DOWA ECO-SYSTEM CO., LTD

The report of investigation on

International Recycling Networks for Mobile Phones in Asian Region

31 July 2007

Term of research	From November 2006 to March 2007
Researcher	E&E Solutions Inc.

Contents;

Introduction

1. Background

- It is required to promote the recycling of e-wastes in many countries, since electric/electronic equipments such as TV and personal computer contain precious metals and other valuable substances, whereas they may release hazardous substances to environment if they are disposed inappropriate manner.
- Under the situation that the risk of improper disposal of e-wastes on human health and environment is increasing along with popularization of electric/electronic equipment in developing countries including East Asian countries, various efforts to promote the recycling of e-waste have been made internationally.
- Especially for mobile phones, recovery and recycle of end-of-life equipment are becoming urgent issue, since mobile phones are spreading rapidly in the world including East Asian countries.

2. Objective

- To establish transboundary movement schemes of end-of-life mobile phones generated in East Asian countries to Kosaka Smelting and Refining Co., Ltd located in Japan and can implement the recycling of e-wastes in Environmentally Sound Manner.
- To establish pilot scheme in FY 2006 through negotiation with relevant authorities in South East Asian countries and conduct the pilot project (research) in FY 2007.
- To investigate the application of the transboudary movement schemes to other e-wastes such as personal computers

3. Structure of the project

- The MOU of this the project was concluded on 1st November, 2006 between Secretariat of Basel Convention, Basel Convention Regional Centre of South East Asia and DOWA ECO-SYSTEM Co., Ltd
- The project is supported by Ministry of Environment in Japan.
- The project is performed in cooperation with PCD in Thailand, DOE in Malaysia and NEA in Singapore as well.
- The project is fully funded by DOWA.
- The research for pilot scheme was conducted by E&E Solutions Inc. from November 2006 to March 2007.

1. Current situations in Selected Countries

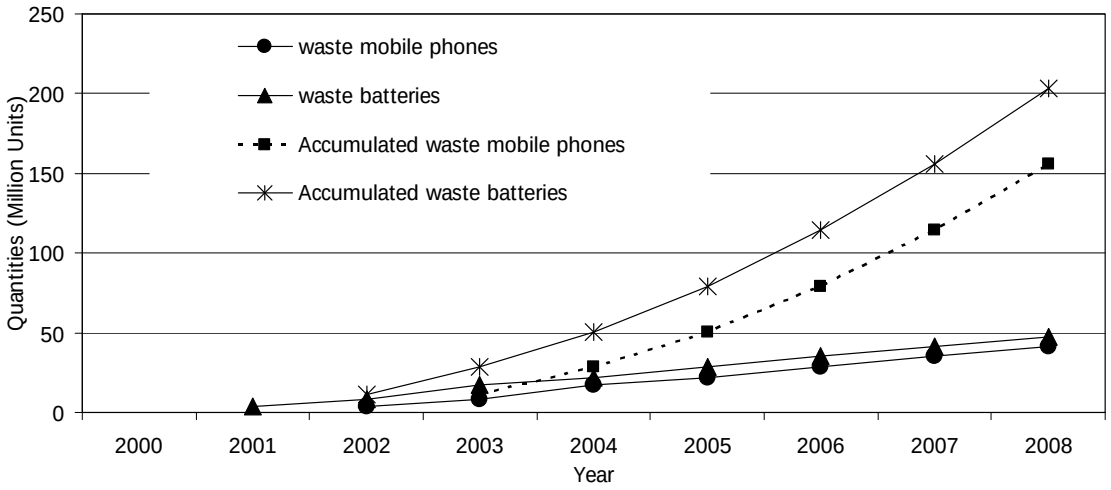
This section describes the current situations of mobile phones in the selected three countries (Thailand, Malaysia, Singapore), based on the published information and the results of interview surveys with relevant organizations in three countries.

1.1 Thailand

(1) Current Situations on Mobile Phone

Although the uses of mobile phone in Thailand can select both Pre-Paid and Post-Paid rate system, users of 80% or more select the Pre-Paid rate system. It is considered that the ease of telephone bill control in the Pre-Paid system is advantageous both for young people and their parents. Companies that produce or assemble mobile phones in Thailand are CP and Mexon (Joint Venture with Korean company). Comparing with Nokia and Motorola, which have been manufacturing in other counties, the production volumes of these two companies are small. Products of Mexon have been exported to outside, and haven't been available in local market.

The diagram below shows the estimate of used mobile and batteries to be generated in near future. As shown in the diagram, it is estimated that the generation of used mobile phone reaches around 50 millions in 2008. In this estimate, the disposal and/or recycling routes of used mobile phone such as reuse as second hand, disposal, and stock in home are not considered.



Source: "Survey on the Discharge of Mobile Telephones in Bangkok" (PCD)

Fig. 1-1 Estimated generation of used mobile telephones &batteries:

It is said that Thailand has the big second hand market of mobile phones, and most of used mobiles phones are sold. For example, there are several hundreds of small-size second hand shops on the 4th floor in shopping center MBK, whose nearest station is National Stadium, in Bangkok. Most shops are taking-in the used phone.

Photo: MBK

According to the results of interview survey, used phone which are not salable in Thailand are exported to neighboring counties such as Laos, Cambodia, Vietnam, Myanmar, and Bangladesh. End-of-Life (EOL) mobile phone, or mobile phones that are not able to be used anymore, are exported to China as the source of spare parts. Although the export of used mobile phone is legal, we have not got the information on the amount or the routes of exports of used phones.

As mentioned previously, in Thailand, used mobile phones have economic values and are distributed in local market and abroad according to market principle. In both domestic and foreign markets, traceability is not secured. In considering the situation that used mobile phones are distributed as valuable good, it can be concluded that some incentives for users are needed to collect the used mobile phones effectively.

