and minimum recycling

amounts. The Ministry of the Environment regulates 4 groups of packages and 5 groups of manufactured goods. In this system, manufacturers usually organize PROs to fulfill their obligations. The ME designates principal manufacturers to regulate. It regulates manufacturers with more than 1 million dollars in sales or more than 0.3 million dollars in imports. The ME then sets the goals for these manufacturers.

The EPR process is as follows. First, manufacturers submit their production records to the South Korean Environment & Resources Corporation (ENVICO). The ME then notifies the manufacturers of the mandatory recycling rate (%) (KECO 2008). (See Figure A1.)

*Mandatory recycling rate (%) = (prior year's mandatory recycling rate × weight 1)+(the mandatory recycling rate from the year before last × weight2)+(the mandatory recycling rate from three years prior × weight3)+(coordination coefficient) (See Table A3.)*

The coefficient adjusts the recycling rate and ranges from 0 to 0.05. The ME determines the coefficient considering factors that affect recycling compliance (e.g., expected quantity of recyclable

**Table A3: Yearly weight (Act relating to PRSR)**

	Weight1	Weight2	Weight3
Second year	1	0	0
Third year	0.6	0.4	0
After fourth year	0.5	0.3	0.2

**Table A4: The surcharge according to the unperformed recycling obligation (ENVICO)**

unperformed recycling obligation rate	Under 5%	Over 5% and Under 15%	Over 5% and Under 30%	Over 30%
Surcharge	Recycling expense per unit× unperformed mandatory recycling amount×15/100	Recycling expense per unit× unperformed mandatory recycling amount ×20/100	Recycling expense per unit× unperformed mandatory recycling amount ×25/100	Recycling expense per unit× unperformed mandatory recycling amount ×30/100

**Figure A1. The EPR Procedure(ENVICO)**

Sanctions	Due date
Submit the delivery record of products and packages of the previous year (Producer->ENVICO) ↓ Announce the total amount of the mandatory recycling by item (Minister of Environment) ↓ Submit the implementation plan (& approve the plan) (PROs, Producers <->ENVICO)	Mar. 31     Dec. 31     Jan. 30 (within 30 days)
Perform the recycling obligation	for the implementa- tion year
Submit the implementation report (PROs, Producers -> ENVICO)  Investigate the performance of the obligation (ENVICO->Recyclers)  Notify of the payment of recycling due (ENVICO->PROs, Producers)  Payment of the recycling due (PRO, Producer->Environment-related special account- ing)	Mar. 31 of the next year      June. 15 of the next year    July. 05 of the next year

items, exported or imported quantity of recyclable products, durability of products, and development of recycling technology, etc.),

**Table A1.** *The items under EPR(Environmental White Paper)*

Existing Items Under DRS	Package	Paper package, Metal Container, Glass bottle, PET
	Product	Electrical and Electronics Product(4kinds), Tire(3kinds), Lubricant, Battery(2kinds), Fluorescent Light
New Items Under EPR	Package	Cellular Phone, Audio, Computer/ Printer, Copy machine, Fax machine, Fluorescent light (2004, reintroduction)
	Product	Plastic Package(Foods, Medicine, Drink, Detergent, Cosmetics, etc), Expanded Polystyrene(EPS)

The manufacturers or PROs then calculate their mandatory recycling amount.

*Mandatory recycling amount = their delivery record of the previous year × mandatory recycling rate.*

They submit their implementation plan and other documents to ENVICO. ENVICO approves manufacturer’s plans within 30 days if the documentation is sufficient. If the documentation is insufficient, manufacturers must submit additional documentation. After fulfilling their recycling obligations, manufacturers then deliver their implementation report to prove the legality of their methods. ENVICO investigates their implementation and announces audit results. ENVICO then notifies the manufacturers or PROs what they must pay.

