Transboundary shipment of E-Waste

-----Regulations, systems, stakeholders and solutions

Master Thesis, Master program of Engineering and Policy Analysis

Author: Wang Juan

Supervisors: Dr. Martin de Jong
Dr. Wim Ravesteijn
Dr. ir. Karel Mulder
Dr. Jaco Huisman
Dr. Thomas Marinelli
Dr. Dirk-Jan Peet

Defended on 19-05-2009, Delft, the Netherlands

Transboundary Shipments of E-Waste -- A Global Problem

(Source: The European Electronics Recyclers Association (EERA) website)

(The picture in title page: Gaulon, *et al,* 2006)

TU Delft
Delft University of Technology

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to the Bo2W project team. Thanks to Dr. Jaco Huisman for bringing me in this project, and extremely patient supervision, all support, recommendations and valuable feedbacks. Many thanks as well to Wang Feng, Lin Zixin, Jan Zanen, especially Simon Gmunder, for their useful inputs and all instructive discussions.

I would like to thank four supervisors from TBM faculty in TUDelft. Firstly to Dr. Martin de Jong, for his fast and helpful answers to all my questions, and be supportive like an old friend. Thanks to Dr. Wim Ravesteijn, your laugh is impressed me a lot, and skills you taught me I would never forget. Thanks a lot to Dr. ir. Karel Mulder for many inspirations on the topic, and so nice to help correcting my English in this thesis. And Dr.Dirk-jan Peet, your help and cheering words are kept in my mind for ever.

I am grateful to Dr. Thomas Marinelli for providing a valuable internship in Philips, NL. Thanks also to Stephan van Ooyen, Liyong Gu, for affording funding, resource, personnel and host during my field works in China.

And last but not least, many thanks to my friends and family for encouraging me in the long process of writing this thesis, especially my boyfriend for always backing me up during difficult moments.

Wang Juan. May 2009.

EXECUTIVE SUMMARY

The e-waste transshipment issue is a very broad and complicated research topic. Especially, few studies are found concerning e-waste transshipment as well as monitoring systems. Under this circumstance, this report, involved in the third phase of the "Best of 2 World" project under StEP Initiative, is intended to provide an overview of e-waste transboundary shipment development from legislative, systematic and practical perspectives. In addition, it offers a series of recommendations to achieve a desired end state through a "Green e-waste shipment" with "monitoring framework". The study mainly focuses on the EU and China, but is also extended to the international shipment cases and regulations. This type of work has not been documented in literature so far.

Legal frameworks

In Europe, Waster Shipment Rule (WSR) is the primary regulation for tracking transborder movements of hazardous waste into, from and through Europe. It specifies exact shipment procedures for "Prohibited", "Notification control" and "Green list controls", based on shipment purpose (recovery/ disposal), shipment destination (OECD/Non-OECD countries) and classification of waste (hazardous and non-hazardous). In China, no specific regulation has been enacted yet to deal with waste shipment, but there are importing lists of waste which could be used as raw materials. There are also several significant gaps when comparing legal framework between the EU and China. Firstly, the regulation motive varies from the EU to China. The aim of EU Directives and legislations is to combat unsound disposal. In China, the motive of legislation is to get more raw materials. Secondly, the legislation base is different. In European countries, public awareness of environmental issues has been developed over the last decades and relevant legislation has been built on environmental awareness. However, in China, environmental awareness and responsibility are much less developed. Thirdly, in the EU contries, e.g. the Netherlands, there is only one leading competent authority, which takes overall responsibility for the WEEE management system; while in China, several authorities at different levels have competences related to the WEEE system.

Given the obvious gaps between the EU and China legal framework, there is no exact and clear information which can be referred to, when it comes to the question: "what can be transshipped between the EU and China". The Chinese and EU regulations are inconsistent. In addition, there is no clear distinction between "recyclable waste, hazardous waste and used good", which creates a gray area into which millions of tons of e-waste have disappeared.

Existing systems to track transbounrdary movement of waste

It is useful to characterize administrative and monitoring systems by "before shipment", "during shipment", and "after shipment". At each stage, theoretically, enforcement agencies across borders should be able to track the information on each shipment and activity, from both the exporting and importing perspectives. However, this is not the situation in practice.

It is found out that Dutch and Chinese systems are not compatible. They differ in the number of enforcement agencies involved, the way they are organized, the kinds of shipment procedures and strategies applied, and the severity of sanctions available. The key issue is that neither the Dutch nor the Chinese monitoring system is capable of tracking a single shipment from origin to destination, when the origin is in one country and the destination is in the other.

The reason of this inability emanates from some other aspects, besides the different legal base and distinct classification of e-waste discussed in legal framework. It is found out that little information was exchanged between two competent authorities, unless severe illegal shipments were detected. And the critical issue is the inability to track the information "after shipment", because the shipment-based monitoring systems are not linked. Each country develops its own monitoring systems without well interacting with each other, and shows less compliance with foreign regulations. As a result, it limits the ability to track a single shipment from origin to destination.

Practical problems from stakeholder perspectives

To conduct a situation analysis, it is necessary to identify stakeholders that play roles in e-waste shipment chain, as well as their problems which are driven particularly by stakeholders' own interests, resources, power and position. The focal problem is recognized as "illegal shipment from the EU to China". The most negative impact is the severe environmental pollution, happening in informal recycling sector in China and is difficult to control. The fundamental cause lies on two governmental bodies. The EU has made strict environmental regulations and has shown high environmental protection awareness in their own territory. However, it pays little attention to the pollution in other places caused by their own wastes. Chinese government is responsible for its "e-waste heartland" position in the world as well, since economic growth is primary focus in national policies in the past decades. Besides governmental bodies, it is found out that other stakeholders are mostly driven by profit interests, but they focus on different aspects. Although each stakeholder cares about his own interests, none of the interests necessarily contradict with an environmental friendly way to manage e-waste. And diversified interests could provide further incentives for the stakeholders to improve the current situation.

Design work: "Green e-waste transshipment channel" and "monitoring framework"

The primary concern for an expected long-term e-waste management system should be environmentally sound, socially responsible and economically sustainable. This thesis proposes a model called "Green e-waste channel" which defines the role of involved stakeholders. The Channel is defined as an infrastructure and a process, including collection, transshipment, reuse, recycle and disposal of e-waste. Producers, the government and NGO's can support the Green e-Waste Channel as administrative, legislative, and facilitative actors, respectively. Certain incentives are created to attract all stakeholders to cooperate in the new system.

In addition, a particular emphasis is given to reporting system, which plays a very important role in monitoring framework. QiHuoTianDe treatment plant in TaiZhou is selected as an example, to further illustrate how reporting system should work in the recycling phase.

Recommendation:

One of the principles in Basel Convention is to "Minimize international movement of hazardous waste". However, it is not possible for every country to be able to deal with hazardous waste, since most countries do not have many processors, modern facilities and best available technology. Therefore, it is inevitable to ship e-waste across borders, in order to find a more environmentally sound way. Under this circumstance, there must be two basic requirements for potential importing and exporting countries, namely "Develop a sound recycling industry in downstream countries" and "Enforce exporter responsibilities in upstream countries", respectively. Besides, "demand for raw material" is another pre-condition. The "Green e-waste shipment channel" and "cooperative and transparent monitoring system" can also be extended from an EU-China case to an international agreement where the transboundary shipment could be performed in a global legal environment. Meanwhile, Bo2W project should also adapt to the changes in the e-waste field, and keep its work state of the art.

GLOSSARY

AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine
BAN	Basel Action Network
BAT	Best Available Technology
BFR	Brominated Flame Retardants
Bo2W	Best of 2 World
CRT	Cathode Ray Tube
EEE	Electronic and Electrical Equipment
EERA	The European Electronics Recyclers Association
EPB	Environmental Protection Bureau
EPR	Extender Producer Responsibility
EU	European Union
E-waste	Waste Electronic and Electrical Equipment
IMPEL	Implementation of and Enforcement of Environmental Law
MEP	Ministry of Environmental Protection
MII	Ministry of Information Industry
MoC	Ministry of Commerce
NDRC	National Development and Reform Commission
NGO	Non Governmental Organization
OECD	Organization for Economic Co-operation and Development
PCB	Printed Circuit Boards
PRO	Producer Responsibility Organization
PVC	Polyvinyl chloride
RoHS	Restrictions of Hazardous Substances
SEPA	State Environmental Protection Agency
StEP	Solving the E-waste Problem
SVTC	Silicon Valley Toxics Coalition
TFS	Transfrontier Shipments of Waste
UNEP	United Nations Environment Programme
VROM	Ministry of Housing, Spatial Planning and the Environment, the Netherlands
WEEE	Waste Electronic and Electrical Equipment
WSR	Waster Shipment Rule

Table of Content

Chapter 1

Introduction

1.1 Background Information

The electronics industry is the world's largest and fastest growing manufacturing industry. Accelerated demand, rapid product obsolescence and discarded electronic and electrical equipments (EEE) become the fastest growing waste stream in the industrialized world (UNCTAD-UNESCAP Workshop, 2005). Discarded electronic products are among the most rapidly expanding types of waste in the developed countries (EU, 1998). The growing transboundary movement of waste from electronic and electric industry, known as e-waste has fallen into the category of eco-burden of hazardous waste, due to the toxic substances, like heavy metal contained in the scraps.

Transfrontier shipments of e-waste are prohibited by a number of international regulations to protect the environment, like the Basel convention and EU Regulation 259/93 on the supervision and control of waste shipment within, into and out of the European Union (EU). However, China, India and some African countries are still the large acceptors of the e-waste, dumped from the developed countries. Most investigators tend to view recycling of electronics as an economically useful but environmentally hazardous activity (Lin *et al.*, 2002). The environmental and health-related problems associated with volumes of e-waste have triggered important environmental and transshipment policy initiatives.

This thesis is involved in the third step of the Best-of-2-Worlds (Bo2W) project under StEP initiative, called “Large on-site recycling tests for a longer period plus completion of a monitoring system”. The thesis studies and analyses the issue of the transshipment rules and the role of monitoring and developments in China and EU (take the Netherlands for example) related to e-waste shipments, as well as expected long-term situation and monitoring frameworks, ultimately recommendation for global e-waste transshipment and future researches.

1.1.1 E-waste Terminology

First of all, Waste Electrical and Electronic Equipment (WEEE), or e-waste for short, is generally used to describe old, end-of-life or discarded appliances using electricity. It includes computers, consumer electronics, fridges, etc., which have been discarded by their original users. In life cycle of EEE [1] (figure 1.1), when the “product” enters the end of its life, it will be called as “e-waste”. And “e-waste” after “reuse” or “servicing” process, it can re-enter the “product” phase. Or, after “remanufacture” and “recycling”, it can become “raw material”, which could become “product” again after manufacturing process. Therefore, we can see “e-waste” is not static definition, but it is highly dynamic during the product life cycle. It is a definition for the discarded equipments, and it is also a phase that the product must flow into.

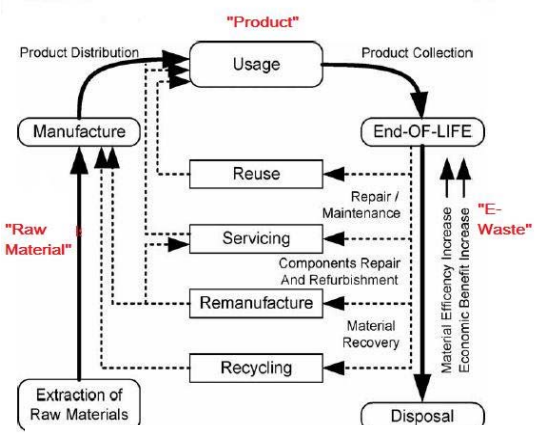

Figure 1.1 life cycle of the product (consult from He, *et al*, 2006)

Secondly, the word “waste” is controversial in this text, because waste usually means negative and valueless items, illegal disposals, etc. But secondhand electrical appliances and recyclable materials cannot be neglected when discussing E-waste, which are definitely valuable. The term “E-waste” used in this thesis is defined rather broad besides its original meaning, including secondhand goods and materials.

Thirdly, there is no widely accepted scope of e-waste until now, it is often associated with relatively expensive and essentially durable products used for data processing, telecommunications or entertainment in private households and businesses. But the ever increasing digitalization of products blurs such a distinction from former electrical appliance such as a kettle, a boiler or an oven; all do or will soon contain electronic circuits and ultimately become e-waste (e-waste guide). On this paper "e-waste" is used as a generic term embracing all types of waste containing electrically powered components (Wikipedia). The table below (table

[1] (1)reuse: the recovery and trade of used products or their components as originally designed; (2) servicing: a strategy aimed at extending the usage stage of a product by repair or maintenance; (3) remanufacturing: the process of removing specific parts of the waste product for further reuse in new products; (4) recycling (with or without disassembly): including the treatment, recovery, and reprocessing of materials contained in the used products or components in order to replace the virgin materials in the production of new goods; (5) disposal: the processes of incineration (with or withoutenergy recovery) or landfill.

1.1) shows an example category of e-waste described in the EU legislation (EU WEEE Directive):

Table 1.1 ten categories of e-waste used in EU WEEE Directive

	Category	Examples
1	Large household appliances	Washing machines, Dryers, Refrigerators, Air-conditioners, etc.
2	Small household appliances	Vacuum cleaners, Coffee Machines, Irons, toasters, etc
3	IT and telecommunications equipment	PCs, Laptops, Mobiles, Telephones, Fax Machines, Copiers, Printers etc.
4	Consumer equipment	Televisions, VCR/DVD/CD players, Hi-Fi sets, etc
5	Lighting equipment	Fluorescent tubes, sodium lamps, luminaries, etc.
6	Electrical and electronic tools (with the exception of large-scale stationary industrial tools)	Drills, Electric saws, Sewing Machines, Lawn Mowers etc.
7	Toys, leisure and sports equipment	Electric train sets, coin slot machines, treadmills etc.
8	Medical devices (with the exception of all implanted and infected products)	Radiotherapy equipment, dialysis, nuclear medicine etc.
9	Monitoring and control instruments	Smoke detector, heating regulators, thermostats etc.
10	Automatic dispensers	Automatic dispensers for hot/cold drinks, candy bar, etc

1.1.2 E-waste crisis

WEEE encompasses a broad and growing range of Electrical and Electronic Equipment (EEE) from household appliances to computers at the end of their lives. E-waste is non-homogeneous and complex in terms of the materials and components, since it contains both valuable as well as harmful materials which require special handling and recycling methods. E-waste has become a problem of crisis proportions because of three primary characteristics:

1) E-waste contains toxic components

E-waste is made from over 1,000 different substances, some of which are toxic. With those toxic substances, e-waste can cause serious environmental problems during disposal if not appropriately treated.

Lead, for instance, is the fifth most widely used metal after iron, aluminum, copper and zinc (E-waste guide). It is used commonly in the electrical and electronics industry in solder, lead-acid batteries, electronic components, cable sheathing, in the glass of Cathode Ray Tube (CRTs), etc. Lead is very toxic to humans, animals as well as plants. It accumulates in the body through repeated exposure and has irreversible effects on the nervous system, particularly the developing nervous system in children. Exposure can also influence the heart, kidneys and brain. For many effects there is no known safe level of exposure (WEEE Directive).

Polychlorinated biphenyls (PCBs) are another type of organic compounds used in a variety of

applications, including dielectric fluids for capacitors and transformers, heat transfer fluids and as additives in adhesives and plastics (E-waste guide). PCBs have been already proved to cause cancer in animals. And PCBs are persistent contaminants in the environment, due to the high lipid solubility and slow metabolism rate of these chemicals (WEEE Directive). The use of PCBs is forbidden in OECD countries, however, as its widely use in the past, it still can be found in WEEE and in some other wastes.

CFCs (Chlorofluorocarbons) are compounds made of carbon, fluorine, chlorine, and sometimes hydrogen. It is used mainly in cooling units and insulation foam. But they have been phased out because when released into the atmosphere, they accumulate in the stratosphere and have a deleterious effect on the ozone layer (E-waste guide).