(2) Situation on collecting and recycling of used mobile phones

Although the recycling of mobile phone battery has been launched in 2005, recycling of used mobile phone is not implemented. The pilot project on the recycling of used mobile phone battery has been implementing under the MOU among 20 organizations including Pollution Control Department (PCD), manufactures such as NOKIA and MOTOROLA, service providers (e.g. AIS), and recyclers such as UMICORE and GENCO. Termination

date of the project is not specified in the MOU. In this project, PCD, manufactures and service providers support the collection, UMICORE sends the collected batteries to its recycling facility in Belgium, and GENCO is responsible for the disposal of non-recyclable batteries. Fig. 1-2 shows the recycling flow of the used battery, and photos in campaign follow it.

Recycling campaign has been conducted 5 times, once 3 months so far. The amount of collected batteries through these campaigns has reached 47 tons (70 gram/battery). The collected dry cells are not counted in the above figure.

As already mentioned the target of this pilot project is not the used mobile phones but used mobile phone batteries. According to the officers of PCD who joined the pilot project, it is difficult to collect used mobile phone through campaign without incentives for uses, because used mobile phones has commercial value and salable.

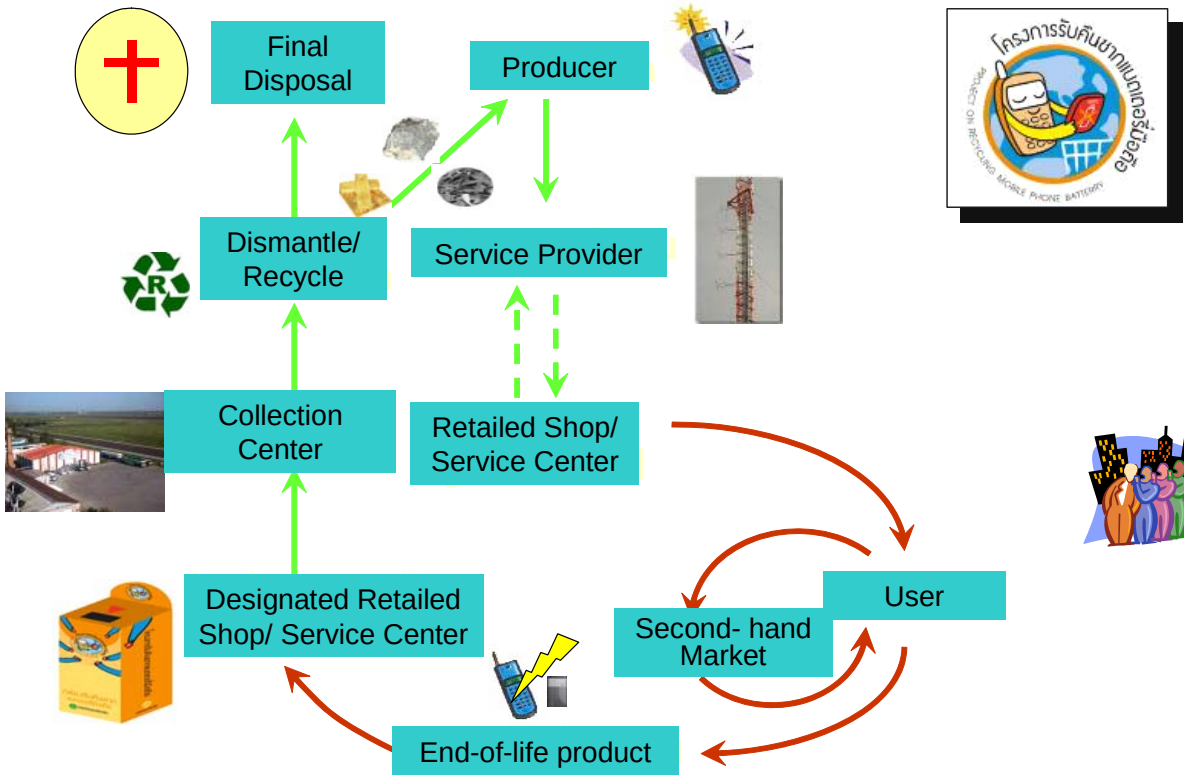


Fig. 1-2 Flow of Pilot Project on Recycling Mobile Phone Battery

(3) MOTOROLA

According to the Motorola Thailand, 5 or 6 collection bins have been set up in its offices since July 2006 to collect used mobiles phones, batteries, Walkie-Talkie and so on. Any incentives to users haven't been provided (For more details of collection Bin, see the attached photos).

These collection bins are installed at places such as the office of Motorola on the 22nd floor of the building where free access are not allowed for security reason.

(4)The flow of mobiles

Based on the result of interview survey, the flow of mobile phones in Thailand can be summarized as shown in the following figure.

The used mobile phones have marketed as second hand items according to market principle. PCD has no intention to be involved with recycling and collecting so far. Meanwhile, PCD has recognized the significant environmental issues after the disposal of used mobile phone batteries, and launched the project of recycling batteries in cooperating with manufactures, service providers, and waste recyclers.