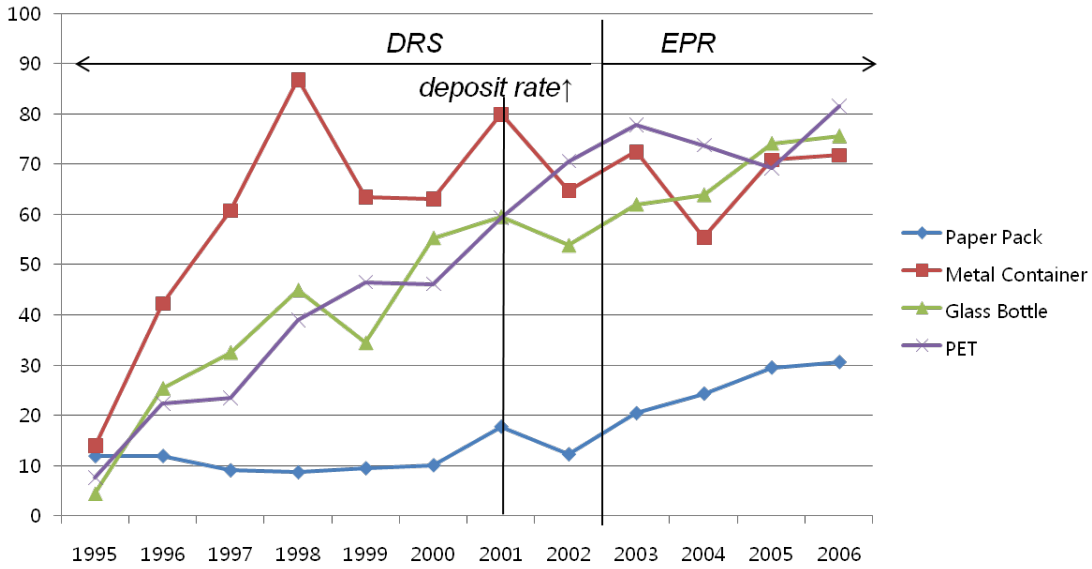
*Recycling due = the unfulfilled mandatory recycling amount × the standard recycling cost × recycling calculation index + surcharge in proportion to the unperformed recycling obligation (See Table A4.)*

### *Recycling Performance*

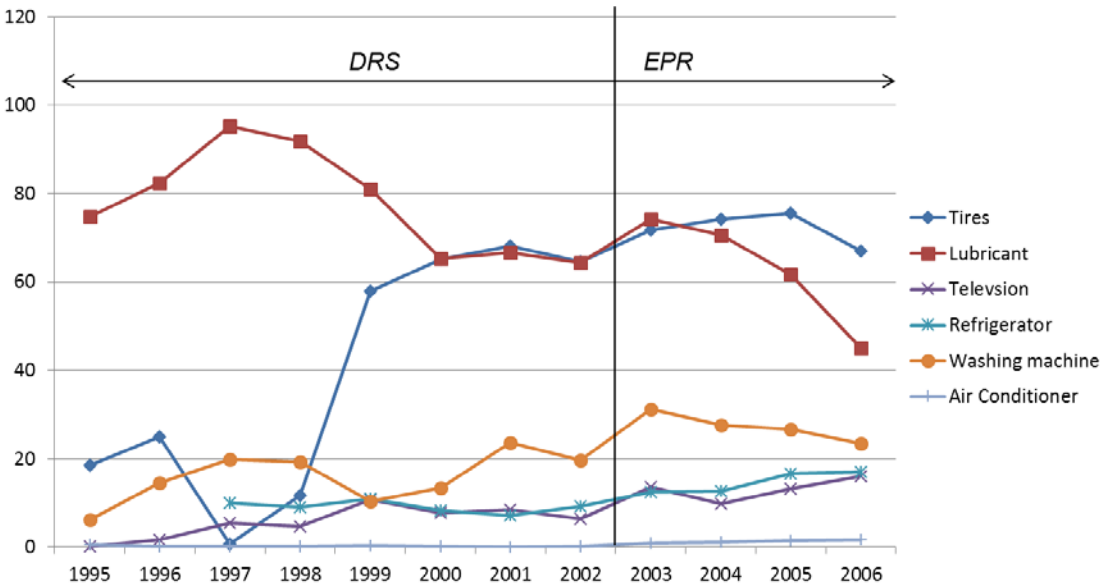
The following compares the efficiency and success of the DRS and EPR programs by examining recycling rates. To compare the performance of the two programs, we converted the compliance units of the DRS to kilograms. The following table shows how the recycling rate (%) has changed for each item. As Figure A4 and A5 show, the recycling rate (%) for most package items has risen since 2003 when the government adopted the EPR. The recycling rate of paper packaging exceeded the increase of other recycling rates. However, the recycling rate for silver oxide batteries has significantly fallen. A large quantity of imported silver oxide batteries contributed to the higher recycling rate under DRS than under EPR because the increased imports allowed the manufacturers or their agents to easily collect the recyclable items (Korea Battery Recycling Association, personal communication, October 31, 2007).