Some hazardous chemicals in a computer (source: Greenpeace)

- ***Brominated flame retardant**s, used in circuit boards and plastic casings, do not break down easily and build up in the environment. Long-term exposure can lead to impaired learning and memory functions. They can also interfere with thyroid and oestrogen hormone systems and exposure in the womb has been linked to behavioural problems.*
- *The **cathode ray tubes (CTR**) in monitors sold worldwide in 2002 contain approximately 10,000 tonnes of lead. Exposure to lead can cause intellectual impairment in children and can damage the nervous, blood and reproductive systems in adults.*
- ***Cadmium**, used in rechargeable computer batteries, contacts and switches and in older CRTs, can bioaccumulate in the environment and is highly toxic, primarily affecting the kidneys and bones.*
- ***Mercury**, used in lighting devices for flat screen displays can damage the brain and central nervous system, particularly during early development.*
- ***Compounds of hexavalent chromium**, used in the production of metal housings, are highly toxic and human carcinogens.*
- ***Polyvinyl chloride (PVC)** is a chlorinated plastic used in some electronics products and for insulation of wires and cables. Chlorinated dioxins and furans are released when PVC is produced or disposed of by incineration (or simply burning). These chemicals are highly persistent in the environment and many are toxic even in very low concentrations.*

2) Environmental pollution in treatment process

E-waste is hazardous when the toxics are released during treatment process. E-waste management practices have various means of final disposal of end-of-life equipment. Generally, it refers to four types of operation: recycling, Incineration, open burning and landfilling. Many environmental problems are generated during the treatment process. Among available end-of-life

disposal means, landfilling is considered to be the most harmful, and recycling is the most environmentally tolerable when hazardous components are removed safely (E-waste guide).

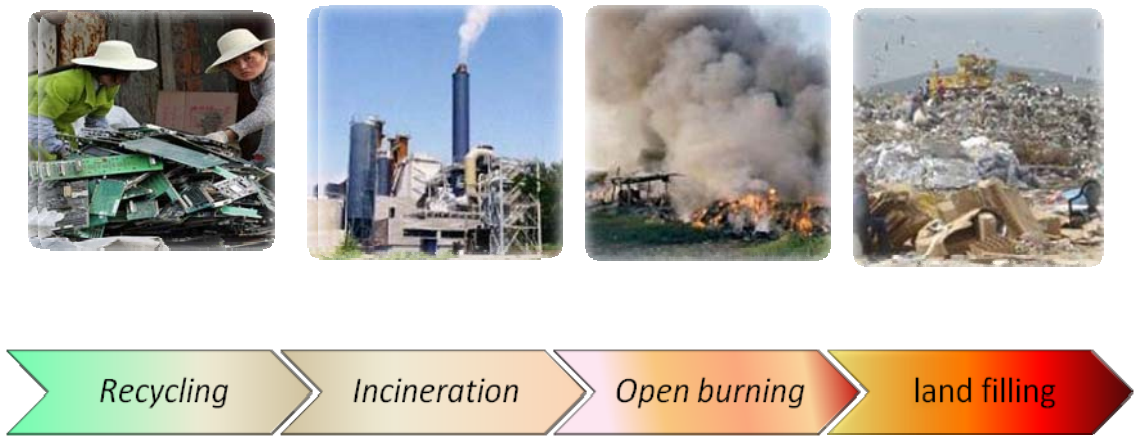

Figure 1.2 the hierarchy of end-of-life disposal methods and their environmental impacts (photo source: E-waste Guide)

- ***Recycling of components***

Hazardous emissions to the air are generated from the recycling process of e-waste which contains heavy metals such as lead and cadmium. Another trouble with hazardous component in untreated e-waste occurs during the shredding process. Since most e-waste is shredded without proper disassembly, hazardous substances such as Polychlorinated Biphenyls (PCB) contained in capacitors, may be dispersed into the recovered metals and the shredder waste (Li, 2005). Inappropriate reprocessing and recycling procedures pollute the environment too (Brigden, *et al.* 2007).

- ***Incineration***

Incineration is the process of destroying waste by burning. Due to the variety of substances in e-waste, incineration has a major risk of generating and dispersing contaminants and toxic substances. The emissions released during the burning and the residue ash are often toxic (E-waste guide). Incineration also leads to the loss of valuable elements which could be recovered if sorted and processed separately

- ***Open burning***

Since open fires burn at relatively low temperatures, they release many more pollutants than in a controlled incineration process at a plant. Inhalation of open fire gas can trigger asthma attacks, respiratory infections, and cause other problems such as coughing, wheezing, chest pain, and eye irritation (Greenpeace). The residual particulate matter in the form of ash is prone to fly around in the vicinity and can also be dangerous when inhaled (E-waste guide).

- ***Landfilling***

No waste landfills could prevent leaking. Even the best 'state of the art' landfills are not absolutely safe and a certain amount of chemical and metal leaching will occur. The situation is

much worse for the older or less qualified dump sites. Around 70% of heavy metals (including mercury and cadmium) found in landfills come from electronic waste (The US EPA, 2001). These heavy metals and other hazardous substances found in electronics can contaminate groundwater as well.

3) E-Waste is generated in great quantities

Due to the extremely rapid rates of obsolescence, the volumes of e-waste generated are much higher than other consumer goods. The production of electrical and electronic devices is the fastest-growing sector of the manufacturing industry in industrialized countries. At the same time, intense marketing and technological innovation engender a rapid replacement process (UNEP, 2005). Consumers rarely take broken electronics to a repair shop as replacement, because buying a new one is now often easier and cheaper than repair. The average lifespan of a computer has shrunk from four or five years to two years (Arensman, 2000). Every year, it is estimated that 20 to 50 million tones of electrical and electronic equipment waste ("e-waste") are generated world-wide, which could bring serious damages to human health and the environment (UNEP, 2005).

Did you know…? *(Data source: Greenpeace and UNEP)*

- *In 1998, six million tones of e-waste were generated which represent 4% of the municipal waste stream. Its volume is expected to increase by at least 3-5% per annum, a rate nearly three times faster than the municipal waste's stream general growth.*
- *More than 500 million computers will become obsolete in the USA alone between the years 1997 and 2007.*
- *Cell phones have a life-cycle of less than two years in industrialized countries.*
- *By the year 2005, one computer will become obsolete for every new one put on the market.*

1.1.3 E-waste transshipment issues

The vast majority of E-waste is generated by industrialized market economies. The volume of obsolete EEE or stored temporarily for later disposal, is a serious problem that is escalating at a rapid peace (UNEP, 2005). Exporting this e-waste to less developed countries has historically been one option for the industrialized world to avoid expensive disposal fee and close public supervision at home (Puckett, *et al,* 2002).

Generally, there are three primary reasons why E-waste is increasingly flooding to African and Asian countries (Puckett, *et al,* 2002):

- *The labor costs are very low (China $1.50 per day), compared with developed countries;*
- *Relevant Environmental regulations are lacking or not well enforced;*
- *It is legal in the U.S., despite Basel Convention[2] to the contrary, to allow export of hazardous E-wastes with no controls whatsoever.*

[2] The Basel Convention is the most comprehensive global environmental agreement on hazardous and other wastes. The Convention has 172 Parties and aims to protect human health and the environment against the adverse effects resulting from the generation, management, transboundary movements and disposal of hazardous and other wastes. The Basel Convention came into force in 1992.

There is no system currently for tracking legal or illegal (under international law) e-waste shipment, and therefore there are no data on the total quantity and on the true final destinations. Some e-waste is shipped as "working equipment" only to end-up as waste upon arrival. The map[3] (figure 1.3) indicates the information collected through investigation by organizations such as Basel Action Network (BAN), Greenpeace, etc.

Figure 1.3 Know and suspected routes of e-waste dumping (source: Silicon Valley Toxics Coalition (SVTC))

From the figure above, it is obvious that most e-waste is exported from developed countries (US, EU, Japan, etc.) to the developing world (China, particularly). Just like most waste trade, e-waste transshipped to developing countries is followed by "brute global economics" (Puckett, *et al,* 2002). That is to say, without appropriate regulation, toxic waste will always run "downhill" on an economic path of least resistance; toxic waste will flood into the world's poorest countries where labor is cheap, and environmental protection is inadequate.

The subject of this report primarily focuses on transshipment of e-waste and will be further explored in the following sections.

- ***'e-waste' heartland, a toxic China***

China, where continuous rapid economic growth has turned the country into "the world's factory center," is also fast becoming the world's largest base for resource recycling. The issue of e-waste is particular significant for China for three reasons.

China official data recorded in State Environmental Protection Agency (SEPA) reveals that Imports

[3] Notice, Canada is not the e-waste donor in the map. The historical data shows Canada is one of e-waste exporting countries, however.

have been on a broadly increasing trajectory since 1999 (Figure 1.4). The peak appears in 2005, 39 million tones namely. In 2005, more than 40% of import quota is occupied by e-waste or relevant waste (waste iron and steel, and waste plastics). However, the latest data, 2007 and 2008, are still missing.

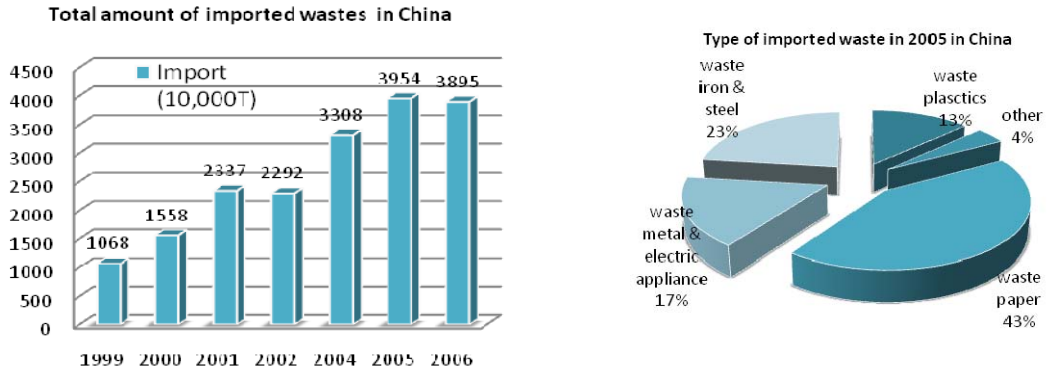

Figure 1.4 statistical data on the amount of e-waste imported from China (Source: SEPA compiled by the author)

Among developing countries, China is one of the main destinations of the e-waste. Accurate numbers about the shady and unregulated trades are almost impossible to obtain. However, experts have made an estimate that 70 percent of the 20 million to 50 million tons of electronic waste produced globally each year is dumped in China, with most of the rest going to India and African nations (Bodeen, 2007), as illustrated in figure 1.5. Besides, importing e-waste actually is prohibited under Chinese laws and regulations. Therefore, here is another interesting issue to discuss in this thesis.

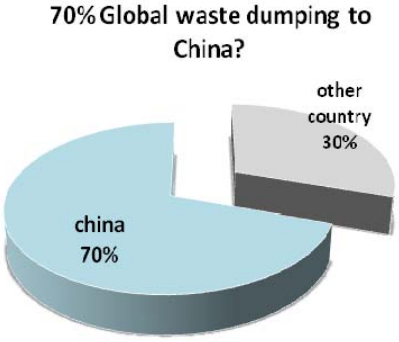

Figure 1.5 estimated data on the amount of e-waste imported into China

Secondly, lacking comprehensive environmental regulations, loopholes in the legislative framework, and low efficiency of enforcement could be regarded as a passive encouragement to illegal e-waste import. At present, China has no clear definition of e-waste from both the official and the academic community. No official data are released for WEEE generation and WEEE flows (Tong, 2004). The main categories include home appliances, personal mobile devices, business electronics, industrial equipment, etc. But current policy focuses only on home appliances and PCs, illustrated by the National Development and Reform Commission (NDRC, 2004).

Last but not the least, e-waste imported to China does not end up in an environmentally friendly way. On contrast, the new E-waste treatment business under the name of “recycling” has brought serious environmental and health damages to China. Under the current situation in China, electronics “recycling” is a misleading characterization of many disparate practices, including de-manufacturing, dismantling, shredding, burning, exporting, etc. Currently, most of these practices are unregulated and often create additional hazards itself. The majority of E-waste

actually ends up in landfills or incinerators (Puckett, *et al,* 2002).

Damage to environment, human health and occupation in China (source: Bodeen, 2007)

Hazardous waste trade is fundamentally unjust and environmentally damaging since it victimizes the poor, burdening them with toxic exposure and environmental degradation.

This is especially striking when the victims get little benefit from the industrialization that created the waste in the first place.

Woman is about to smash a cathode ray tube from a computer monitor in order to remove the copper laden yoke at the end of the funnel. The glass is laden with lead but the biggest hazard from this is the inhalation of the highly toxic phosphor dust coating inside.

- ***One main donor: Europe***

Much of the concern about Transfrontier shipment of waste also arises in Europe. E-waste is routinely exported from the EU to developing countries, often in violation of the EU policies. A body of integrated legislation has been constituted in the EU, which has been proven innovative and successful in many aspects, for instance, the application of the principle of producer responsibility (UNCTAD-UNESCAP Workshop, 2005). However, there still has been a noticeable increase in exports from Europe to China since 2000, with Germany, Belgium and the Netherlands being major exporters in all product categories. These three countries account for approximately 80 percent of waste plastics exports from Europe (Yoshida, 2004). EERA researchers (the Netherlands-based non-profit organization representing the interests of Europe's e-scrap recycling companies.) found definitive proof of illegal exports of e-scrap from Rotterdam to Dubai, from where it is often shipped on to India, Sri Lanka, to Hong Kong, which acts a pivot for exports to mainland China and directly to Africa. They also found that the phrase 'for re-use' was employed intentionally to cover illegal export practices (Beck, 2007). According to Mr Zonneveld, one of the researchers in EERA, the destination and treatment of some 3-4 million tons valued at Euro 700-1000 million (US$ 910 million) is kept secret. Since "The raw materials lost to China represent a value of more than Euro 100 million (US$ 130 million) and cause high risks to health, support child labor and cause huge environmental damage." Although it is evident that exports to any countries where waste is not treated in an environmentally sound way is illegal under all applicable waste agreements.

Illegal export in the Netherlands (source: Basel Action Network)

Carl Huijbregts of the Inspectorate of Housing, Spatial Planning and the Environment (VROM) within the Dutch Ministry of the Environment:
"The results of our investigation into illegal exports of e-scrap were shocking, For instance, it was found that at least 20% of discarded televisions had been illegally collected and exported to non-OECD countries, mainly to Asia and Africa.

In this sense, current enforcement of e-scrap exports from Europe is insufficient and inefficient. The EERA's Executive Secretary also gave many reasons that cause ineffective enforcement of the WEEE Directive within the EU, for instance, the lack of priority, capacity and power allocated to proper inspections, the absence of systematic co-operation of local, national and international enforcement agencies, etc. It is also stated that there is an increasing dumping of "garbage" largely due to the lack of strong and tough measures to punish rule violators in Europe (Bodden, 2007). Meanwhile, in China, no comprehensive body of environmental legislation is specifically established concerning e-waste treatment.

1.2 Problem statements

There are many bi- and multi-lateral agreements on waste shipment at the international and regional levels. On behalf of the international agreements, the Basel Convention and Organization for Economic Co-operation and Development (OECD) Control system plays an importance role in the control of transboundary movements of hazardous waste and their disposal. The EU and China adapt these international agreements and integrate them into their own regulations, the implications of which will be the highlight in this thesis. Besides legal frameworks, this thesis further research on administrative and monitoring systems developed in the EU and China, to examine the enforcement of relevant regulations in both countries. In addition, there are different stakeholder groups with different interests, resources, power and positions. A schematic overview of the current e-waste transshipment situation is missing. Finally, a monitoring scheme of waste and material flows and appropriate measurement tools to assess its performance, are other focuses of this thesis. A full elaborated description is given as follows:

Firstly, two suits of regulations control one waste stream

The Waste Shipment regulation (WSR) published by the European Commission is drawn upon OECD Decision (Canneman, 2008). WSR classifies wastes into one of two categories according to their hazard, namely the Green List and the Amber List. For the two categories, different control procedures apply, i.e. Green and Amber control procedure.