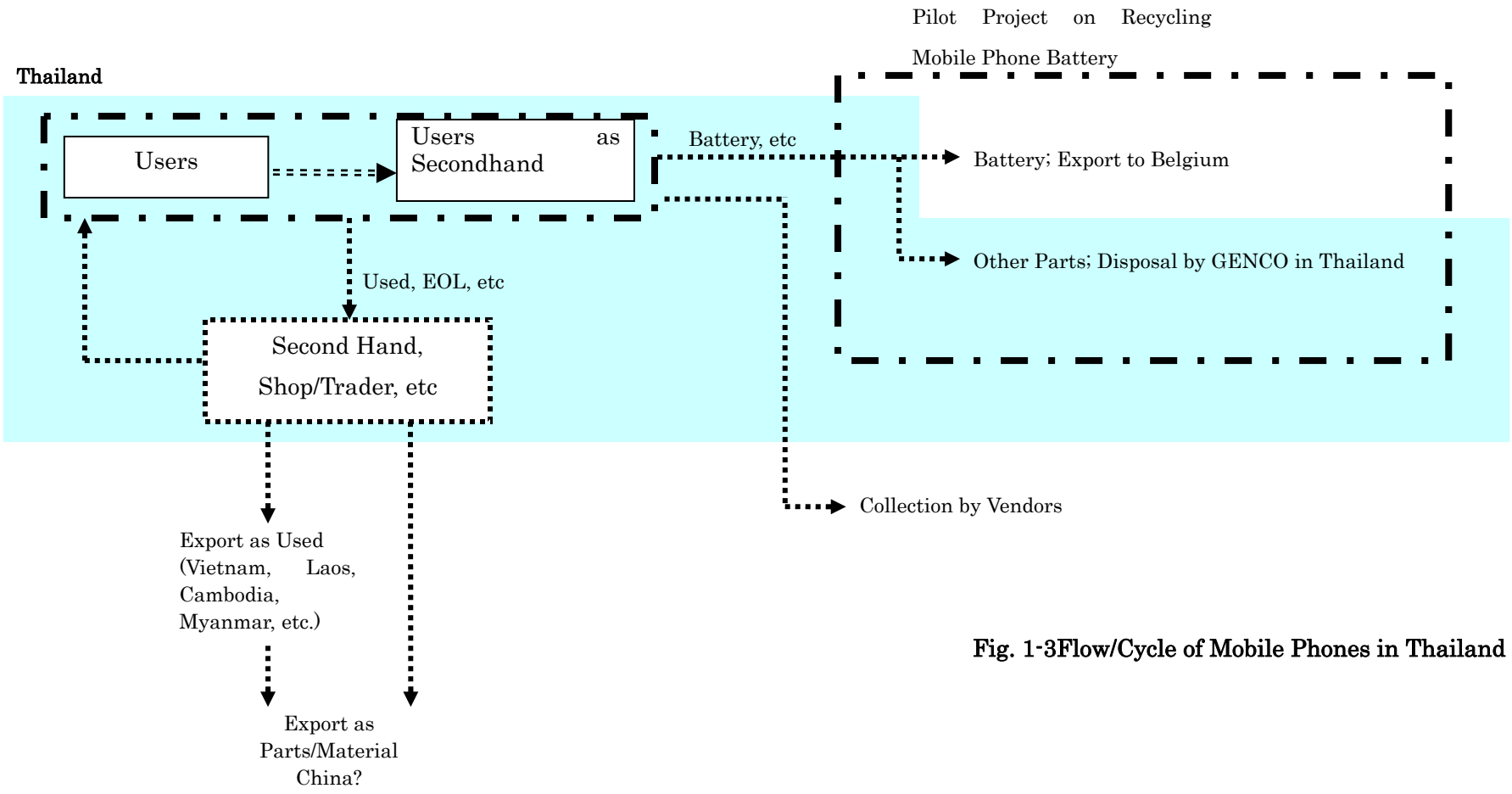


Fig. 1-3Flow/Cycle of Mobile Phones in Thailand

1.2 Malaysia

(1) Current Situation of Mobiles Phones

According to mobile phone manufactures, around 17 million mobile phones have been used in Malaysia. It is said that the diffusion rate is 70% in whole country, and 100% in urban areas. Although some users change into new ones in every 6 months, the frequency of changing mobile phones is once per 12-18 months in average.

(2) Situation of recycling mobile phones

Department of Environment (DOE) has been conducting the recycling of mobile phone batteries since 2002. The aim of this activity is to prevent environmental problems to be caused by the disposed batteries as general waste. It has been conducted in only Putrajaya (newly developed administrative area and DEO is also sited), and the amount of collection bin is around 350.

The amount of collected used batteries is around 400kg per year. They haven't been sorted by type, and have been stocked in the storage of DOE. It is said that dry cells occupy around 50-60% in it. More information about stock status is not available. DOE has been keeping the collected batteries and has been investigating the recyclers that can recycle them in environmentally sound manner.

Although only batteries phones have been collected at the initial stage, currently mobile phones also have been collected (see the attached photos) by modifying the collection bins. DOE recognizes that the awareness of the public on the importance of recycling and the education for the awareness-raising are important to implement the recycling effectively.

(3) NOKIA

Nokia has been collecting used mobile phones and batteries in Malaysia since 2001 by using collection bins installed at its service centers. At present, collection bins are set up at 35 sites. In the past, Nokia entrusted the treatment and disposal of collected batteries, accessories, mobile phones to Citirarya. However, after its bankruptcy, they have commissioned to AER. The recycling of PCB is conducted outside Malaysia.

The amount of collected batteries, accessories and mobile phones is quite few, or around 900kg per year in total. Although there are some mobile phones disposed as general waste, it is said that many users keep used mobile phone in their homes.

In Malaysia, after the expiration of warranty by manufactures, many users purchase quite cheap batteries made by third parties at electric appliance stores. Thus, only a few users change batteries at service centers. In recent years, only lithium-ion battery has been used for mobile phones of Nokia. Nickel-cadmium batteries haven't been used any more.

Nokia is planning to restart the incentive system that was implemented in 2000 and 2001. In this incentive system, 20% discount coupon applicable only to accessories (not applicable to mobile phone) is presented to users who give used mobiles of any makers to service stations of Nokia.

The purpose of the recycling of used mobile phones by Nokia are not only respecting EPR but preventing the degrading of its brand image by the recreating and/or abusing its products by third parties. Nokia had collaborated with service providers when it just started the recycling of used mobile phone. However, service providers don't participated in anymore now, as they have concluded that this activity has no merit for them.

(4) SONY Ericsson

Although irreparable products within warranty period have been sent to Singapore for recycling, after the guidance of DEO to deal them in the country, Sony is investigating the response to the guidance. In case that recycling is made in Malaysia, AER in Penang is the first candidate of local recycler and non-recyclable parts in the country must be treated in abroad.

Although some users understand the importance of recycling of used mobile phones in environmentally sound manner, most of them don't know how they should do. Under the above understanding, Sony is planning to provide more information on the recycling of mobile phones to users through Web and press advertising. The first target of the advertisement would be young people, and next one would be children. The awareness of users is the most important.

Beside the above, Sony has been investigating the corroboration with other manufactures and introduction of incentive systems like providing discount vouchers.