**Figure A4: Recycling Rate of Packages**



**Figure A5: Recycling Rate of Product**



**Table A5: Financial disadvantage to not fulfilling one unit of compliance (unit: won/kg)**

Item	Package & Product (average weight)	DRS	EPR	Difference
Paper Pack- age	under 200 ml(11g)	77.8	233.4~263.8	155.6 ~ 187.4
	over 200 ml(21g)	76.4		
Glass Bottle	under 100 ml (118g)	27.2	42.9~48.5	15.7 ~ 39.0
	under300 ml(447g)	9.5		
	over 350 ml(566g)	17.0		
PET	under 500 ml(28g)	191.1	220.9~253.8	0.5 ~ 78.7
	under1,500 ml(34g)	220.4		
	over 1,500 ml (55g)	175.1		
Metal Container	Unified Cap(15.3g)	174.9	110.2~124.1	-64.7 ~ -50.8
	Separated Cap(44.8g)	167.3	220.8~248.1	53.5 ~ 80.8
Battery	Silver oxide bat- tery(0.45g)	166.5	44.8~50.6	-121.7 ~ -115.9
Tires	Large size	6.8	37.8~42.8	31.0~37.0
	Medium & Small size	5.8		
Lubricant		26.8	25.2~28.5	-1.6 ~ 1.7
Electrical and Elec- tronics Product	Television	80.3	208.1~235.3	127.8 ~ 155.0
	Washing machine	107.0	153.9~174.0	46.9 ~ 67.0
	Air conditioner	107.0	112.3~127.0	5.3 ~ 20.0
	Refrigerator	149.8	165.2~186.8	15.4 ~ 21.6

## **The Evaluation Criteria for the Both Tools**

We evaluate the two programs and compare the economic incentives (or enforcement) to the producers and the manageability of the programs. These are the most important components of the two recycling programs (Choi, 2004; Field, 2006; Kun, 1999; Lee, 1997; Lee, 2001; Salamon, 2002; Kim, 2004; Kim, 2004; Kim, 2007). The economic incentives (or enforcement) include the penalty, the flexibility in fulfilling the obligation, the incentive to improve recycling records beyond the requirements, and the financial burden on producers. Manufacturers improve their recycling performance if the penalty for non-compliance is greater. Manufacturers are more motivated to comply if they have options to fulfill their obligations. Manufacturers improve their recycling records if they get more incentives. Manufacturers are more willing to obey and fulfill an obligation if they bear fewer compliance costs.

To improve recycling performance, the government must implement means to effectively manage and enforce regulations. To measure effectiveness, we examine predictability of the recycling amounts, possibility of ensuring recycling responsibility, and manageability. The government can enforce regulations more effectively when it clearly specifies the unit of performance and it limits the number of manufacturers.