- Green List wastes are considered to be non-hazardous wastes. Green list wastes are not controlled under the OECD system, but documentation must still accompany transhipments.
- Amber List wastes are considered to be hazardous wastes (DECISION OF THE OECD COUNCIL C(2001)107/FINAL)

As the main receiver of global e-waste, WEEE legislation in China is evolving at the same time. In 2001, China issued a ban on importing e-waste and promulgated additional policies and regulations, which state that the wastes, including e-wastes, are strictly controlled by the Basel Convention. In order to control e-waste imports, only 500 companies are certified as importers and processors of the 7th waste category[4] in 2002. This category includes e-waste and other metal waste. Companies only with a certification are qualified to recycle the 7th waste category.

[4] In "List of Restricted Import Waste Materials", there are 10 category wastes are allowed to import into China. The 7th category refers to "All mixed metal scrap, used electrical equipment and electrical products".

Although the official ban on WEEE imports to China has been launched since 2000, little improvement has observed, since numbers of illegal imports continue to grow (Puckett, *et al,* 2002). On one hand, evolving legislation demonstrates the gradual and continuous efforts to improve the current situation; on the other hand, it also address another problem, that is, lacks of uniform and coherent guidance under different legislative frameworks, for the classification of the waste and requirements with which shipment must comply. It is well known that, the Waste Shipment Regulation can only apply to the company registered in Europe, and their obligations are invalidated once their cargo is shipped out of the EU, to China (Dietmar *et al*, 2005).

Secondly, system gaps between two countries

Exporting and importing countries have developed their own systems to manage and control the transborder shipment of waste according to a number of related international rules and provisions of domestic laws and regulations. However, relevant activities to ban the imports are largely ineffective (Liu, *et al.* 2006), which, to some extent, indicates low enforcement efficiency on both sides. Lack of adequate resources to enforce the regulations is the known bottleneck to fundamentally alter the illegal imports (BCRC, 2005, and IMPEL-TFS, 2006). Moreover, it is difficult to communicate with the competent authorities who are responsible for waste shipment in other countries, especially those who are responsible for the monitoring of important waste processing facilities (Eugster, *et al*, 2007).

The EU has taken intensive efforts to promote communication and cooperation between enforcement authorities on the international level. Nevertheless, it only stays at the stage of uniform working methods and alignment of enforcement activities EU wide (IMPEL-TFS SEAPORT PROJECT II, 2006). Transboundary movements of wastes exceed borders of countries, as a result, more international collaboration between authorities involved is essential to enforce relevant legislation adequately. As a key factor in the e-waste problem, integrating administrative and monitoring systems between upstream and downstream countries are missing in previous studies.

Thirdly, different types and groups of stakeholders.

The e-waste shipment is very complicated issue. It refers to a channel that the e-waste should go through, right from the collection of the equipment discarded by consumers, to the very last step in the process - raw material, through several intermediate steps including the take-back, shipment, recycling and different loops to extend the lifespan. In each step, different stakeholders are involved in the chain, with their own perceptions and resources to influence the outcome. Driven by particular interests, resources, power and position toward e-waste, each stakeholder has certain problems as well as expectations toward long-term situation. Some of them want to comply with consistent and simplified shipment procedure, some of them want to lower recycling cost, and some of them just want to get more materials. To design a desired situation, first of all is to identify the current problems of stakeholder. The Additional efforts have to be made to meet pragmatic expectation and develop more comprehensive transshipment channel.

Fourthly, study on the long term situation is absent

No literature can be found so far which can point out what a preferable e-waste shipment channel and monitoring framework should look like. In the e-waste problem, transparency and traceable monitoring system plays a vital role for promoting accountability and providing policy possibilities. Additional efforts have to be made to meet corporate pragmatic expectation and develop more comprehensive transshipment legislation, but one of the major barriers is the absence of valid information on substance flow through the product end-of-life chain (IMPEL project report1, 2005). Inspections normally end at borders, then it is reasonable to doubt whether exported waste reaches the designated locations and waste processed in an environmentally sound manner. Only a comprehensive and widely accepted monitoring system enables the control of waste shipments at its origin and its final destination, such that eventual differences in its composition and quantity can be identified. The question, whether the waste is being processed in accordance with the granted permissions and in its required environmentally sound manner, can be answered. By doing so, enforcement of waste shipments is being done 'from cradle to grave'.

1.3 Research objective

The objective is fourfold in this research. The first objective is to study international waste transshipment rules, with a special focus on the EU and China. It aims to

- Review recent development in international waste shipment regulation. And enhance awareness and understanding of these environmental requirements and adjustment approaches.
- Study the main regulations on the transfrontier shipments of waste in the EU and China, and categorize the type of waste, their notification procedure and information requirements.
- Examine the gaps between two legislative frameworks. Focus on the e-waste could be transboundary shipped.
- Also pay attention to current trade activities between the EU and China.

The second objective is to detect the bottlenecks for an effective and efficient enforcement.

- Gain an insight into the administrative and monitoring systems developed by EU and China, with regard to transboundary waste shipment.
- Identify specific barriers, encountered during the enforcement actions, from both the EU and China.

The third objective is to identify the current situations through stakeholder approach.

- Survey the stakeholders relating to e-waste flow chain from the EU to China, to obtain the current problems from stakeholder perspectives, concerning waste movements from empirical information and knowledge.
- Further explore the possible causes behind their problems, mainly focus on their interests, resources, power and position.

Based on the knowledge accumulated from three levels above, the fourth objective tempt to propose a new "Green e-waste shipment channel" with appropriate monitoring framework, so as to regulate e-waste and related material flows along the whole shipment chain. The concept of

the “green channel” come from Anahide’s master thesis, who is the first one to put forward “Green e-waste channel” for a reuse and recycling system of e-waste in South Africa (Anahide, 2007). But this channel extends from a domestic case to an international case in the thesis. It means a channel that the e-waste should pass through, right from the collection of the discarded equipment, to the very last step in the process - raw material, through several intermediate steps including the take-back, the recycling and different loops to extend the lifespan.

- Design a proper e-waste shipment channel as well as a monitoring framework, to monitor the e-waste “from cradle to grave”.
- Recommend for further generalization study aiming at global e-waste shipment issues

1.4 Research questions

The research objective is leading to the following research questions, which will be answered in this thesis. The main research question is summarized as follows:

What should an e-waste transshipment channel look like, given the legislative, systematic and practical problems concerning transboundary movement of waste?

And Sub questions:

For the theoretical level:

- *What are the worldwide developments in international waste shipment rules, concerning new environmental standards?*
- *What are main regulations on the transfrontier shipments of waste in the EU and China?*
- *What are the gaps between the legislative frameworks of the EU and China, concerning the e-waste that can be shipped?*

For the systematic level:

- *What management and control systems have been developed by the EU and China, concerning waste transborder movement?*
- *What are the gaps between two administrative and monitoring systems?*

For practical level:

- *Who are the main stakeholders involved and what roles do they play?*
- *What are the main problems for each stakeholder in relation to the e-waste transshipment issue?*
- *What are the main causes and effects, among all problems described?*
- *What are the stakeholder’s interest, resource, power and position on regulating e-waste shipment?*

For design work and recommendations:

- *What is expected “Green shipment channel” as well as a “monitoring framework”?*
- *How to make the study generalized for other e-waste exporting and importing countries?*
- *What are recommendations for further research?*

1.5 BO2W project under StEP Initiative

1.5.1 Why BO2W project?

In Europe, a more mechanical and technological solution is generally chosen to treat e-waste. E-waste is first mechanically pre-processed by a shredder combined after a harsh sorting processes. Then resulting fractions are further processed using high standard refineries. For the complex fractions, like PWBs, technologies are available to recover most of the materials with high efficiency (Gmunder, 2007). Basically, the total cost for the whole process including collection, recycling and management, would exceed the final revenue. In order to cover these costs, often an advanced recycling fee is paid by consumers at the point of sale.

The e-waste recycling system in China differs from the European one. Due to cheap labor cost, the e-waste in China is generally disassembled manually as far as economically and technically possible (Gmunder, 2007). And the material value of the e-waste is, in general, higher than the collection and treatment costs. Besides, the manual dismantling receives higher eco-efficiency compared to EU practice, because "the much better separation of materials and component in more pure fractions by large scale manual dismantling compared to mechanical shredding and sepration"(Huisman, 2006). The biggest environmental concern rests with the further processing of the complex and hazardous fractions. The companies engaging in recycling business still remain in the start-up phase, the processing craft and facilities have not been mature, and a scientific, systemic recovering system of e-waste has not been created (Li, 2005).

Thus, the ideal situation seems to combine the recycling advantages from both developed and developing countries. Following this idea, the "Best of 2 Worlds" (BO2W) project is launched by the StEP initiative (Solving the E-waste Problem), initiated by the United Nations University (UNU). It aims to combine Chinese strengths with European ones in order to give a sustainable alternative to the current recycling system. The approach is to combine manual dismantling to get pure fractions and small material losses, with the best available technology (BAT) for the further processing of complex material.

1.5.2 Position of this thesis

The StEP Initiative launched a project called "BO2W" in 2004. The ultimate goal is to set up a large scale recycling facility for demonstration. The table below shows the five steps of the project:

Table 1.2 Five steps of BO2W project

Step	Content	Progress
1	A theoretical eco-efficiency study for various example products	Finished
2	Small scale testing with individual batches of domestic Chinese e-waste	Finished

3	Large on-site recycling tests for a longer period plus completion of a monitoring system	On-going in 2008
4	Full scale demonstration with full and transparent reporting on the project approach and the main eco-efficiency findings to the public, an established monitoring system and acceptable EHS standard applied	On-going in 2008
5	Continuous operation with permanent monitoring and potentially expanding to other e-waste categories	Planned in 2009

In the first and second phase of project, the outcomes of the small scale testing indicate that a deep level dismantling with control over the relevant fractions has the highest eco-efficiency for treating desktop PC's (Huisman, 2007). The picture 1.5 basically explains the key outcomes of comparing the high level dismantling results in environmental and economic terms.

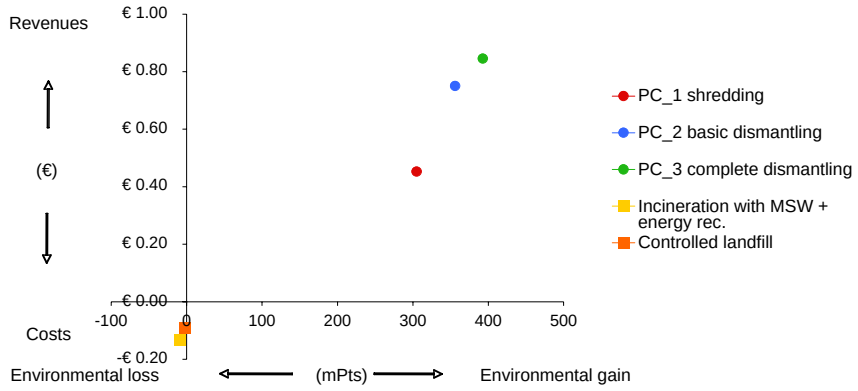

Figure 1.6 environmental and economic parameters in different recycling technology[5] (source: Gmunder, 2007).

The first "shredding" indicates the EU scenario with direct shredding and separation; "Basic dismantling" indicates the current Chinese way to deal with e-waste; and "complete dismantling" indicates a new combination of EU technology and Chinese manual way, namely manually dismantling in China first, and afterwards ship hazardous component back to Europe. Then, the "complete dismantling" shows more advantages on both environmental and economic parameter. Since all tests were carried out aiming at domestic waste in China, there are no research result yet to demonstrate that "EU waste treated in China" is the environmental and economic feasible alternative as well. But the researches done before indeed deliver a promising picture that the Chinese recycling way is a preferable option, when combined with EU technology, by either shipping back or installing them in China.

Thus, transboundary shipment of e-waste does not necessarily mean a disaster to developing countries, if they are controlled under certain preconditions, such as a monitoring system. As current researches are still restricted to domestic e-waste instead of imported e-waste, then the

[5] "shredding" means to Pre-process the whole input device with a shredder (mechanically); "basic dismantling" means to dismantle the big and not very time consuming fraction manually; "complete dismantling" means to dismantle to the very end except for complex and composite materials like PWBs and batteries, and Hazardous or precious metals containing fractions were processed in Europe.

following research will be based on an assumption that:
If taking all shipment cost (from the EU to China) into consideration, the "complete dismantling" is still an economic and environmental efficient alternative to dealing with e-waste.

Meanwhile, this thesis is involved in the third step of the Best-of-2-Worlds project under StEP. It intends to implement the BO2W concept further. It will focus on the transboundary shipment rules and the role of monitoring systems related to e-waste movements, as well as the expected situation in the long term.

In addition, StEP is an initiative of various United Nation organizations with the overall aim to solve the e-waste problem. Therefore, this thesis is not consigned by any stakeholders involved in the global e-waste shipment system, but it jumps outside of the system to provide an overview on sustainable solutions for the e-waste problem. The work is sponsored by Philips Netherlands, and serves as a Master Thesis of the M.Sc program "Engineering and Policy Analysis" in TUdelft.

1.6 Setup of the report

This thesis studies the e-waste issue from legislative level to practical level, and from theoretical level to operational level. The analysis starts from legislative frameworks at the international, EU and China levels respectively, followed by administrative and monitoring system research at the EU level (take the Netherlands for example) and China level. Then it turns into practical study, namely the problem identification from stakeholder's points of view, and possible causes behind their problems. Afterwards the conclusion is drawn from empirical studies, and put forward design requirements for long-term expected situation. Finally, it is proposed a new model for e-waste transshipment system between exporting and importing countries, and further recommendation for global e-waste streams and Bo2W project. The report is organized as follows (table 1.3):

Table 1.3 Thesis structure

<table>
<tr><th></th><th>Empirical study</th><th>Conclusion</th><th colspan="2">Recommendation</th></tr>
<tr><td>Legislative level</td><td>Chapter3 Synopsis of Relevant Law, Policy and Trade Activity</td><td rowspan="3">Chapter6 Conclusion and Design Requirements</td><td></td><td>Chapter8 Recommendation for Further Study</td></tr>
<tr><td>Systematic level</td><td>Chapter 4 Current System to Track Transboundary Movement of Waste</td><td rowspan="2">Chapter7 Design the desired Long-term Situation</td><td rowspan="2"></td></tr>
<tr><td>Practical level</td><td>Chapter5 Practical Problems from Stakeholder Perspectives</td></tr>
</table>

Chapter 2 illustrates the methodology applied in the whole thesis.

Chapter 3 provides a synopsis of relevant international regulations and domestic laws and policies in the Netherlands and China governing the transboundary movement of waste. It also introduces the current shipment situation between the EU and China. Basically, it builds up a legal base for the discussion in later chapters.

Chapter 4 presents a summary of current practices. Issues of administrative and monitoring systems are drawn from interviews with Chinese and Dutch officials. It examines the compatibility of monitoring systems between China and the Netherlands. It also identifies gaps between regulation and enforcement in these two countries. In essence, Chapter 4 reviews what is being done in the field to implement the international and domestic laws outlined in Chapter 3.

Chapter 5, after theoretical research, it deals specifically with the practical limitations of existing e-waste systems from stakeholder perspectives. The reasons they cause environmental, economic and/or social nuisance are explained. And stakeholder analysis is conducted to reveal the possible drives of their behaviors from interests, resources, power and position perspectives respectively.

Chapter 6 concludes the findings of previous three chapters, and tries to answer a part of research questions. Based on the knowledge from empirical study, the design requirements and general objectives are set forth for “Green E-waste transshipment Channel” as well as “monitoring framework” that can minimize those problems.