(5) Flow/Cycle of Mobile Phones

The diagram 3.2-1 shows the flow of mobile phones in Malaysia. As in case of Thailand, most used phones are distributed as second hand items. Details of actual flow of used mobile phone is not clear, while Nokia has indicated that many used phones are kept in houses of users. Positive activities to promote the collection of mobile phone have not been conducted yet, while collection of used mobile phone batteries are implemented by DOE in some places.

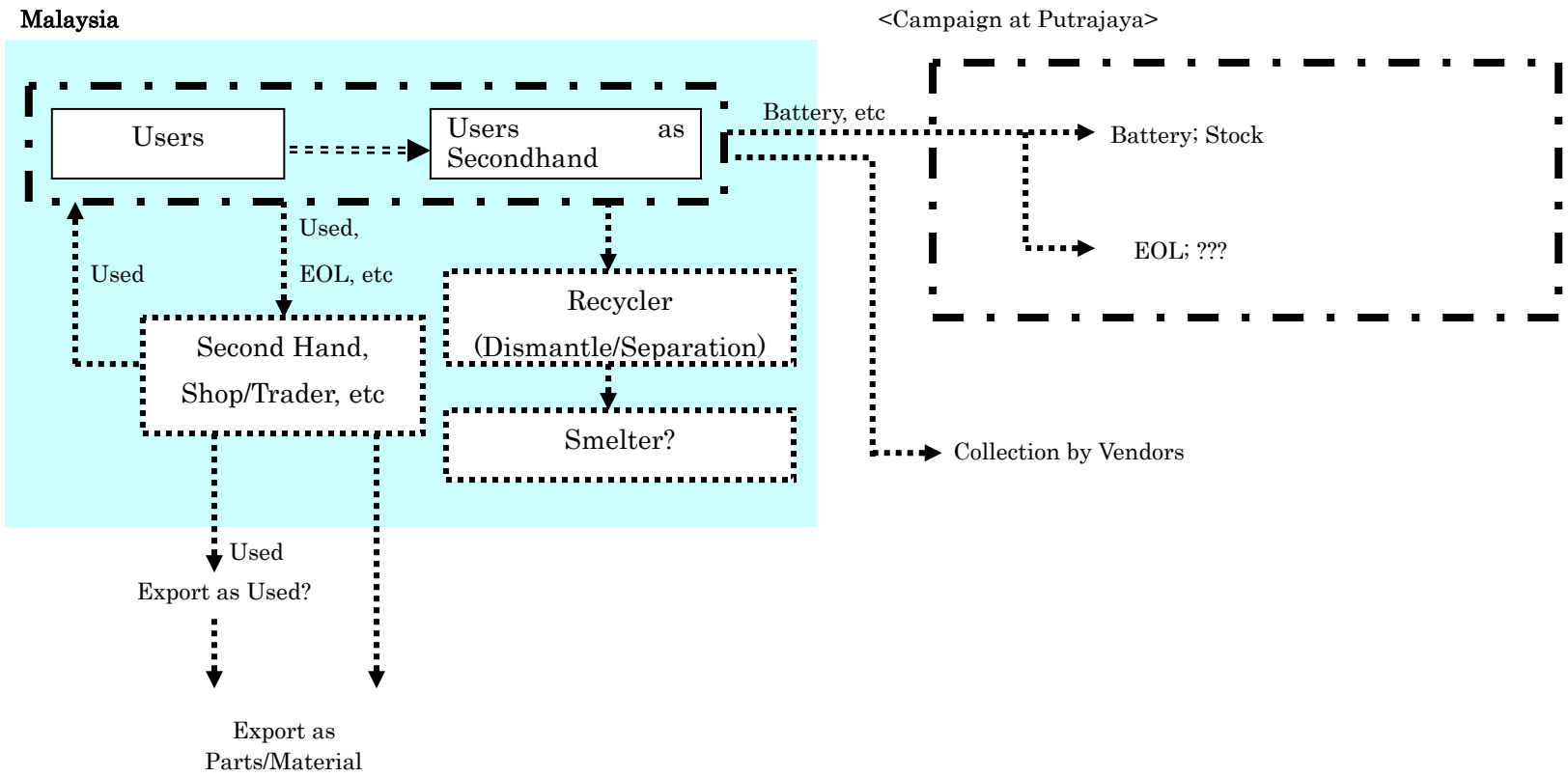


Fig. 1-4 Flow/Cycle of Mobile Phones

1.3 Singapore

(1) Current Situation of mobile phones

Take-back and take-in by retailer have been conducted in Singapore on a commercial basis, and the prices of used mobile phones are set according to qualities. Leasing scheme in which mobile phone can be used during contract period (e.g. 2 years) at lower cost than sales price are widely used. It is said that around 95% of used mobile phones are taken back.

Second hand market of mobile phone is well developed in Singapore, many retail shops are dealing second hand phones. Advertisement of second hand phone on newspaper is widely made. Meanwhile most of them have been exported since Singapore people do not like the use of second hand good.
National Environmental Authority (NEA) has not engaged in the control of the export of used mobile phone and has no detail information on it, because the export is conducted by many small and medium size companies, and also used phones are categorized not as wastes but as products.

There are many shops that buy and sell used mobile phones in cities. Shops are providing price information through newspapers and internet. Many users in Singapore keep original packages and manuals in good conditions, because keeping condition as good as new is useful to sell the used goods at higher price. Even non-repairable phone can be sold at around 10 S$, because it can be used as a source of spare parts. In view of the above situation, to promote the recycling of used mobile phone, it is necessary to introduce incentive system. Many Singaporeans research the price of take back at second hand shops in cities, and sell the used mobile phone to shops that purchase it at the highest price.

(2) Situation of recycling of mobile phones

There are many shops which deal with used mobile phones in Singapore, and take back prices are displayed in each shop. Since users search the shop which purchases it at the highest price, it is difficult for private companies to collect used mobile phones for recycling directly from users on commercial basis.

Used batteries are exported to foreign countries including Japan and France for recycling. Applications for the export license under Basel Convention are not so many. An export to China is not allowed, while an export to developed countries such as

Japan is allowed.