## **The Comparative Evaluation of the Two Recycling Instruments**

### *Economic Penalty*

Both programs impose financial responsibility on manufacturers to motivate them to improve their recycling performance. The DRS encouraged manufacturers to increase the amount they recycle by returning their deposit based on their recycling records. The DRS also imposed a penalty for noncompliance. It did not refund the deposit to manufacturers who produced waste materials without recycling it. The other program, the EPR, imposes recycling penalties, which are greater than the recycling costs, to motivate manufacturers. Table A5 shows a comparison of the penalty that the programs imposed for one unit of non-compliance. (See Table A5). The EPR imposes a greater penalty for most items. However, the penalty for silver oxide batteries and capped metal under EPR is less than under the DRS.

### *Flexibility for Fulfilling the Obligations*

The manufacturers could choose how to fulfill their obligations under both programs and had the same number of options. Manufacturers could recycle, contract recyclers, or pay in order to join a PRO. However, PROs have increased since the adoption of the EPR. Manufacturers have had a greater incentive to organize or join a PRO, which uses national recycling systems, because the EPR assigns mandatory recycling amounts to manufacturers. Manufacturers in PROs save money because they do not have to establish their own recycling systems.

### *Incentive to Improve Recycling Performance beyond the Recycling Requirements*

The EPR does not provide incentives to make manufacturers improve their recycling performance over the mandatory recycling requirement. The EPR only encourages them to meet the minimum recycling amounts because any additional recycling amount they save expires after two years. However, the program imposes recycling dues to make producers fulfill recycling objectives. On the other hand, the DRS imposed a certain rate that was closer to the actual cost of recycling and returned deposits at a higher rate, as the following table shows. The values include the proportion of the deposit to the recycling cost and the return rate. Especially in case of silver oxide batteries, the producers had a stronger incentive to recycle more than the required amount under the DRS. (See Table A6). The DRS offered additional monetary advantages where the EPR does not.

**Table A6: Correlation between the Proportion to Actualization of Deposit Rate and the Return rate**

<i>Year</i>	<i>1996</i>	<i>1997</i>	<i>2001</i>	<i>total</i>
<i>(number)</i>	<i>(n=18)</i>	<i>(n=15)</i>	<i>(n=16)</i>	<i>(n=49)</i>
Coefficient of correlation	0.650	0.597	0.577	0.701

### *Financial burdens on producers*

Manufacturers prefer a recycling policy that imposes fewer costs, even if the penalties for non-compliance are more severe. In order to compare the costs with manufacturers under both programs, we calculated the costs under the DRS using the deposit and the costs under the EPR using the mandatory recycling amount. To compare the costs, this paper uses the total deposit amount of each item in 2001 under the DRS and the recycling cost for the mandatory recycling amount under the EPR. (See Table A7)

The financial burden declined under the EPR with the exception of three items (glass bottles, metal, and tires). Manufacturers do not have to pay the total recycling cost to fulfill their obligations under the EPR. They did under the DRS. However, under EPR the tire manufacturers pay twice more than they did under the DRS because the EPR uses weight (kg) instead of units.

### *Uncertainty at the Regulatory Level*

The South Korean government can manage a program more easily when it has precise measures and expectations. Under the DPR, the ME set the deposit rate and required producers to measure how much they recycled. It did not attempt to estimate how much manufacturers would recycle. Manufacturers might recycle different amounts even if the agency assigned the same deposit rate. However, the ME can predict how much manufacturers will recycle under the EPR because the EPR provides mandatory recycling amounts to manufacturers. The EPR calculates a mandatory recycling amount with a formula that includes the previous year's obligations. The ME can also impose monetary penalties if the manufacturers do not fulfill their obligations.