Chapter 7 put forward the recommendation in practical and systematic levels. It defines the “Green E-waste Transshipment Channel” and “monitoring framework”, and describes the elements included in the design of the Channel using a stakeholder approach: the role of each stakeholder and the responsibility are discussed, considering as much as possible their expectations and the targets of the Channel. It also offers a case study in TaiZhou, which shows an example to build up a monitoring system to track substance flow, environmental impact and money flow in a treatment plant.

Chapter 8 put forward the recommendation in legislative level. It generalizes the study to global e-waste transshipment issues, followed by the recommendations and propositions for further studies.

Chapter 2

Research Methods

The whole study falls into five steps. In step one, recent developments in transshipment rules concerning e-waste shipment in international level and regional levels are reviewed. Special focus is given to EU and China, which represent major e-waste donor countries and acceptor countries, respectively.

In step two, a series of interviews are conducted with officials involved in transboundary shipment from the Netherlands to China. Interview results combined with literature study provide in detail the information on administrative and monitoring schemes for waste from both countries. The information is characterized by three stages, namely before-during-after shipment. These three stages are usually called the life-cycle concept, which is helpful to understand how provisions in various domestic statutes and regulations affect the monitoring of transboundary movement of waste.

In step three, the findings of the assessed countries are compared based on the data collected and processed in step one and two. The comparisons are made among basic regulative elements from legal framework, and also among administrative and monitoring systems from two countries.

In step four, the problems of the existing waste shipment system are dealt with, from stakeholder perspectives. The possible causes behind low efficiency works are also examined. Stakeholder analysis is conducted at the end of the step.

In step five, based on the observed and analyzed flaws in the current legislation system, a preferable “Green E-waste Shipment Channel” and its “monitoring framework” is proposed.

The five steps are summarized in Figure 2.1.

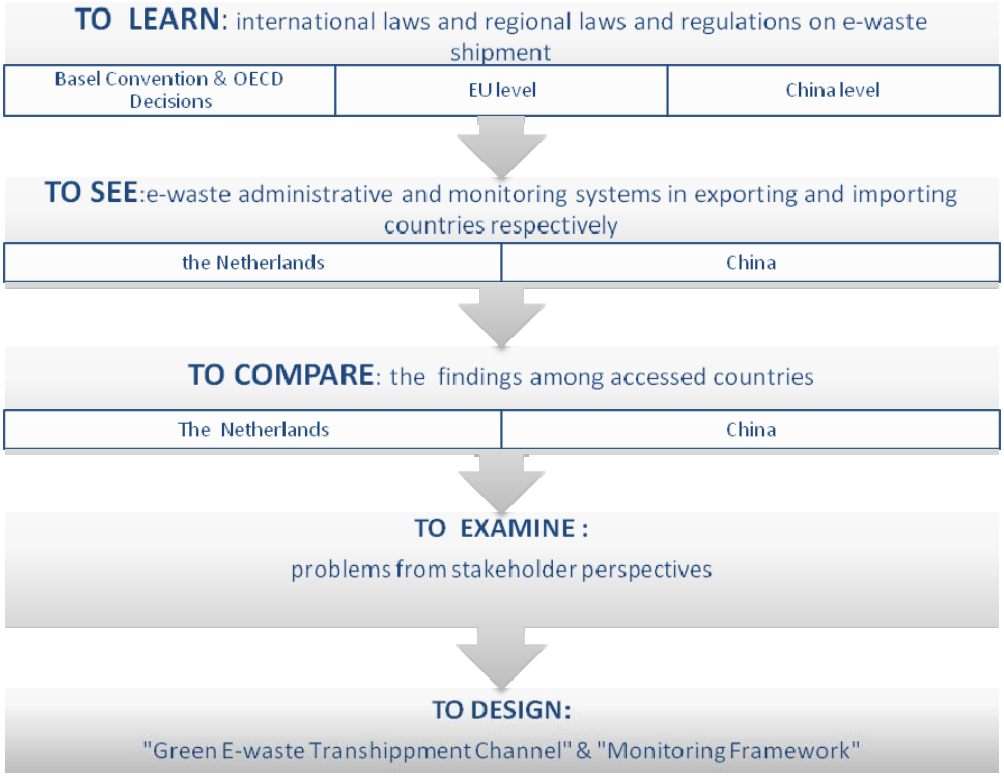

Figure 2.1 Five step of the thesis.

2.1 Step One “TO LEARN”

As international agreements have driven the specific controls governing international movement of waste in each country, they establish the broadest framework. And also domestic provision for monitoring and controlling these shipments are the legal base for the further individual administrative and monitoring system. Thus, it is important and necessary to learn first on those reverent laws and regulations.

Figure 2.2 Step one “to Learn”

Step one is named “To learn”. In this part, the main study approach is desk research. The study area includes the international waste shipment rules, namely Basel Convention and OECD Council decisions, and EEE legislations on the EU and China.

Composed of exporting countries, European Commission had made series of regulations, including the Waste Electrical and Electronic Equipment (WEEE) Directive, Restriction of certain

Hazardous Substances in electrical and electronic equipment (RoHS) Directives, and the EU waste Shipment Regulation (most relevant to our study). Each member state has corresponding competent authorities to incorporate into their national legislation and enforce them. In addition, the informal network of environmental authorities of the Member States, known as IMPEL-TFS, is build up to implement and enforce environmental law.

In China, no complete and integrated law is enacted yet considering waste shipment. A number of regulations, provisions, and standards are currently in operation to fulfil the obligations. China mainly focuses on two agencies and their regulations, National Development and Reform Commission (NDRC) and The SEPA. In particular, China pays additional attention to the Notification on the import of the seventh category of wastes, published on 2000.

2.2 Step two "TO SEE"

After "To Learn" relevant legal frameworks, the next step is "To See" what administrative and control system are in place, with regard to waste transborder movements.

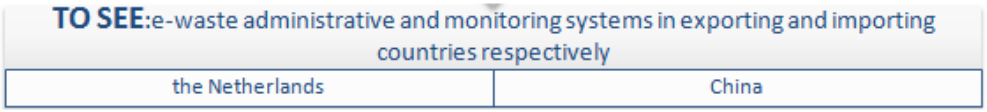

Figure 2.3 Step two "to see"

The second step, called "To See", aims at identifying the e-waste administrative and monitoring systems in the Netherlands and China. Based on our literature study, it is observed that no research has been carried out in the field of e-waste monitoring system, either in exporting countries or importing countries. All available data and information are fragmented and incomplete. Therefore, it is necessary to combine desk research and face-to-face interviews in the process of data collection.

- **Review of Available Literature**

We have reviewed publications relevant to the schemes. A full bibliography has been provided in the reference list.

- **Interviews with officials and consultants**

Face-to-face discussions have been conducted with the officials and consultants in the relevant countries to collect information and understand their views. The interview list can be found in the interview guide.

Besides, a "life cycle model" is created correspondingly to characterize the administrative and monitoring system. It is useful to characterize systems: *before shipment*, *during shipment*, and *after shipment*. This life-cycle characterization helps to rationalize the design of certain administrative and monitoring systems, and helps to explain their utility for enforcement of domestic hazardous waste management laws. At each stage, theoretically, enforcement agencies across borders should be able to check compliance with the rules from both exporting and importing perspectives, and provide information on individual shipments and on activities over time of an individual participant—generator, shipper, transporter, management facility, treatment

plant or even manufacturers (Figure 2.4).

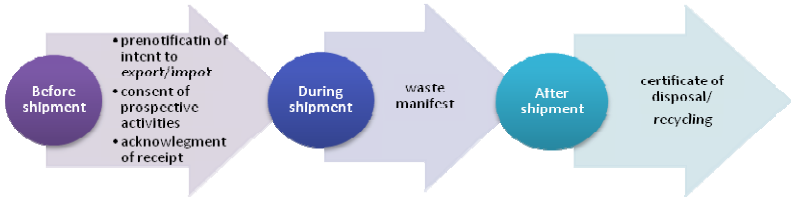

Figure 2.4 Life cycle of administrative and monitoring system

The **"*Before shipment*"** stage focuses on pre-notification of intent to export or import, consent of that prospective activity, and sometimes acknowledgment of receipt of consent. Exchange of this information typically takes place among government agencies, with respect to waste types, quantities, frequency of shipment, and ultimate disposition.

Systems that handle information ***"During shipment"*** contain information drawn from waste manifests, such as exact types and quantities of waste being shipped, identification of the generator (or shipper), identification of the intended recipient, intended ports of entry, and intended management method. These data are supposed to be precise and travel with each shipment of waste from "cradle to grave". These systems require private participants in the waste management cycle to interact with multiple government agencies.

The third stage of system handles information about waste management ***"After shipment"***. These data generally are not tracked *per shipment,* but are submitted to regulatory agencies. Data in these reports include, for example, annual total quantities of each type of waste handled, annual quantities received from (or shipped to) certain generators (or management facilities) , and how these shipments ultimately were managed. With respect to the tracking of the transborder movement of hazardous waste, this is the most important stage which is required to be in compliance with the information provided in first two stages.

2.3 Step Three "TO COMPARE"

Based on abundant knowledge obtained from the previous two steps, on both legal base and monitoring systems of China and The Netherlands, the next step is to compare legal systems of these two countries and to find the gaps that lie in between. An analysis of the reasons that cause the gaps is also provided.

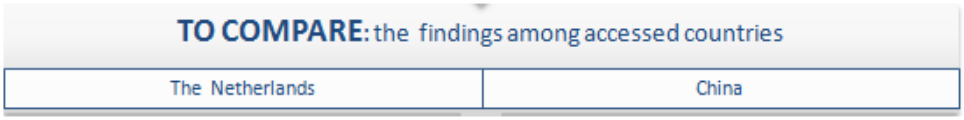

Figure 2.5 Step three "to compare"

The compatibility of the assessed countries will be checked as soon as the data has been collected and processed. Comparison is made between two administrative and monitoring systems from the Netherlands and China. The key question here is: "whether and to what extent the monitoring systems across borders are compatible with each other." The question is highly relevant since the compatibility of systems seriously influences the ability of individual nations to enforce their own laws and international agreements.

2.4 Step four "TO EXAMINE"

Knowing gaps and compatibility of two systems is far less than enough; deep insight into practice is still missing. Therefore, the next step is to examine the problems from the stakeholder's point of view.

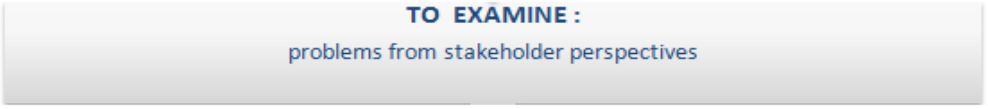

Figure 2.6 Step four "to examine"

It shows the current situation through a stakeholder approach, with the tool of problem tree analysis. "Problem trees are one of the main tools of the 'logical framework' approach to planning, and therefore a core element of planning cycle based approaches" (Schmeer, 1999). The aim of using problem trees is not to identify the symptoms or effects, but to find the fundamental causes of the problems, and the most important effects that they generate. The output of a problem tree design exercise is therefore a cause and effect diagram which creates a logical hierarchy of causes and effects and the links between them.

Question 1: Who are the main stakeholders and what roles do they play

Based on the resources available, the maximum number of stakeholders should be listed. Identifying any people, organizations and institutions which may be affected by or may have an interest in e-waste shipment issues, includes considering:

- *What does the e-waste transshipment system look like?*
- *Who is involved in this transnational shipment system?*
- *What roles do they play in the system, such as polluter, regulator, commercialist, etc.*

Question 2: What are the main problems for each stakeholder in relation to the e-waste transshipment issue?

Different stakeholders played in different positions, are likely to have very different perceptions of the problems. The analysis is mainly qualitative and involved mostly face-to-face interviews based on a set of open questions (see interview guide). Interviews are served to better understand the current situation and to assess the quality of the work, and shed light on many unforeseen aspects of the process. Besides, additional information can be collected through desk study on the basis of an exercise or discussion during the interviews with stakeholders.

Question 3: what are the causes and effects?

With the tool of the problem tree, the relations and hierarchy among all identified problems is expressed. Each stated problem is preceded by the problem(s) which cause(s) it, and followed by the problem it causes itself. There are four steps to conduct problem tree analysis.

- *Select One Problem (focal problem), which involves the interests and problems of the stakeholders present.*
- *Identify immediate and direct causes of the focal problem*
- *Identify immediate and direct effects of the focal problem*

- *Construct a problem tree showing the cause and effect relationships for the problem. And review the problem tree and verify that it is complete and valid.*

Question4: What are motives behind their problem, considering from stakeholder's interests, resources, power and position?

It is also necessary to define the stakeholder's characteristics, which could show causes of their problems as well as provide input for further "design process". The elements include:

- ***Interests****:* the stakeholder's interest in the policy, or the advantages and disadvantages that implementation of the policy may bring to the stakeholder or his or her organization.
- ***Resources:*** the quantity of resources—human, financial, technological, political, and other—available to the stakeholder and his or her ability to mobilize them.
- ***Power:*** the ability of the stakeholder to affect the implementation of the reform policy. The power index can be made according to the resources.
- ***Position:*** whether the stakeholder supports, opposes, or is neutral about the policy, which is key to establishing whether or not he or she will block the policy implementation.

The analysis used in this step is mostly interviews with governmental officials, consultants and industry representatives. If unavailable, the estimates are given based upon annual reports, and previous research. Notice, there are no direct questions concerning stakeholder characteristics during the interviews. They are summarized from author's personal judgments when contacting with stakeholders.

2.5 Step Five "TO DESIGN"

The final step is to design a strategy for how best to engage different stakeholders in a project, identifying who will make what effort and how, what information they will communicate and how they will follow-up. The approach applied here is "developing a table of objectives".

Figure 2.7 Step five "to design"

In the analysis of objectives, the problem tree is transformed one by one into a table of objectives (future solutions of the problems). More specifically, based on previous "Problem tree analysis", reformulate all the elements into positive and desirable conditions. If required, revise statements or delete objectives that appear unrealistic or unnecessary and add new objectives where required. Instead of tree of objectives, an table of objectives is preferable option, because it could presents a clear comparison between problems and proposed objectives.

This methodology could help solve the problems identified before, and promote a blueprint towards international and regional cooperation on transboundary water issues. Central to this blueprint is the integration of the "Green e-waste transshipment channel" within a "monitoring framework". The "Green e-waste transshipment channel" aims to connect all involved stakeholders and to build up an infrastructural model for an e-waste recycling system that is in an environmental friendly manner. The "monitoring framework" coordinates between different

stakeholders, provides verifiable and secure data, allows for the interpretation of the data, harmonizes and transparent the e-waste transshipment process.

The case study is done in the QiHuoTianDi treatment plant located in TaiZhou in China, to show how proposed reporting system should work in recycling plant.

2.6 System boundary

As discussed in previous sections, e-waste is so broad an issue that it cannot be fully elaborate in one thesis. Due to various practical limitations, attention was paid to waste streams shipped between EU and China, with a special focus on waste streams that cause environmental hazards.