(3) NOKIA

Nokia has material recovery centers in Hungary, India (Chennai), and Mexico, where collected mobile phones or defective parts are separated to each part or material. Nokia is planning to set recovery center in China in the future. The numbers of collection boxes set up by Nokia is 200 to 300 in China, around 130 in Asian regions except for China, and 7 in Singapore. It is reported that collection in China has been successful so far.

(4) MOTOROLA

Motorola has conducted take-back of equipments or walkie-talkie since more than 10 years ago, and started it for mobile phones a few years ago. The background of Take-Back system is not only the provision of services to users but also the concept of EPR (Expanded Producer Responsibility). MOTORORA started the collection of used mobile phones in US and EU, and then has been expanding target countries. It has reached 13 countries including Japan, Australia, Hong Kong, China, Singapore, and Malaysia in Asia Pacific now. It plans to extend this activity to small market such as Cambodia, Pakistan, and Myanmar. The effort is not the response to regulation in each country but voluntary activity.

In spite of efforts, the amount of collected used mobile phone and collection rate are very low, because many used phones are sold to shops or presented to friends. On the contrary the collected amount of batteries, chargers, and earphone are relatively higher.

The Take-Back scheme of Motorola is a bit different according to the situation of each country. Singapore is in Phase-1 of the scheme, and collection has been conducted by themselves (not corroborating with service providers) by using collecting bin installed at its service centers and offices. In China, it has corroborating with China Mobile (service provider) and Nokia.

The collected used mobile phones are sent to designated place in each region, and then crushed and separates into PCB, plastics, batteries, etc. In Asia Pacific region, Malaysia is designated as the collection point.

(5) Flow/Cycle of Mobile Phones

The diagram 3.3-1 shows the flow of used mobile phones in Singapore. Unlike other two countries government-led recycling campaign hasn't been run, while Singapore has second hand market of mobile phone like other two countries. NEA has no intention to conduct aggressively it currently because used mobile phones are categorized as not wastes but as products. Although manufactures are making efforts to collect used phone like in other countries, collected amount is limited.

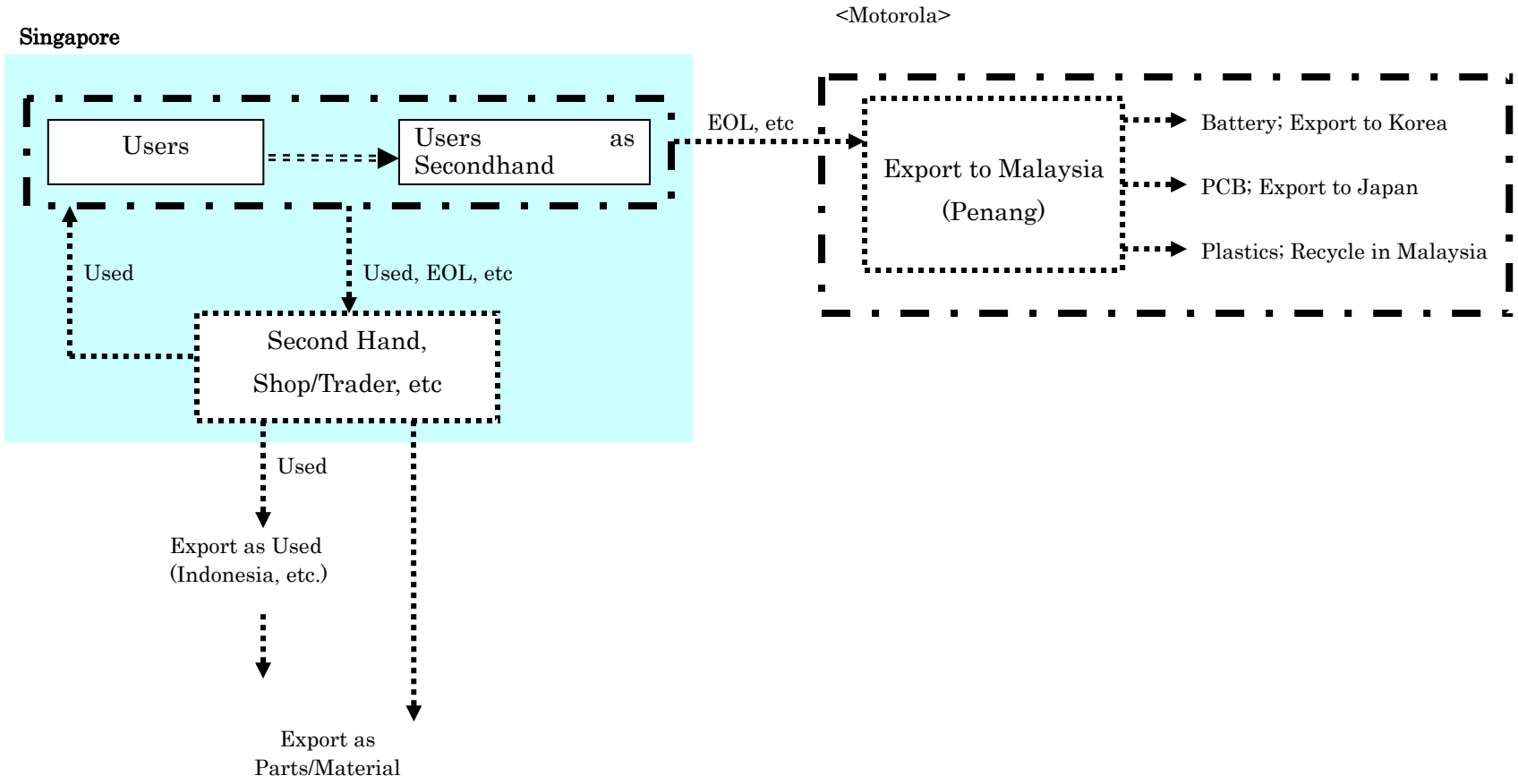
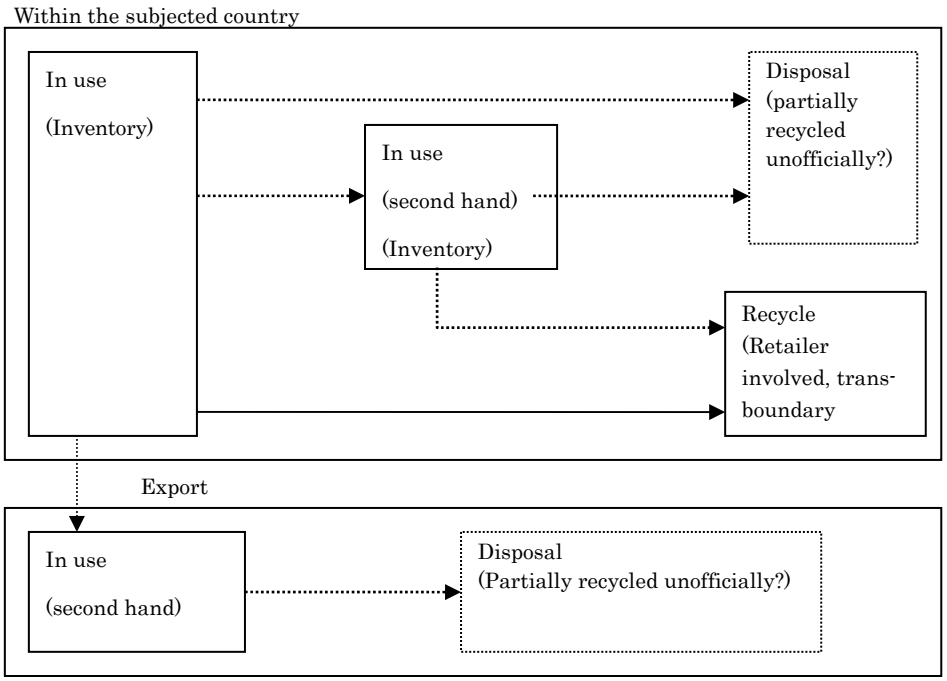