**Table A7: Comparison of financial burden on producers (unit: thousand won)**

Item	DRS	EPR	Difference	Increase Rate
Paper Package	5,038,345	2,727,420	-2,310,925	-45.87%
Glass bottle	9,532,683	9,662,848	130,165	1.37%
PET	15,779,979	12,156,065	-3,623,914	-22.97%
Metal Container	13,559,686	14,894,993	1,335,307	9.85%
Lubricant	4,799,334	2,670,826	-2,128,508	-44.35%
Tires	2,696,806	5,250,342	2,553,536	94.69%
Silver oxide battery	384,026	69,422	-314,604	-81.92%
Television	3,990,795	1,331	-3,989,464	-99.97%
Refrigerator	19,151,065	2,379,870	-16,771,195	-87.57%
Washing machine	4,373,920	1,589,750	-2,784,170	-63.65%
Air conditioner	6,248,007	50,791	-6,197,216	-99.19%

### *Ensuring the Responsibility of the Manufacturers*

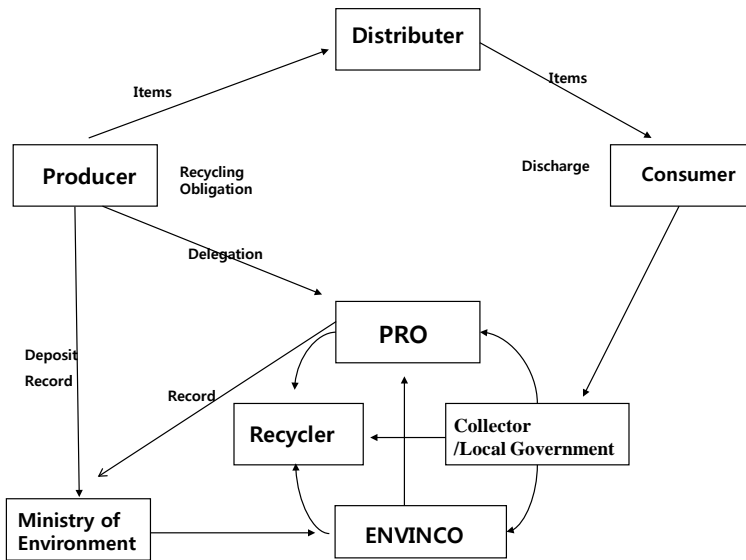
The South Korean government can more easily and efficiently manage recycling programs when they can ensure that manufacturers are meeting their obligations. Under the DRS in South Korea, the ME allowed manufacturers to determine how much they would recycle. It could not determine if the manufacturers had complied with its goals. It also could not ensure manufacturers would improve their recycling performance by raising their deposits. It could not distinguish between high recycling performers and low recycling performers. If it increased the deposit, all producers recycled more, not just those with low recycling performance. (See Table A6)

However, under the EPR, the ME can set the recycling rate and ensure manufacturers meets their obligations. It can set mandatory recycling amounts and identify manufacturers that fulfill their obligations. When manufacturers do not fulfill their obligations, the ME can impose non-compliance fees. The ME can more easily hold manufacturers accountable under the EPR.

*Manageability in the Relationships with Other Institutions*

The South government can more easily achieve its policy goal if it can adjust the regulatory level. Under the DRS, the ME could raise or lower deposit rates in order to adjust the regulatory level. This work required a complex political process and legislative action. The government failed to raise deposit rates to levels the ME originally proposed because other ministries intervened for manufacturers.

**Figure A2. The System of the DRS**



The EPR uses a formula to calculate recycling rates. The ME can increase mandatory recycling levels or adjust rates after it consults with other ministries. The ME can also use its discretion to adjust regulatory levels in different situations, such as during crisis.

ENVINCO has a more important role under the EPR than it did under the DRS because it implements what the ME has planned. ENVINCO only participated in recycling activity under the DRS. In this regard, the systems are not so different, as the Figures A2 and A3 show.