Within this thesis, transboundary shipments of waste are being analyzed and monitored in Europe and this information is used as a starting point to track the transport and treatment in the intended facility ("downstream"). Identification of the final destination can be earmarked as a critical factor to meet one of the essential targets of waste shipment regulations: ensure that waste is being processed in an environmentally sound manner. Only after it has been confirmed that all wastes will generate no damage to the environment, it can be regarded as an ending point of the whole monitoring system. By verification as such, enforcement of waste shipment regulations becomes more than a "paper tiger". An illustration of the working procedure regarding verification is presented in the following scheme (Figure 2.8)

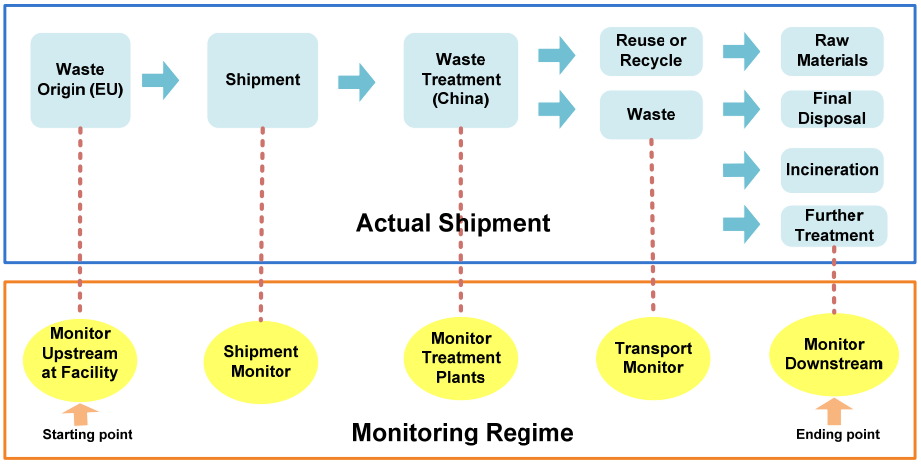

Figure2.8 Monitoring working procedure, consulted from IMPEL project report, 2006

2.6.1 Monitor scope

The key component of this research is the monitoring system for WEEE. A variety of definitions of "monitoring system" can be found. In this thesis, the monitoring system is one element of "Auditing System" (Huisman, 2006), which refers to the performance to ascertain the validity and reliability of information, and also provide an assessment of a system's internal control. There are other elements included in the auditing system as well, such as Environmental Health and safety

Standards (EHS), and relevant performance indicators in the recycling and reuse parts.

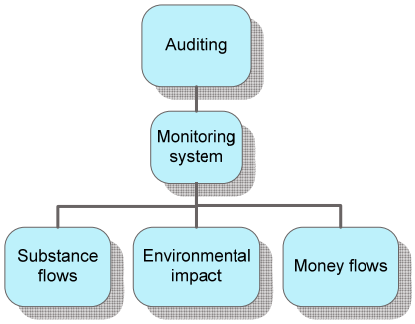

Figure2.9 The Monitor scope, consult form Huisman

As we can see from figure 2.9, the main monitoring objects include substance flows, the environmental impact and the money flow. The substance flows concern the quantity, the type and the destination of EEE. The environmental impact is generated during the process. Finally, money flows are said to be true and fair when they are free of material misstatements, in financial audits.

2.6.2 Field work location: Netherlands, Shanghai, and Taizhou

In Europe, exports of recyclable wastes from EU countries to destinations outside the Community are shown in Table 2.1. It suggests that the Netherlands was taking the leading position on shipping of "hazardous waste for recycling and disposal" or "other waste for recycling and disposal". The amount shipped from the Netherlands is far more than the sum of five other EU countries[6]. Therefore, it can be concluded that the Netherlands plays a very important role in EU even world e-waste export.

Table 2.1 Export of waste under prior notice and consent from selected EU nations in 2001 (data source: Kojima, 2005)

(Unit: tons)

	Exports (subject to the Basel Convention)				Imports (subject to the Basel Convention)			
	Hazardous wastes for recycling and disposal	Other wastes for recycling and disposal	Hazardous wastes and other wastes for recycling		Hazardous wastes for recycling and disposal	Other wastes for recycling and disposal	Hazardous wastes and other wastes for recycling	
			Worldwide	To EU			Worldwide	From EU
Belgium	746,479	0	635,439	627,243	605,419	0	575,652	562,023
France	196,966	9,802	189,063	185,249	1,317,046	30	703,462	617,760
Germany	270,005	47,523	238,283	230,713	799,063	216,130	676,212	650,242
Italy	229,872	133,742	130,454	100,187	1,148,193	797	847,639	558,525
Netherlands	1,676,467	458,296	1,956,782	1,935,482	341,368	170,731	470,009	461,106
UK	35,907	0	35,832	15,426	180,833	45	164,985	150,220

Notes: (1) "Other wastes" refers to wastes generated by household, which is defined in the Basel Convention.
(2) If wastes not subject to the Basel Convention but for which prior notification was undertaken are included, Germany exported 1.54 million tons and imported 2.63 million tons.
(3) The statistics on imports and exports of wastes for recycling within the EU are those for 2001, i.e. for the EU 15 prior to the expansion of 2004.

During the last decade, imports of secondary materials have increased rather steadily in China. The recycling of imported e-waste is one of the fastest-growing industrial sectors in several clusters in coastal China. Figure 2.10, based on data provided by the SEPA in 2002, shows the

[6] Since Rotterdam harbor is one of biggest transferring harbor in the Europe, the figure in the table does not necessary indicate those waste are all generated in the Netherlands, but the amount of e-waste shipped from the Netherlands.

spatial pattern of recycling enterprises licensed by the government to import recyclable goods of the 7th category, which included e-waste. As labor-intensive and manufacturing center, the coastal areas have developed into concentrated areas of importing regenerated resources. Guangdong in the Pearl River delta and Zhejiang in the Yangtze River delta are the two regions with the highest concentration of recycling activity. This project is basically carried out in Taizhou and Shanghai in the Yangtze River delta area, which are the most representative recycling areas in China.

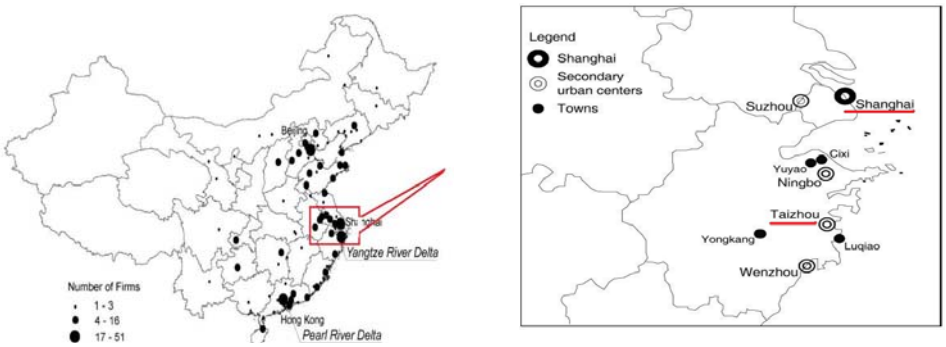

Figure 2.10 Industrial clusters related to recycling of e-waste in the Yangtze River delta (source: Tong, *et al* 2004)

Shanghai is the most economically developed metropolis in China, where high level government agencies and most multinational electric and electronic companies are located. Meanwhile, Shanghai is quite close to the Taizhou Chiho recycling factory which is the main playfield for this project.

Taizhou is an important harbor city on the southeast coastline of China. It constitutes a cluster of recycling enterprises and secondary product markets. A large amount of recyclers in the area are conducting e-waste dismantling and material recovery. This is also where the testing factory for the Bo2W project is located.

Chapter 3

Synopsis of Relevant Law, Policy and Trade Activity

All transboundary shipments of WEEE are subject to numerous bi- and multi-lateral agreements on waste shipment. This chapter aims to provide a synopsis of relevant laws and regulations not only at the international level, but also more specifically the EU and Chinese legislative frameworks governing the transborder movements of e-waste. Since the vast set of laws and regulations is rather tedious and complicated, only the information most relevant to e-waste shipments is screened and discussed in this chapter.

In contrast to the available laws and regulations, we also examine the trade activities between the EU and China. Material presented in this chapter has been abstracted from the literature, the text of the various laws and regulations.

3.1 Basel Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal is the most comprehensive global environmental treaty on hazardous and other wastes. It was adopted on 22 March 1989 and entered into force on 5 May, 1992. It is accepted by 170 member countries (Parties) and mainly aims to prevent the adverse impacts resulting from the generation, management, transboundary movements and disposal of hazardous and other

wastes. Basically, there are three principles that the Basel Convention calls for:

> ***1. Minimize the generation of hazardous wastes***
> *The less waste there is to start with, the less money and work and risk is involved in cleaning it up. The most successful industries of the future will include those that become better and better at minimizing unwanted by-products and designing products with fewer hazardous components; they will become increasingly adept at recycling or reintegrating leftover materials back into the manufacturing cycle.*
> ***2. Treat and dispose of hazardous wastes as close as possible to where they were generated.***
> *Local solutions are only possible if the necessary legislation and infrastructure are in place. Waste-management facilities need to be of a high technological standard. Site operators must be highly qualified and trained. Monitoring must be sophisticated enough to detect any leaks or emissions above acceptable standards. Emergency procedures must be in place in the event of spills or other accidents. There must be safe storage facilities for any residues from waste recovery or incineration.*
> ***3. Minimize international movements of hazardous wastes.***
> *The Basel Convention seeks to minimize the movement of wastes across international borders through an agreed regime of rules and procedures. This regime starts by rigorously identifying the kinds of wastes that are considered hazardous and are thus subject to the rules on transboundary movement.*

3.1.1 Waste definition

The wastes covered by the Basel Convention are covered by reference to a set of technical annexes, supplemented by a provision that allows every party to determine, by national legislation, additional hazardous wastes.
According to the Article 2.1 of the Convention, wastes are defined as:

> ***Basel Convention waste definition (Article 2.1)***
> ***"Wastes" are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law***

Followed by several operations qualified as “disposal”, Article 2.4 lists in two list Annex IVA (operations which do not lead to the possibility of resource recovery, recycling, reclamation, direct reuse or alternative uses) and IVB (operations which may lead to resource recovery, recycling, reclamation, direct re-use or alternative uses).

3.1.2 Classification

Basel convention classifies the waste from “non-hazardous” waste to “hazardous” waste, list below:

> ***Basel Convention hazardous waste definition (Article 1.1)***
> *(a) Wastes that belong to any category contained in Annex I, unless they do not possess any of the characteristics contained in Annex III; and*
> *(b) Wastes that are not covered under paragraph (a) but are defined as, or are considered to be, hazardous wastes by the domestic legislation of the Party of export, import or transit.*

In order to facilitate a more specific classification of hazardous waste streams that actually exist in practice, the Convention has developed more detailed waste lists:

- a list of wastes deemed to be hazardous (List A -Annex VIII) and
- a list of wastes deemed to be non hazardous (List B - Annex IX).

These lists were developed according to the substances contained in the wastes, and it classifies hazardous wastes solely depending on intrinsic hazardous properties. The Annexes VIII and IX are applicable among Parties worldwide since November 1998.

3.1.3 Transboundary Movement Procedures

Firstly, the Basel Convention regulates the transboundary movements of hazardous and other wastes applying the "Prior Informed Consent" procedure (shipments made without consent are illegal). That means, without a prior agreement, shipments to and from any parties are illegal, and will be punished through national or domestic legislations. ***"It should be recognized that any country has the sovereign right to ban the entry or disposal of foreign hazardous wastes and any other wastes in its territory".*** Secondly, the Convention obliges its Parties to ensure that hazardous and other wastes are managed and disposed of in an environmentally sound manner (ESM). It is expected to minimize the quantities that are moved across borders, to treat and dispose of wastes as close as possible to their place of generation and to prevent or minimize the generation of wastes at the source. Transboundary movements of hazardous wastes are prohibited if the exporting and importing countries believe that the hazardous wastes in question shall not be managed in an environmentally sound manner.

3.2 OECD Council Decisions

The organization for Economic Cooperation and Development (OECD) is a unique forum where the governments of 30 democracies work together to address the economic, social and environmental challenges of globalization. Since March 1992, OECD initiated a specific intra-OECD system to supervise and control the transboundary shipment of wastes destined for recovery operations between Member countries. This Control System, which is established by the Council Decision C(2001)107/FINAL, provides a valuable framework for Member countries to control transboundary movements of wastes destined for recovery operations in an environmentally sound and economically efficient manner. "Environmentally sound management of waste" was considered to be a basic condition for allowing or prohibiting an export/import of waste within, as well as outside, the OECD area.

Generally, The OECD Control System is comprised of two basic wastes types and their corresponding control procedures. The Wastes subject to these control procedures are listed in Appendix III and IV to Decision C(2001)107/FINAL: the so-called Green and Amber lists of wastes.

- Green list: for wastes that present low risk for human health and the environment and, therefore, are not subject to any other controls than those normally applied in commercial transactions;
- Amber list: for wastes presenting sufficient risk to justify their control.

The controls of waste shipments are implemented by national competent authorities and Customs Offices as appropriate, through the use of notification and movement documents.

Amendments, which came into force on 20 November 2003, states that "Basel lists" of wastes are incorporated into the "OECD lists" of wastes.

3.2.1 Waste definition

Under chapter 2 of Decision C(2001)107/FINAL, the waste definition list as follows:

> *WASTES are substances or objects, other than radioactive materials covered by other international agreements, which:*
> *(i) are disposed of or are being recovered; or*
> *(ii) are intended to be disposed of or recovered; or*
> *(iii) are required, by the provisions of national law, to be disposed of or recovered.*

From the context, there is no difference between the definition of the "waste" in the Basel Convention and OECD countries. But the "disposal" and "recovery" are classified as below:

> *DISPOSAL means any of the operations specified in Appendix 5.A to this Decision.*
> *RECOVERY means any of the operations specified in Appendix 5.B to this Decision.*

"Disposal" operations are exactly the same in both Basel Convention and OECD Council Decisions. But only OECD gives a specific definition of the waste destined for "recovery", which prove OECD Council Decisions also governs the transboundary movement of wastes destined for recovery.

3.2.2 Control procedure

A two-tiered system serves to delineate controls to be applied to such transboundary movements of wastes:

1) Green Control Procedure

Wastes falling under the Green control procedure are those wastes of Appendix III of this Decision. This Appendix has two parts:

- Part I contains the wastes in Annex IX of the Basel Convention, some of which are subject to a note for the purposes of this Decision;
- Part II contains additional wastes that OECD Member countries agreed to be subject to the Green control procedure, in accordance with criteria referred to in Appendix VI to this Decision.

2) Amber Control Procedure:

Wastes falling under the Amber control procedure are those wastes in Appendix IV to this Decision. This Appendix has two parts:

- Part I contains the wastes in Annexes II and VIII of the Basel Convention, some of which are subject to a note for the purposes of this Decision;
- Part II contains additional wastes that OECD Member countries agreed to be subject to the Amber control procedure, in accordance with criteria referred to in Appendix VI to this Decision.

In the case of a mixture of wastes, for which no individual entry exists, there shall be subject to the following control procedure:

- A mixture of two or more Green wastes shall be subject to the Green control procedure,

provided the composition of this mixture does not impair its environmentally sound recovery;

- A mixture of a Green waste and an Amber waste or a mixture of two or more Amber wastes shall be subject to the Amber control procedure, provided the composition of this mixture does not impair its environmentally sound recovery.

Finally, the content of this control procedures are recommended for review at specified time intervals in order to ensure that the objective of environmentally sound management is met.

3.3 EU level

3.3.1 The EU network of enforcement authorities

In the EU Environment is ranking high on the political agenda. Particularly for electronic products, several initiatives have been taken to come to Directives and Regulations, which should stimulate good environmental performance. European Community has established a comprehensive body of environmental legislation, on the basis of EU Directives on WEEE and Restriction of Hazardous Substances (RoHS) approved in October, 2002. A new Waste Shipment Regulation was also enacted on 12 July, 2007. The purpose of all these Directives and Policies is to create a common basis for law making of the Member States. Under these Regulations, each EU Member State must incorporate the provisions of the EU Directives into their national legislation, and implement the Directives. If an issue is not addressed in the Directives, Member States are free to regulate it as they wish, which result in some differences between the legislation of the different EU Member States.

Taking the Netherlands for example, the competent authorities are Ministry of Housing, Spatial Planning and the environment (VROM), SenterNovem and Dutch Customs. The formal institutions are listed in table 3.1.