Fig. 1-5 Flow/Cycle of Mobile Phones

2. Framework of collection scheme in subjected countries

2.1 Base concept of a collection scheme

From the study in the previous chapter, current flow of mobile phone in the selected countries (Thailand, Malaysia and Singapore) can be summarized as below.



As shown above, in the subjected countries, most used phones are either retailed as second-hand merchandise or kept at home. In both cases, the phones will eventually be disposed of. Dotted lines indicate that the route is not traceable for its flow of goods in either case of disposal within the country or in foreign countries. The solid line indicates a legitimate recycling route for which the activity is tracked down. From the various sources of information, it is thought that the amount of mobile phone being recycled through this route is limited.

Current involvements of relevant institution or organizations who may be involved in development of a pilot scheme are listed below.

	Thailand	Malaysia	Singapore
DOE, PCD, NEA	No active involvement (conducting battery collection campaign).	Promoting battery collection in limited area. This is also intended for the phone itself.	No involvement in either battery or phone collection.
Service provider	Involved in battery collection but not enthusiastically.	Showing indifference in the matter.	
Manufacturer	EPR is becoming increasingly important. Starting to implement the collection scheme in the developed countries in Asia.		
User	Second-hand market is large. Suspected to have some stored away at homes. Eventually disposed of however difficult to keep track of the flow of the goods.		

From above, conclusions are drawn that:

- □ Many of the used phones are in the second-hand market and in some cases traded internationally,
- □ Some are exported and collected in components or in the form of valuable elements,
- □ Administrative authorities don't supervise the second-hand market therefore detail information on the flow of goods are not available,
- □ Many of the used phones are kept at home,
- □ Used phones that are kept at home or reused are disposed of without records,
- □ Major manufacturers such as Nokia and Motorola are collecting used phones as a part of their EPR. However, the quantity collected is relatively small.

2.2 Investigating the Scheme

(1) Estimation of collected metal value

In investigating used mobile phone collection scheme, the financial feasibility needs to be verified. Economic value added from extraction of valuable metals is highly dependant on the price of the metals therefore directly affected by the fluctuation of it. Gold, silver and copper, which are considered the most valuable of the various metals collected from the mobile phones, are used in the estimation of the value in this study. The estimated value based on the metal prices of March 2007 (case 1), annual average of 2005 (case 2) and 2004 (case3) are listed in Table. The prices show an outstanding increase in the recent years for all three metals.

Table 2-1 Metal price for value estimation

	Gold (Yen/kg)	Copper (Yen/ton)	Silver (Yen/kg)
Case 1	2,600 (2,592 in 2007/03)	800 (800 in 2007/03)	50 (54 in 2007/03)
Case 2	1,619 (2005 annual average)	459,8 (2005 annual average)	27.93 (2005 annual average)
Case 3	1,472 (2004 annual average)	356,8 (2004 annual average)	25.09 (2004 annual average)

The value from mobile phone collection is expressed in terms of metal value equivalent as follows. The collected metal worth between ¥400,000 (case 3) and ¥740,000 (case 1) per 10,000 units (1 tonne) assuming that each phone weighs 100g, therefore, the worth of individual mobile phone is between ¥40 to ¥74. Note that these estimations do not include the collection efficiency and the metal quantity used in the estimation is the metal content of the mobile phones multiplied by the weight of the phone (100g).

Table 2-2 Metal value of mobile phones

	content	Metal content per 10,000 units	Metal value equivalent		
			Case 1 (Mar 07)	Case 2 (05 average)	Case 3 (04 average)
unit	g/unit	kg	¥/10,000 units (1 tonne)		
Gold	0.02	0.20	520,000	323,800	294,400
Copper	15.00	150.00	120,000	68,970	53,520
Silver	0.20	2.00	100,000	55,860	50,180
Total			740,000	448,630	398,100
Per item			74.0	44.9	39.8

(2) Cost estimation

① Collection in the subjected countries

As estimated in (1), recycling mobile phones can be feasible with the price of valuable metals soaring high. However, cost created from collection from individual users and transportation to Kosaka Smelter need to be taken into account.