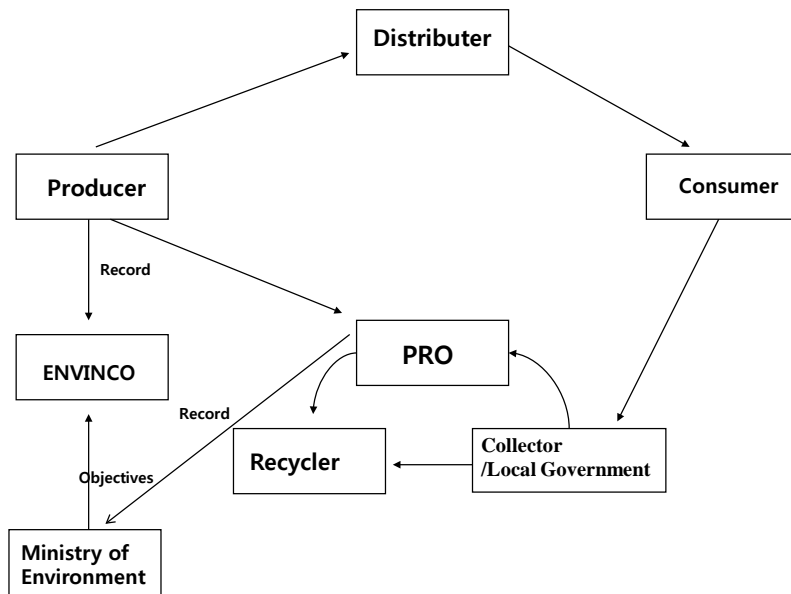
The ME can more easily implement programs if more manufacturers join PROs because the PROs directly monitor manufacturers. The PROs manage production and recycling records and report the records to the ME. The PROs allow the ME to limit direct contact with manufacturers. PROs monitor producers and relieve the ME of this responsibility. The ME can more easily manage recycling through PROs under the EPR.

*Specificity of the Performance Unit*

The South Korean government can enforce its regulations more easily if it uses an identical unit of performance during the whole implementation process and specifies the unit of performance. Under the DRS, the ME charged deposits based on the quantity of products manufacturers expected to sell and refunded deposits based on what producers recycled. Because the recyclable wastes (e.g., packaging) are easily broken and compressed during the waste collection process,

manufacturers or their PROs used weight in measuring the recycled items rather than quantity. When producers or PROs reported to the ME, they converted the unit of recycled items from weight to quantity. In this way, regulators could not precisely monitor the quantity of recycled waste. On the other hand, under the EPR the government imposes recycling targets based on the weight (i.e., kg.) of recyclable items. When manufacturers or PROs report their recycling records, they do not have to convert the unit of recycled items. The regulators can easily identify any gap between mandatory targets and producer performance because an identical unit is used during the whole waste management cycle.

**Figure A3. The System of the EPR**



The South Korean government must accurately monitor how well manufacturers perform to enforce compliance standards. When standards are more concrete, the government can see if manufacturers are meeting their obligations. The DRS indicated how manufacturers should perform to fulfill their obligations. However, the EPR clearly specifies which items to recycle. In the case of lubricants, the standard under the DRS simply indicated that manufacturers or recyclers should recycle waste. Under the EPR, the standard stipulates that the recycled products should be types of oil. The government can more easily determine if manufacturers fulfill their obligations under the EPR.

*Specificity of the Mandatory Manufacturers*

The South Korean government can more easily monitor compliance if it can identify the mandatory manufacturers. The DRS required all manufacturers to meet their obligations. The EPR exempts manufacturers that have less than 1 million dollars in annual sales or less than 0.3 million dollars in annual imports. ENVINCO monitors annual sales and annual imports to identify exempt manufacturers. However, some exempt manufacturers may produce more than exempted

amounts but avoid their obligations by manipulating their annual sales reports. This was not a problem under the DRS.