Table 3.1Institution and function for management of e-waste in the EU

	Competent authorities	Main function
EU level	The European Commission	• Proposing legislation to Parliament and the Council • Managing and implement EU policies and the budget • Enforcing European law (jointly with the Court of Justice); • Representing the EU on the international stage, for example by negotiating agreements between the EU and other countries
Member state level	The Ministry of VROM	• Preparing memoranda formulating the views of VROM; • Establishing legislation in co-operation with social partners; • Inspections aimed at making sure that rules are observed; • Supplying organizations and individuals with subsidies;
	SenterNovem	• Carrying out a great many of the tasks in the policy field of waste for the Ministry of VROM. • Monitoring all waste streams and report to the EU and National Government on the progress in waste management.

		• Licensing and monitoring of import, export and transhipment of waste
	Dutch Customs	• Checking whether a declaration is correct and how it should be processed. • Inspecting incoming and outgoing goods • Levying and collecting taxes and national insurance contributions

To inspect the wastes shipment, it is very difficult for the competent authorities in one country or a customs at a single port to increase the effectiveness of control and enforcement. Therefore, the EU requires an informal framework to facilitate high-levels of information sharing and stronger, more harmonious enforcement within the Community. The network of regulators known as IMPEL-TFS and its activities is an original EU framework that was designed to address these problems.

IMPEL

IMPEL is an informal European network for "Implementation of and Enforcement of Environmental Law" and consists of representatives of relevant national authorities from all member states, the European Commission, Norway and the Accession Countries.

TFS

The TFS (Transfrontier Shipments of Waste) network operates under the umbrella of the IMPEL network and was set up in order to harmonize the enforcement of EU Regulation 259/93 regarding the supervision and control of waste shipments into, out of and through the European Union.

The regulations are operated and enforced differently by individual countries, so that problems will arise in the regulations enforcement. The sharing of expertise among regulators is also critical to efficiency in the enforcement of legislation. Environmental regulators across the EU were aware of these problems, and established the IMPEL network in 1992.

The Seaport Project is one of the more interesting experiments being undertaken by the IMPEL-TFS. The project includes joint on-site inspections of wastes, not labeled as waste or labeled as if green list wastes, bound for non-OECD countries, and so on. As part of the project, manuals (uniform working methods) were compiled for inspection of customs documents, inspection at storage locations and warehouses, and waste inspections in transit.

3.3.2 EU regulations on transboundary movements of wastes

The European Community enacted two Directives relevant to WEEE in 2003 and the Waste Shipment Regulation since 1993:

- ***Waste Electrical and Electronic Equipment Directive (WEEE Directive):*** aim to prevent generation of WEEE and promote their reuse and recycling
- ***Restriction of Hazarous Substances Directive (RoHS Directive):*** aim to reduce use of hazardous substances in production of electric and electronic appliances
- ***Council Regulation (EEC) No 259/93, The Waste Shipment Regulation (WSR)***: aim to prohibit the export of hazardous wastes to non-OECD countries altogether.

The WEEE Directive is based on the producer-pays principle. The scope of this Directive includes producers, distributors, consumers and all parties involved in the life chain of EEE. Producers are

requested to finance the collection, treatment, recovery, and environmentally sound disposal of WEEE. In addition, this directive imposes a high recycling rate for all targeted products. The rate varies from 50% to over 80% depending on the type of WEEE.

The RoHS directive bans the presence of certain hazardous substances in EEE being traded in the EU market. RoHS ensures that new EEE does not contain mercury, lead, cadmium, hexavalent chromium, polybrominated biphenyls, or polybrominated diphenyl ethers. It aims to control the environmental impact of EEE by implementing clean production.

Transboundary shipment of waste is regulated by the United Nations via the Basel Convention and implemented by the EU in the Waste Shipment Regulation. The activities were all subject to controls under Council Regulation EEC/259/93 before 11 July, 2007 (the Waste Shipment Regulations-WSR) on the supervision and control of shipments of waste within, into and out of the European Community (as amended). Revision of the rules governing shipments of waste: Regulation (EC) No 1013/2006, replaced Regulation (EEC) No 259/93 with effect from 12 July 2007. It aims to develop a simplified but stronger regime for waste movement, ban certain types of waste exports, establish greater enforcement actions and streamline existing procedures. It also seeks to incorporate into Community legislation the amendments to the lists of waste annexed to the Basel Convention as well as the revision adopted by OECD in 2001.

The new regulation is seen as clearer than the old one, but e-waste trade remains a complex process. The international shipment of waste will depend on couple of questions, generally speaking:

- ***Whether the waste is being sent for recovery or disposal*** - most shipments for disposal are prohibited, and if they are allowed they are subject to notifications controls.
- ***The 'status' of the countries of dispatch and destination*** - if wastes moving within the EU, the procedures are different from those that apply if wastes moving out of or into the EU or to and from OECD countries.
- ***If being moved for recovery, the classification of waste*** - European legislation contains several annexes specifying different types of hazardous and non hazardous waste (ANNEX III, ANNEX IV, ANNEX V).

According to Regulation (EC) No 1013/200, the whole decision procedure can be recapitulated as follows:

Figure3.1: Decision Tree Procedure, based on Regulation (EC) No 1013/2006

On the one hand, noticing the waste subject to notification and consent features in the "Amber list" (Annex IV), while waste referred to for information purposes only features in the "green list" (Annex III). On the other hand, waste that is prohibited for shipment features in separate lists (Annex V). According to previous features of the shipment mentioned above, international waste shipments procedure is divided into three ways:

1) Prohibited (ANNEX V) - movements not allowed under any circumstances including almost all:

- exports for disposal
- exports of hazardous waste to developing countries (Non-EU and Non-OECD), even if moving for recovery

2) Notification controls (amber list control, ANNEX IV) - the procedure for prior written notification and consent. These apply to all permitted imports and exports of:

- hazardous waste moving for recovery
- any type of waste moving for disposal within EU
- and to some imports and exports of non-hazardous wastes for recovery

Where these controls apply the exporter need written permission before moving the waste and they must comply with a range of other requirements.

3) Green list controls (ANNEX III)- the procedure in which shipments are accompanied by certain information.

These are the lowest level of control and only ever apply to some (but not all) imports or exports of non-hazardous waste for recovery. Where these controls apply, exporters do not need any permission in the importing country before moving the waste, but they must provide a range of required information.

From the discussion above, it is obvious that EU WSR categorize the e-waste by its components, namely what components are in the WEEE, whether it belongs to the amber list or the green list. If it is found that it contains any components listed in the amber list, then it is not allowed to ship outside of Europe. However, it is also tricky to find that the entire WEEE or parts of WEEE are not listed anywhere. Box 1 lists the main categories relating to WEEE that should be considered when attempting to categorize WEEE that has not been subject to any sort of processing prior to shipment.

Categories relating to WEEE in the Waste Shipment Regulation *(source: "REVISED CORRESPONDENTS' GUIDELINES No 1, WSR")*

Annex III (green list)

GC010 Electrical assemblies consisting only of metals or alloys

GC020 Electronic scrap (e.g. printed circuit boards, electronic components, wire, etc.) and reclaimed electronic components suitable for base and precious metal recovery

Annex IV (amber list)

A1030 Waste having as constituents or contaminants any of the following:

- Arsenic; arsenic compounds

- Mercury; mercury compounds

- Thallium; Thallium compounds

A1160 Waste lead-acid batteries, whole or crushed

A1170 Unsorted waste batteries excluding mixtures of only list B batteries. Waste batteries not specified on list B containing Annex I constituents to an extent to render them hazardous

A1180 Waste electrical and electronic assemblies or scrap♦) containing components such as accumulators

and other batteries included on list A, mercury-switches, glass from cathode-ray tubes and other activated glass and PCB-capacitors, or contaminated with Annex I constituents (e.g. cadmium, mercury, lead, polychlorinated biphenyl) to an extent that they possess any of the characteristics contained in Annex III (note the related entry on list B, B1110)♣)

A2010 Glass waste from cathode-ray tubes and other activated glasses

A2050 Waste asbestos (dust and fibres)

AC150 Chlorofluorocarbons

A3180 Wastes, substances and articles containing, consisting of or contaminated with polychlorinated biphenyl (PCB), polychlorinated terphenyl (PCT), polychlorinated naphthalene (PCN) or polybrominated biphenyl (PBB), or any other polybrominated analogues of these compounds, at a concentration level of 50 mg/kg or more♥)

Waste not listed (Art. 3(1)(b) of the WSR)

- WEEE, or parts of WEEE, not listed elsewhere

•) This entry does not include scrap assemblies from electric power generation.

♣) PCBs are at a concentration level of 50 mg/kg or more10.

♥) The 50 mg/kg level is considered to be an internationally practical level for all wastes. However, many individual countries have established lower regulatory levels (e.g. 20 mg/kg) for specific wastes.

3.3.3 Member level: The Netherlands

Since 1998 The Netherlands have regulations concerning WEEE. In 2005 the EU directive on Waste electric and electronic equipment (2002/96/EC) and the directive on the Restriction of the use of certain Hazardous Substances in electrical and electronical equipment (RoHS, 2002/95/EC) were transposed to Dutch legislation: The WEEE management decree and the WEEE management regulations. There are two take-back systems: ICT Milieu and the Netherlands Association for Disposal of "Metalectro" Products (NVMP). Both programs are voluntary programs started by manufacturers and importers in December 1999. ICT Milieu covers ICT equipment (i.e. computers, printers, fax machines, photocopiers, and telephones) and NVMP covers white and brown goods (i.e. refrigerators and electrical consumer products such as television sets). These two programs are based upon the producer's responsibility, as well as the collecting system of discarded equipment.

The Ministry of Housing, Spatial Planning and the Environment (Ministry of VROM) takes the responsibility of implementing Regulation 259/93. The Ministry of VROM grants the permission to transport certain waste substance to certain destinations in the form of Regulation 259/93 decisions, and enforcement carried out by the Inspectorate from VROM. They not only determine whether administrative obligations have been effectively implemented but also examine whether the composition of the waste substances and the processing methods are in accordance with Regulation 259/93 or the Regulation 259/93 decision.

3.4 Chinese level

3.4.1 The Chinese network of competent authorities

Related with e-waste import and export, there are mainly 5 government departments in charge of this issue: China General Administration of Customs, and National Development and Reform Commission, the State Environmental Protection administration, the General Administration of Quality Supervision, Inspection and Quarantine, Ministry of Commerce (MoC), Ministry of Information Industry (MII), China General Administration of Customs, and local Environmental Protection Bureau, see table 3.2.

Table 3.2 Institution and Function for Management of E-waste in China

Competent Authorities	Main Function
National Development and Reform Committee (NDRC)	• Studying and resolving major problems, concerning the coordinated development of economy, society, environment and resource; • Putting forward polices and plans for resource conservation and comprehensive utilization; • Participating in the formulation of environmental protection plans, coordinating work related to environmental protection, and promoting clean production
State Environmental Protection Administration of China (SEPA)	• Organizing related departments to draft laws, regulations, catalogues and policies; • Coordinating among different departments; • Implementing the Basel Convention and licensing of waste import; • Supervising pollution prevention efforts of waste exporters and users of imported waste.
General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ)	• Registering overseas suppliers of waste materials and domestic recipients; • Conducting pre-shipment inspection and entrance inspection, and quarantine according to environmental control standards; • Issuing Customs Clearance Form of Entry Goods for accepted wastes.
Ministry of Commerce (MoC)	• Participating in drafting laws, regulations, catalogues and policies of import waste.
Ministry of Information Industry (MII)	• Studying out the medium-term and long-term development plans, policies and measures for manufacture of electronic and information products and industry of software;
Port Customs	• Taking charge of entry inspection, duty collection, and clearance based on import permit, as well as for combating waste smuggling.
Local (EPB)	• Supervising the operation of those units which generate, collect, store, transport, utilize and dispose solid waste and hazardous waste.

3.4.2 Chinese Regulations on transboundary movements of wastes

Generally speaking, there are currently no special regulations or policies in China concerning e-waste management problems. However, as a developing country member in the Basel

Convention, China has taken a series of actions to control the transnational flows of hazardous waste since the early 1990s. A series of laws and regulations are launched to better regulate the recycling, storage, and disposal of imported wastes, as well as banning imported waste that cannot be used as raw materials, see figure 3.2.

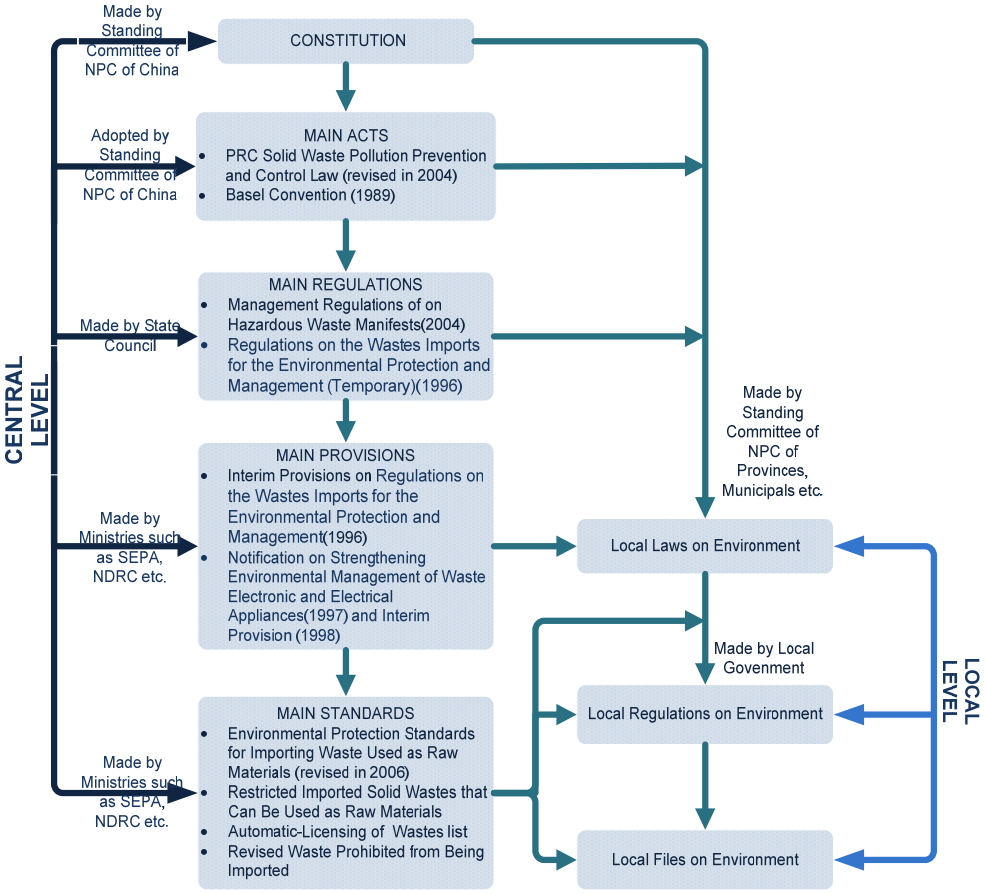

Figure 3.2 Legal framework for regulating imported wastes

The first law issued in 1996, named "**Law on the prevention of environmental pollution from solid waste**", was initiated by the SEPA. This law, in principle, regulates solid waste pollution and primarily introduces basic concepts of pollution prevention and control:

1) the principle that solid wastes should be reduced, properly recycled, and disposed of in an environmentally sound manner and

2) the institutions and individuals who generate solid wastes should take proper measures to prevent and reduce the pollution caused by those wastes (Li, *et al.* 2006).

The revised edition of "Law of the People's Republic of China on the Prevention and Control of Environmental Pollution by Solid Waste" was approved in December, 2004.

In 1996, the ***"Regulations on the Wastes Imports for the Environmental Protection and Management (Temporary)"*** and its "***Interim Provisions***" were issued by the SEPA. These provisions listed 30 types of waste could be imported as raw materials under nine categories: "(1) base metal scraps (especially iron, steel, copper, and aluminum); (2) smelt slag; (3) wood and wood articles wastes; (4) waste and scrap of paper or paperboard; (5) textile waste; (6) animal

wastes; (7) waste electric motors, as well as electric scraps, wires and cables; (8) waste transportation equipment; and (9) other wastes demanding special treatment. In October 1996, a tenth waste, plastic scraps, was added to the importing categories". Wastes outside of these ten categories is prohibited (Lin, *et al*. 2002).