In considering the cost of collection, two steps should be included, the first step being the process associated with collection from individual users either by (a) dropping

his/her phone to a drop-off point or (b) getting it posted and the second step being the transportation form the drop off points to Kosaka Smelter. Possible drop-off locations using option (a) to have each user dropping it at designated drop-off points are listed below:

a) Authorized retail stores
b) Shopping centers
c) Office buildings (public and governmental)
d) Environmental promotion events
e) Schools
f) Voluntary organizations

Advantages and disadvantages of each drop-off points are listed in Table 2-3.

Table 2-3 Advantages and Disadvantages of each drop-off point

	Advantage	Disadvantage
a) Authorized retail stores	- A collection assured at the purchase of a new phone - Easy management per store	- Need some "gain" for the users - Partial reimbursement or other means of "benefit" for the user?
b) Shopping center	- Easy access for many users	- Need some "gain" for the users - Partial reimbursement or other means of "benefit" for the user? - Need to prevent of phone getting stolen.
c) Office buildings (public and governmental)	- Easy management as the source is limited - Promotes corporate image therefore easily approved of. - No "gain" expected from users?	- Collection rate may be low
d) Environmental promotion event	- Make users environment conscious.	- Collection would be temporary and need to pair it up with other methods - Need some means of "gain" for the user.
e) school	- Encourages environmental education	- Cost required for donation
f) charity	- Social Contribution	- Cost required for donation

Studying the trend overseas, collection at the purchase of a new phone seems the most practical option in terms of management. It has an advantage of involving the manufacturer in the process as a part of their EPR (Extended Producer Responsibility).

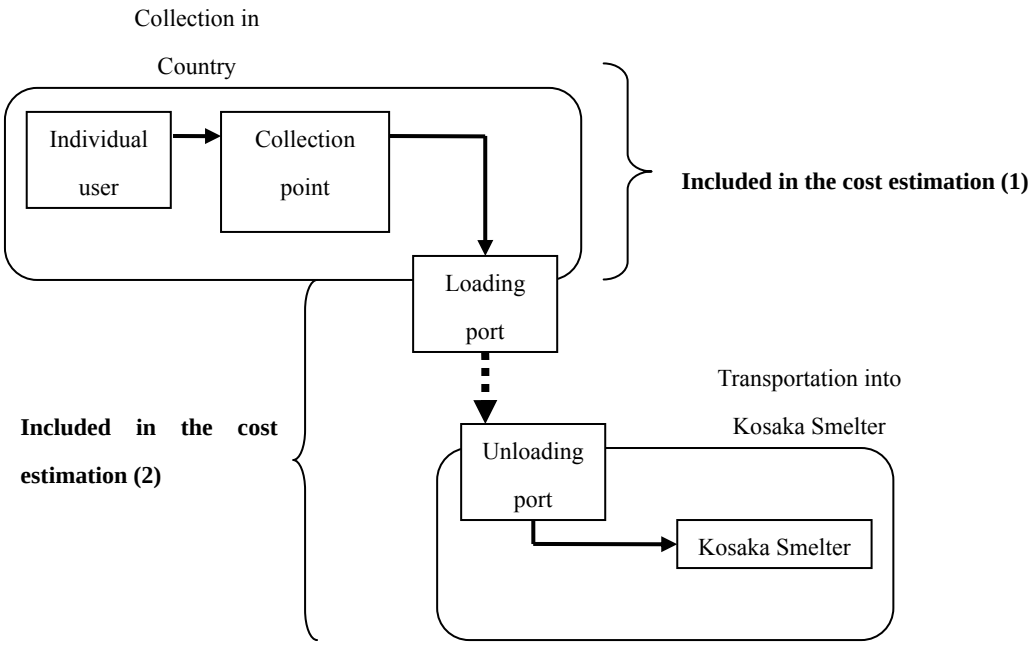
However, in Asia, where used mobile phones are salable as secondhand merchandise, some form of "return" to the user becomes essential.

Promotional event at relevant institutions such as governmental institutions, manufacturers and service providers, although limited to a short term. However, it has an advantage of raising public awareness toward recycling and is expected to grow environmental consciousness among the public. This can lead to an expanded collection rate in the future. Similarly, collection at schools can be introduced as a form of Environmental Education and in return to the service, repaid by donation of school supplies.

Costs related to the collection would ideally be covered mainly by the local manufacturer with aid provided by the local government and DOWA.

(2) Shipment to Japan and transportation into Kosaka Smelter

In the second step of the collected items are transported to a port for loading and shipped to Japan. Once unloaded in Japan, it is then transported to Kosaka Smelter. For quality assurance reasons, it is advisable that DOWA takes full responsibility for the whole transportation process, including the budget.



Cost for transporting items from Singapore to Kosaka smelter is estimated below as an example.

Route: From Singapore port →Tokyo port (unloading)→ transport into Kosaka Smelter.

Shipment cost　LCL1tonne	¥7,400
Custom clearance in Japan	¥20,000
Port Charge	¥16,843
Domestic transportation（1tonne, mix loading）	¥10,000
total	**¥54,243**

The metal value estimated in (1) holds some uncertainties. Assuming the metal value of phones to be ¥400,000/ 10,000 items (from 2004 estimate) and subtracting the transportation cost estimate above, the worth of individual phone is calculated to be ¥35. This would pay for the other expenses and in some cases pays other participants for their share and provide aid for the expenses in the collection processes.

(3) Rechargeable battery

Collection service for used mobile phones most likely includes collection of the rechargeable batteries. Considering a relatively large demand for recycling rechargeable battery (even larger than that of the mobile phones), options for collection and recycling of rechargeable batteries that are currently not possible at Kosaka smelter, needs to be investigated.

In Japan, following types of batteries are traded in for recycling at prices of the metal value equivalent.

- Lithium-ion（for alnico magnets（Co, Fe, Al））
- Nickel-hydrogen battery（For special alloy steel（Ni, Fe））
- Nickel-cadmium battery（For special alloy steel（Ni, Fe) and for Cadmium）

To trade the batteries in, the batteries must to be sorted into lots according to the three types listed above. The minimum trading weight is 20kg per lot. Price for each lot depends on the weight and the metal value at the time of the trade in.