### *Number of the Regulated Manufacturers*

The South Korean government can more effectively enforce regulations if it monitors fewer manufacturers. The ME must check production records and recycling amounts under the both programs. The following table represents the number of the producers to be monitored by the agency. (See Table A8)

Under the EPR, the government monitors more manufacturers because the EPR includes new items, such as plastic packaging (EPS, PVC) and electrical & electronics products. However, precise measures of how much administrative burdens have increased are not possible.

**Table A8: The number of the manufacturers to be regulated (ENVICO)**

Year	2000	2003	2004	2005	2006
Total number of the producers	1003	4750	6319	7227	7333

## **Conclusion**

### *Summary and Discussion*

This paper compares the DRS (Deposit Refund Systems) and the EPR (Extended Producer Responsibility) in South Korea, evaluates the government management of the programs and examines the incentives for manufacturers. The two programs are compared within sub-components in the table above. The EPR performs better than the DRS on economic incentives because the EPR includes stronger economic penalties, allows for more PROs and costs manufacturers less. However, the DRS provided additional incentives to improve recycling performance beyond minimum requirements.

**Table 1: Summary of the Evaluation**

Evaluation Criteria	DRS vs. EPR
Economic Penalty	EPR is stronger
Flexibility for fulfilling the obligation	EPR, more PROs
Incentive to improve recycling performance additionally	DRS is stronger
Financial burdens on producers	EPR is less
Uncertainty of the regulatory level	EPR is lower
Manageability in relationship with interest groups	EPR is better
Ensuring the responsibility for the producers	EPR is better
Specificity of the performance unit	EPR is more specified
Specificity of the mandatory producers	DRS is more specified
Number of the regulated manufacturers	DRS is less
Manageability through the PROs	EPR is better



The government can also manage the EPR more easily than the DRS. The government can ensure manufacturers meet their recycling obligations due to the setting of mandatory recycling amounts. The EPR also specifies performance units used to monitor compliance. In addition, manufacturers participate in PROs, which help the government manage the program. However, the EPR increases the number of manufacturers the government monitors, and some manufacturers can avoid scrutiny through exemptions and by manipulating records.

Although the DRS has been repealed, the comparison of the two waste recycling program is still meaningful because it offers insights that may be applied to other contexts where such programs are being considered. Each recycling program has strengths and weaknesses in promoting environmental practices of manufacturers; so, the policy context may determine a choice of waste recycling program. . From this perspective, a comparative consideration of the waste recycling program is necessary to enhance the waste reduction as well as the mitigation of environmental hazards.

Regarding disaster management, a waste recycling program contributes to a resilient community as mitigating hazards with pro-environmental effort. In order to deal with disasters, establishing equipment in preparedness, effective response during disaster, quick recovery after disaster are all important; also, in a broader perspective, mitigation should be seriously taken as reducing the potential of hazard. Although recycling resources do not seem to directly connect to an effort on disaster management, it is ultimately related to mitigation of environmental hazards through the waste reduction efforts.. Those pro-environmental programs contribute to mitigation of soil and air pollution from landfill and incineration, and the effectiveness of the programs may differ relying on the contexts. Policy designers also should consider the elements of the environmental programs in perspectives of regulatory agencies as well as regulates to improve the levels of recycling and ultimately mitigate environmental hazards.

### **Suggestion and Limitations**

The EPR provides more incentives to manufacturers than the DRS, but the program has not greatly improved recycling performance. The EPR could provide more comprehensive incentives to encourage manufacturers to recycle more than the minimum. Enforcement could also more scrupulously identify mandatory manufacturers and monitor compliance. This could reduce the administrative burden on the ME through EVINCO.

Although this research compares two waste recycling policy programs, it does not comprehensively prescribe the effectiveness of each. Rather, it subcategorizes components of the materials or items although the evaluation of the program is scrutinized. Also, this paper does not investigate in depth how effectively the EPR monitors each item, focusing on the economic incentives and manageability of the programs. Future research could scrutinize how effectively the EPR monitors each item.

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