"Notification on Strengthening Import management of Used Electrical Appliances" was issued by the Ministry of Foreign Trade and Economic Cooperation in October, 1997. It regulates that waste machinery and electronic products would not be imported no matter what resource of foreign exchange, commercial mode and import channel unless it must be approved for special reasons by the national import and export office of machinery and electronic products after January 1st, 1998. Without authorization of foreign trade, each unit could not sign any agreement to import waste machinery and electronics.

In October, 1998, ***"Interim Provision of Notification on Strengthening Import Management of Used Electrical Appliances***" was issued presenting *"the List of Important Used Electrical Appliances subject to Import Restriction"* in which all the categories listed couldn't be imported. In the list of limited-import waste which can be used as resource confirmed by SEPA associating Ministry of Foreign Trade and Economic Cooperation and Customs, category seven conclude all kinds of waste ironware, electric machinery, electric and electronic products, waste electrical wire and cable, waste metals, waste transportation products.

In February 2000, China published SEPA Document No. 19/2000 of January 24, 2000. This document entitled, "**Notification on Import of the Seventh Category of Wastes**," announced the following new law: From February 1, 2000, the seventh category of wastes approved by the State Environmental Protection Administration for import shall not include the following:

- Computers, monitors, and CRTs
- Copiers
- Microwave ovens
- Air conditioners
- Video cameras
- Electric cooking devices, rice cookers
- Telephones (except for pay-phones)
- Video games (except for processing for re-export)
- Televisions and picture tubes
- Refrigerators.

As China joined WTO in 2000, SEPA made significant adjustments and reforms for import waste management in 2001, and divided waste into the following two licensing categories: restricted imported wastes that can be used as raw materials, automatic-licensing imported wastes as raw materials and prohibited import.

- ***List of Restricted Imported Solid Wastes that Can Be Used as Raw Materials.***

Any imported wastes that need to be sorted or cured before recycling or could cause slight harm to the environment are listed as restricted imports. Here below lists the restricted import materials (table 3.3):

Table 3.3 List of Restricted Import Waste Materials (source: SEPA.)

Category	Denomination
Category1	Animal waste and manure
Category2	Refinery (metallurgy) scrap
Category3	Waste and scrap of wood and its byproducts
Category4	Recovered (waste and scrap) paper and paperboard
Category5	Textile wastes
Category6	Waste and scrap of metals and their byproduct
Category7	**All mixed metal scrap, used electrical equipment and electrical products**
	Used wires and cables (copper)
	Metal scrap and used electrical equipment (aluminum)
Category8	Used transportation equipment
Category9	Special imported waste
Category10	Waste plastics

- ***List of Automatic-Licensing Imported Solid Wastes that Can Be Used as Raw Materials.***

To streamline the importation of recyclable wastes that pose negligible environmental impacts, in December 2001, a new list was issued that identifies wastes that can be given automatic licenses. The 24 types of wastes that can be directly recycled with little or no pretreatment within China includes waste bones, wood, paper and cardboard, textiles, and scrap iron, copper, nickel, aluminum, zinc, tin and tantalum.

- ***List of Wastes Prohibited Import.***

a. *"Notification on Import of the Seventh Category of Wastes"* in Jan. 1st, 2000, is issued by SEPA, Ministry of Foreign Trade and Economic Cooperation, Customs General Administration and State Administration for Entry-Exit Inspection and Quarantine of the People's Republic of China. It points out that since Feb. 1st, 2000, the waste approved to be imported by SEPA did not include discarded TV sets and picture tubes, refrigerators, air-conditioners, microwave ovens, personal computers, display, duplicating machines, video cassette recorders, electric cookers, game-machines (except in processing trades) and telephone sets.

b. Catalogue of Goods Prohibited against Import (Batch V) (bulletin No. 25, 2002, issued by MOFTEC, China General Administration for Customs and SEPA). The name list of the 5th group of waste banned to import contained 21 sorts of E-waste such as air-conditioners, refrigerators, and products like computers, displays, printed circuit boards and TVs.

As regulated in the document *"**Notification on Strengthening Environmental Management of Waste Electronic and Electrical Appliances***" issued by SEPA in 2003, any E-waste containing discarded lead storage battery, Ni-Cd battery, mercury switch, CRTs, PCBs or other hazardous waste, it belongs to hazardous waste (called "e-hazardous waste" below for short). The e-hazardous waste should be provided or committed by the producer to those units with operation permits of hazardous waste for collection, storage and disposal; the transporters of e-hazardous waste must fill in the transportation manifests strictly according to *"Management*

Regulation on Hazardous Wastes Manifests" and also need to report to relevant environmental protection sections. This regulation was enacted in May, 2004 by State Council. It bans to dispose E-waste with lagging technologies and facilities which could result in pollution. It is also forbidden to refine metal by means of incineration in the open air or simple cupola or soaking in acid.

In addition, *"**Environmental Protection Control Standards for Importing Waste Used as Raw Material**s"* includes 12 tentative standards released in 1996 that outline environmental indicators that restrict radioactive, hazardous, and municipal waste from entering China. Such wastes require licensing for import and must be carefully inspected. Thirteen formal standards were issued in 2006.

3.4.3 Local level: Taizhou

Situated on the east coast of central China, the Taizhou city straddles 9,411 square-kilometer land area and encompasses more than ten national tourist sites. In the last two decades, e-waste has been perceived as a source of additional income by more and more peasants and unemployed laborers in Taizhou. It has become one of the first and biggest e-recycling sites in China nowadays.

As rapid local economic growth occupied, the issue of environmental pollution by E-waste in Taizhou had been attached great attention by the governments of all levels, media and some international non-governmental organizations. In recent years, the local government of Taizhou has put pollution control in the first place in the daily work (Taizhou Municipality website). And basically, local government is supposed to enforce the central government's policies effectively, or make their own policies and regulations even stricter than central government's, according to practical situation.

Up to day, Taizhou government has made great efforts to develop an environmental protection and construction of a ecotypic city. There are mainly five points of local policies:
(1) Local Environmental Protection Bureau (EPB) started to punish rigorously all illegal or unsound recycling activities and corporations in Taizhou since 2003.
(2) EPB supported the enterprises with licenses, which must be applied for environmentally sound treatment technologies, and seriously controls the effluents or waste subject to national or local environmental protection standards.
(3) EPB had banned around 40 locations or corporations who engage in illegal dismantling, metal refining and waste PCB recycling in 2006 (Taizhou EPB). Although disperse personal workshops which engaged in recycling waste PCBs still existed in Taizhou area, they were effectively controlled by the propaganda and encouragement mechanism to promote local people's prosecution and supervision.
(4) To accelerate the construction of the centralized processing park of discarded metal and electric goods. In this case, it centralizes all the processes to make sure not to lead to secondary pollution.
(5) EPB promoted the cooperation with other departments involved, such as port customs and Technical supervision bureau. There are several combined actions per year to control illegal imports and treatment.

3.5 What can be shipped from Europe to China?

It is very interesting to notice that, EU's WRS matches the international agreements to a large extent. It simplified wastes by its chemical properties, namely hazardous or non-hazardous, and divided into two categories "amber list" or "green list". But China incorporates the Basel Convention into its own positions, as all materials covered in shipment rules are accompanied by a postfix "can be used as raw materials". It seems quite difficult to connect and match two different regional systems, but there are some crossovers between the two, which might imply what is allowed to be shipped from the EU to China.

Firstly, let's examine what is legal shipment in China. In the list of restricted import waste which can be used as resources, category 7 is involving: "all kinds of waste ironware, electric machinery, electric and electronic products, waste electrical wire and cable, waste metals, waste transportation products". Another notification approved by SEPA later, is regulated that 7th category did not include: computers, monitors, CRTs, copiers, microwave ovens, air conditioners, video cameras, electric cooking devices, rice cookers, telephone set, video games, televisions and picture tubes and refrigerators (showed in figure 3.3). It seems China has developed an exclusive method to eliminate the illegal shipments. If the equipment belongs to the 7th category, and it is not listed in the prohibition list above, then it is allowed to import to China as it can be used as raw materials. Here it obviously generates a doubt "what if this equipment contains hazardous substances?" Furthermore, the metal scraps, plastics, and those e-waste byproducts are legal to ship to China, which might induce another problem "how pure should those scraps be". No quantitative parameters are given about that until now.

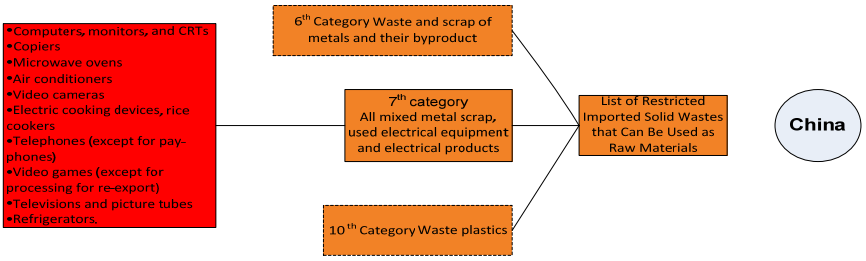

Figure 3.3 allowable e-waste imported to China

On the other side, it is not possible to get the answer from the EU shipment decision tree either (figure 3.4). With the help of WSR, It is rather straightforward to judge whether certain materials are allowed to be shipped outside of Europe, but it is not easy to categorize WEEE or parts of WEEE since they are not listed anywhere. In addition, any hazardous waste basically cannot be exported for disposal. But e-waste can be exported for "recovery", which includes reuse, repair and under certain conditions recycling, creating a grey area into which millions of tons of obsolete e-waste fall.

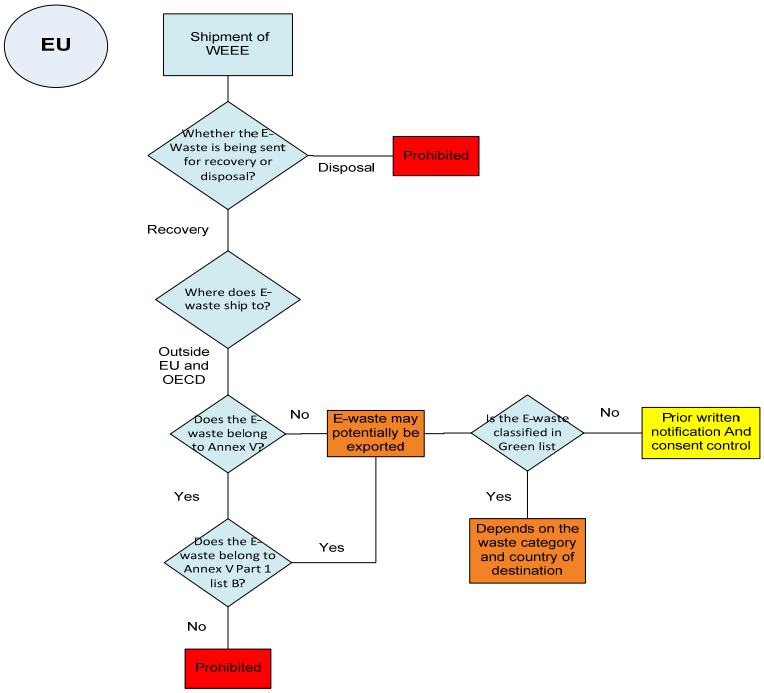

Figure 3.4 Allowable shipments from EU to China

Then take two legislative frameworks into consideration, the EU and China both are signatories to the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal. However, the convention becomes flexible when the goods are to be used for the same purpose, such as old computers are to be used as second-hand machines. As a result, the relevant regulating agencies in both exporting and importing countries have excuses to deny the import of hazardous waste and say that bringing in used computers is permissible since they will be reused.

3.6 An overview of waste shipments between the EU and China

No single source of waste flow data among the EU and China currently exists. Yet, a reasonable view of waste flow can be pieced together from a variety of sources. Interestingly, each country's view of waste flow differs somewhat from the others. After studying the laws and regulations from international level to local level, it is known that exports of entire waste of electronic equipments to China are strictly prohibited by Chinese Ban, EU WSR, as well as Basel Convention. But separated components, metal scraps for instance, are possible to import as they could be regarded as recyclable materials by Chinese regulations.

Information presented in this section is based on records of legal shipments of hazardous waste. One can only estimate about the size and volume of illegal shipments across international borders. Many consider this one of the key issues with respect to the enforcement of laws and regulations governing transborder movement of hazardous waste.

First of all, let us examine the official import data from China. Since the economic reforms began in the late 1970s, the demand for cheap industrial materials has increased in China. The imports of recyclable materials have increased rather steadily during the last decade, as shown in Figures 3.5. As a result, the global market shares also grew to the highest level in 2003 (Figure 3.6), accounting for almost 12% aluminum scrap, 35% copper scrap, 10% iron scrap and 40% global plastic scrap, are imported to China. Presently, China is one of the largest importers of recyclable materials in the world.

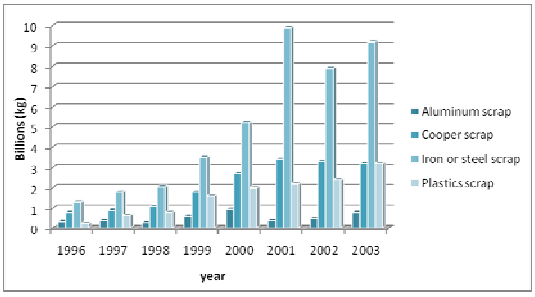

Figure 3.5 Volume of recyclable materials imported by China. (Source: SEPA compiled by the author)

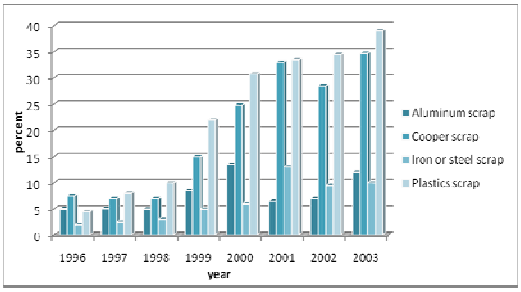

Figure 3.6 Global market shares of recyclable materials imported by China. (Source: SEPA compiled by the author)

Among the imported materials, data from Chinese customs statistics in 2004 reveals that more than 90 percent of imports were from Asia (34.8%), Europe (15.2%), North America (34.2%), and neighboring countries (8.3%). From a group of figures below (figure 3.7 to 3.10), we can see that there has been a conspicuous increase in exports from Europe to China since 1999. Among them, the EU became the largest exporters of aluminum scraps in 2004. And it is recorded that Germany, Belgium and the Netherlands were the major three exporters in all product categories (China Customs Statistics). These three countries account for approximately 80% of waste plastics exports from Europe (China Customs Statistics). At the same time, exports from the UK, France, Italy and Spain have also been on the rise in recent years (China Customs Statistics).

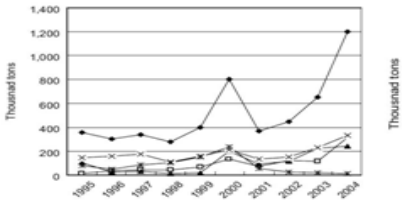

Figure 3.7 Chinese Aluminum Scrap Imports (Source: Chinese customs statistics).

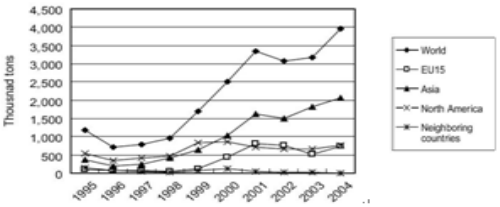

Figure 3.8 Chinese Copper Scrap Imports (Source: Chinese customs statistics).

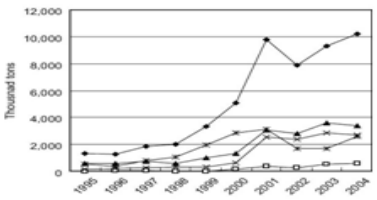

Figure 3.9 Chinese Iron and Steel Scrap Imports (Source: Chinese customs statistics).