For Li-ion batteries and Ni-H batteries, Basel Convention does not apply as the toxic chemical content of each battery is below the minimum value that is stated in the Basel Convention. Moreover, as the batteries are imported as commodity and not taken in as “waste”, Japanese Waste Management Law does not apply.

For Ni-Cd batteries Basel Convention applies and when the importer is paid for the collection and import of the batteries by the disposer, the Japanese waste management law also applies at the import of the batteries in which case, necessary procedures must be taken. However, in cases where the metal is being imported as commodity, in which this case is included, the Japanese Waste Management Law does not apply.

It should be noted that for the Japanese Waste Management Law to be applied, the importer is limited to who have a treatment facility and necessary permits. A possible example of such an importer is Japan Recycle Centre. Furthermore, for the Basel Convention to be applied, Ni-Cd Battery requires the suitability of the exporter. In this case, the exporter is the DOWA's local bases (for Singapore, Ecosystem Japan Inc. Singapore office) are assessed for its suitability.

(4) Collection Scheme

A prospective collection scheme is shown in Fig. 2-2, taking into consideration the aspects discussed above.

In the immediate future, it can be concluded that the most realistic approach for DOWA is the participation in the battery collection regime in Thailand and Malaysia while establishing a cooperative relationship with the related organizations. This will allow in the mean while to develop a framework for cooperation with the local manufacturers which would enable DOWA to be involved when manufactures are to implement the recycle system in the future.

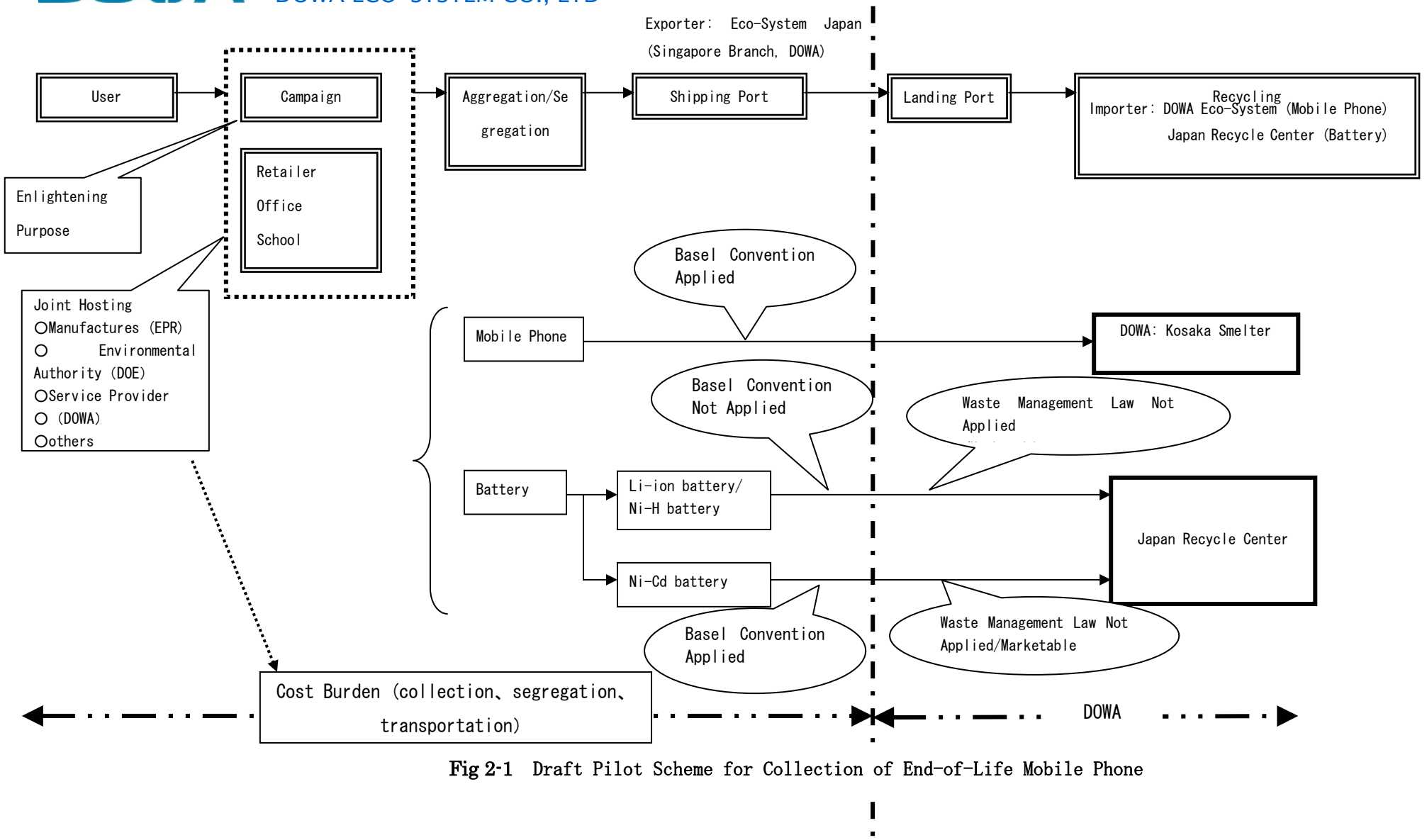


Fig 2-1 Draft Pilot Scheme for Collection of End-of-Life Mobile Phone

2.3 The tasks carrying out the scheme.

It is assumed that the main task is keeping the high amount of collecting the used mobile phones when the scheme is carried out. It would be ideal if high volume is collected at no cost. However, considering that there is no regulations regarding recycle, they are distributing as used items according to market principles, high volume of collecting them is hard to expect, and it will be high cost accordingly. In this case, basically organizations on the spot (the environmental agency, service providers, and makers) should bear the expense of collecting them, although it will be needed for organizations to meet to discuss as for the reasonability for the cost in the future. Especially, positive involvement in increasing awareness for environmental issues to people is expected, the involvement by makers is needed in terms of EPR. DOWA recommend taking the strategy that it participates in campaign, of which the part of the cost it will bear, or buys the used mobile phones at first, and it will lead to increase the awareness or the amount of collecting them including stock in home.