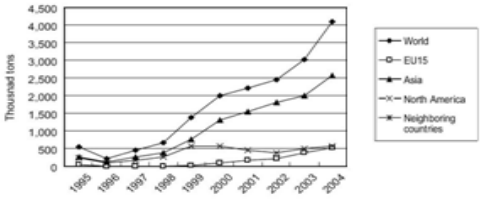

Figure 3.10 Chinese Waste Plastic Imports (Source: Chinese customs statistics).

Note: Asia: Hong Kong, Taiwan, Japan, Korea, Singapore, Malaysia, Thailand, Indonesia, the Philippines, Macau, Mongolia, And India.

Europe: the 15 countries of the EU.

North America: the United States and Canada.

Neighboring countries: Russia, Kazakhstan, etc.

From Chinese official data, there is no doubt on the contributions the EU had made to Chinese

raw materials import. This information can also be proved by the EU statistic data. Exports of recyclable wastes from the 15[7] to destinations outside the Community are shown in table 3.3. In 2003, it exported 1.12 million tons of waste plastics, 4.88 million tons of used paper, 8.74 million tons of ferrous scrap, 538 thousand tons of copper scrap and 528 thousand tons of aluminum scrap. Beside ferrous scrap export, China and Hong Kong are the main destinations for the rest of EU recyclable wastes.

Take copper for instance, China recorded around 500 thousand tons that were exported from EU15 in 2003, while the EU shows there are approximately 340 tons (538*62%=340) shipped to China (table 3.4). So we can conclude more than 60% of copper scraps were imported from EU15 in 2003.

Table 3.4 Exports of Recyclable Wastes from the 15 EU Member States (source: EU trade statistics)

	Exports (thousand tons)		Top 3 Export Destinations in 2003		
	2002	2003	First	Second	Third
Waste plastics	771	1,125	Hong Kong (56%)	China (24%)	USA (7%)
Used paper	4,444	4,888	China (29%)	Indonesia (22%)	India (9%)
Ferrous scrap(1)	7,874	8,740	Turkey (41%)	USA (11%)	India (10%)
Copper scrap	378	538	China (62%)	India (13%)	Hong Kong (6%)
Aluminum scrap	492	528	China (51%)	India (7%)	Taiwan (6%)

Note 1: The specific tonnages are unknown in some cases. For the top three export destinations, the weights have been calculated using those exports for which tonnages are known.

It is clear that there are some differences on the data recorded in China and the EU. Take aluminum for instance, China recorded less than 200 thousand tons were exported from EU15 in 2003, while the EU shows there are nearly 210 tons (518*51%=210) shipped to China. And it is also incredible to find a statement that 70% of global e-waste is shipped to China. However, during the interviews, officials declare that the figures described in Medias are absolutely impossible. Therefore, there seems to be a great conceptual gap on actual amount of e-waste imported to China. According to the responses from several interviewees, there are many reasons to account for this gap:

- ***Difference in definition of e-waste.***

As most e-wastes originate from the U.S, a super country that did not sign Basel Convention yet, some e-waste are classified as “e-waste” according to U.S regulation, do not necessarily appears to be real “e-waste” that are prohibited under Chinese regulation. So, the “e-waste” appearing in the report are not necessarily refering to so called “e-waste”.

- ***Hong Kong’s special position.***

Hong Kong is such a big and free harbor in the world that a large amount of good are transferred in Hong Kong. As Hong Kong is a special administrative region of China, the e-wastes that are supposed to be transshipped in Hong Kong and actually destined to other countries, like Pakistan and India. This may lead to miscalculations as well.

- ***Smuggles that are not following formal procedure at all.***

In the south of China, especially in Guang Dong Province, there are some illegal shipments landing in unknown ports, which completely ignore the required formal shipment procedures. Little is known about this figure.

[7] Prior to expansion in 2004, the EU was comprised of 15 countries, namely: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the UK.

But when it comes to the question "how much waste has been exported", the answer will be "nobody knows". Because a large amount of illegal shipments is unreported, the volume is shocking and hard to estimate.

> *Illegal shipments refers to (illegal) export of waste to countries that are party of the Basel Convention (article 16 of the Regulation), ACS countries (article 18 of the Regulation), or (illegal) shipment of waste without a notification and without permission of the competent authorities (article 26 of the Regulation).*

The analysis in illegal e-waste shipments in the Netherlands is shocking as well. "For example, it was found that at least 20% of discarded televisions had been illegally collected and exported to non-OECD countries," according to the inspector from VROM. The equipment was roughly exported under the name of" second-hand goods for reuse", but VROM discovered that 50-90% of the material had been processed and should therefore have been considered as waste. In addition, data reveals that around 4-5 million tones WEEE is discarded each year in Europe. But only one million tonnes were collected through the official take-back schemes, nobody knows what happens to the rest (Beck, 2007).

Although Basel convention, OECD Decisions and European WSR have made a dent in the export of old electronics to China, leakages, and sometimes bribes, allow many to skirt the requirements (Bodeen, C., 2007). The business is driven mostly by economics. "For the West, where safety rules drive up the cost of disposal, it is as much as 10 times cheaper to export the waste to developing countries. In China, poor migrants from the countryside willingly endure the health risks to earn a few yuan and are exploited by profit-hungry entrepreneurs" (Bodeen, C., 2007).More than 90 percent ends up in dumps that are not controlled by environmental standards, where shredders, open fires, acid baths and broilers are used to recover gold, silver, copper and other valuable metals while spewing toxic fumes and runoff into the skies and rivers (Bodeen, 2007).

IMPEL's Seaport project (source and photo source: IMPEL, 2006)

In June 2006, the IMPEL network - which includes EU enforcement authorities and representatives from other European countries dealing with transfrontier waste shipment issues - carried out 175 inspections of waste exports in 13 EU member states, including 97 custom document checks, 60 inspections at storage locations, 68 traffic inspections, and 27 vessel inspections.

IMPEL found that, out of 1103 waste shipments, some 564 - or 51% - turned out to be illegal. Of these, 473 - or 43% - fell foul of Article 11 of the EU's Waste Shipment Regulation. Most of the ships were checked in Belgium and the Netherlands. Of these, some 20% of waste shipments were found to be illegal, while infractions were recorded in, respectively, 15% and 51% of cases. Problems were evenmore apparent in the UK: as a result of 153 physical examinations at seven ports, 133 loads (86%) of UK waste shipments to destinations around the world were found to be illegal.

3.7 Conclusion

This chapter presents an overview of transboundary shipment in international level, EU level and China level. These international agreements, such as Basel Convention and OECD Decisions, establish the broadest framework. They distinguish e-waste from “hazardous waste” to “non-hazardous waste”, and “hazardous waste” is absolutely prohibited when it transshipped outside of OECD countries for the purpose of “disposal”.

National status and regulation establish domestic provisions compliant with these international agreements, as well as adapting them to their own positions. There are some fundamental differences if we compare the EU and Chinese e-waste legislation frameworks (table 3.5):

Table 3.5 Comparison between the EU and China WEEE legislative frameworks.

	EU	China
Lead authority	One (ministry of VROM)	Several (SEPA, NDRC, AQSIQ, etc.)
Regulation on WEEE management	WEEE Directive, RoHS Directive, and WSR Regulation	None yet
Waste classification	By chemical property (hazardous or non hazardous)	By resource demand (whether it can be used as raw materials)
The aim of legislation	Combat unsound disposal.	Get more resources.
Legislation base	builds on environmental awareness	Environmental awareness/responsibility is as yet less developed

The number of competent authorities is different. In some European countries, there is one lead authority at the national level that assumes the overall responsibility for the WEEE management system, with other authorities cooperating. In China, a number of different authorities at all levels have competences related to the WEEE system.

There are several regulations on WEEE management are issued in the EU. It is found out that there is no special regulation dealing with waste shipment so far in China, although there are some relevant regulations and policies.

The waste classification is different. All material lists covered in shipment rules in China, are all accompanied by a postfix “can be used as raw materials”. But just simplified wastes by its chemical properties, namely hazardous or non-hazardous, into two categories “amber list” or “green list”.

The aim of legislation is different. In Europe, e-waste is generally considered as worthless, and is discarded normally. The aim of the EU Directives and legislation is to combat unsound disposal. In China, e-waste is generally seen as a resource, and there is a market for it. As a result, the aim of Chinese legislation is to get more resources to meet domestic huge demand, and upgrade existing systems of collection / re-use / recycling to make them economic profitable.

The legislation base is different. In some European countries considered, public awareness of

environmental issues has developed over the past decades. Relevant legislation builds on environmental awareness. In China, environmental awareness and responsibility are much less developed.

When it comes to the question “what can be transshipped between EU and China”, there is no exact answer. It is found that neither a Chinese nor EU regulation has strict and precise descriptions on e-waste that can be imported or exported. And e-waste can be exported for “recovery”, which often under the name of “reuse, repair, second-hand product”, creating a gray area into which millions of tons of e-waste have disappeared.

Besides the loopholes in laws and regulations, there might be some problems in the monitoring system. In the next chapter, we will study the administrative and monitoring systems in EU and China, based on the current legal framework. Followed by the discussion on the current gaps between two systems, it aims at testing the tracking capacity of a single shipment from origin to destination.

Chapter 4

Current Systems to Track Transboundary Movement of Waste

Domestic statutes and regulations incorporate the administration and monitoring systems of transboundary movement of e-waste as articulated in international agreements. These laws make it compulsory for waste exporter, competent authorities, shippers, treatment facilities, storage facilities, etc., to submit information to relevant government agencies at three phases of shipment:

- Prior to shipment, generally obtain the export/import permits, registered in the information system, and notification to export or import
- During shipment, generally accompanied by the form of waste manifest information ,
- After shipment, namely receipt at the final treatment, storage or disposal facility, generally in the form of a management log or annual report.

This life-cycle concept is helpful to guide us understand how provisions in various domestic statutes and regulations affect the monitoring of transboundary movement of waste.

The study is carried out in China and the Netherlands, which represent typical importing country and exporting country respectively among global e-waste stream. This chapter shows the principal statutes and regulations that establish tracking and control systems within each of the countries.

4.1 The Dutch administrative and monitoring system on exporting waste

The Ministry of Housing, Spatial Planning and the Environment (Ministry of VROM) is the competent authority in the Netherlands to implement the EU Regulation 1013⁄2006 on waste shipments import from, export waste to, or transport waste through a EU member state. As a part of ministry of VROM, the VROM-Inspectorate performs several international activities and projects related to e-waste.

In addition, as a national and international knowledge centre on all matters related to waste, SenterNovem's Waste Management Department (WMD) is the Dutch principal organization for managing and tracking movement of e-waste at the international level. It performs a wide variety of waste-related activities for the Ministry of VROM, including:

- *Implement the National Waste Management Plan (LAP)*
- *Monitor and evaluate waste policy*
- *Stimulate waste prevention and the separate collection of waste*
- *Explore future developments in the national and international waste market*
- *Stimulate sustainable purchasing and sustainable enterprise.*

(Source: SenterNovem website).

Any enterprises wishing to import or export waste across national borders must comply with the EU regulation on the supervision and control of shipments of waste within, into and out of the European Community (EU Regulation EC 1013⁄2006). The procedure that must be followed depends on the list on which the particular waste substance appears. The Regulation contains two lists: the green list (Annex III) and the amber list (Annex IV). A shipment of Mixture of waste substances is also covered in the rules. No matter what wastes are being shipped, they are generally subject to two procedures if they are allowed: the procedure of prior written notification and consent (amber list control) and general information requirements (green list control).

When we consider the shipments export from the EU to China, we take a procedure of prior written notification for an example, see table 4.1.

Table 4.1 administration and monitoring system in the Netherlands

Shipment procedure	Prior written notification and consent procedure		authority
Before shipment	Contract between the exporter and the importer	Exporter to take back the waste if the shipment has been an illegal shipment Importer to recover or dispose of the waste if it has been effected as an illegal shipment Certificate that the waste has been recovered, in accordance with the	

		notification	
	Notification and movement documents	Notification form Transport form relevant annexes must be accompanied by a consignment note	SenterNovem
	Financial guarantee	Costs of transport Costs of recovery or disposal, including any necessary interim operation Costs of storage for 90 days.	SenterNovem
	Export permit		SenterNovem
During shipment	Port inspection	Inspect the entry and exit of waste shipment Duty collection	Port customs
After shipment	Environmental sound management	ANNEX VIII, GUIDELINES ON ENVIRONMENTALLY SOUND MANAGEMENT (ARTICLE 49)	no authority designated

1) Before shipment

Firstly, all shipments of waste for which notification is required shall be subject to the requirement of the contract between the exporter and the importer for the recovery or disposal of the notified waste. The contract shall include obligations for both the exporter and the importer.

Secondly, Dutch companies have to send a notification of the proposed shipments to Senternovem's WMD. WMD must be notified of all waste movements so that it is possible to track any consignment at any point in the shipment. The notification must be made on a set of documents and forms which are standard throughout the EU. These forms, consisting of a notification form and a transport form, and any relevant annexes must be accompanied by a consignment note.

Once the notification has been properly carried out, the competent authority of dispatch shall transmit the notification to the competent authority of destination with copies to any competent authority (ies) of transit, and shall inform the exporter of the transmission. A written consent to a planned shipment should be complete between competent authorities of destination, dispatch and transit.

Thirdly, enterprises wishing to transport waste across national borders have to provide a financial guarantee to cover the costs that the competent authority in the country of dispatch has to make in the event it has to take back the waste and arrange the processing of the waste. The level of the guarantee differs from the quantity and nature of the waste. The guarantee is only deleted when declarations have been received from the final processor of the waste that all the waste has been processed in an environmentally sound matter.

Finally, the type of permit is issued by WMD, depending on the nature of the waste that will be

transported across the border, the method of waste processing and the country of destination.

2) During shipment

Dutch Tax and Customs Administration are responsible for a wide range of activities nationally and internationally, including levying and collecting taxes and national insurance contributions, detecting fiscal, economic and financial fraud, and supervising the import, export and transit of goods.

Taking Customs Rotterdam for example, millions of tons of goods enter and leave the harbor per day. Particular attention is paid to the containers and bulk goods that are imported, exported and carried in transit. The volume of goods transported in containers is constantly increasing. Customs monitors these transports by using container scans, mobile scans and mobile detection gates, amongst other things.

3) After shipment

Basically, in order to ensure that wastes are handled in an environmentally sound way, the competent authority of dispatch in the Community shall do following checks, although there are no competent authorities designated to enforce this requirement.

> - *Require and endeavor to secure that any waste exported is managed in an environmentally sound manner throughout the period of shipment*
> - *Prohibit an export of waste to third countries if it has reason to believe that the waste will not be managed in accordance with the requirements of point.*
>
> (Source: WSR Regulation)

4.2 The administrative and monitoring system on import waste in China

At present, there is no single institution to supervise the all-process stream of e-waste including import procedure, treatment and ultimate waste disposal. The supervision on each phase of the whole process has been conducted by some domestic institutions under the assistance of industry's associations. Table 4.2 summarizes all necessary information.

Table 4.2 Chinese administrative and monitoring system before, during and after shipment

Shipment procedure			Authority
Before shipment	Registration	• Registration of overseas suppliers • Registration of Domestic Consignee	AQSIQ
	licensing	• Import license of Waste as Raw Materials under Automatic License Category • Import of Solid Waste as Raw	SEPA

		Materials and Under Import Restriction	
	Pre-shipment Supervision	• Cargoes conforming to the project examined and approved by the State; • Quantity and specification of cargoes conforming to those specified on the contract and loading list; • Preliminary evaluation for safety, sanitation, and environmental protection.	CCIC oversea
During shipment	Entrance inspection	• Entry inspection • Duty collection • Clearance based on import permit • Combating waste smuggling	Port Customs
	Port Supervision & Quarantine	Issuing Customs Clearance Form of Entry Goods for accepted wastes	QTSB
After shipment	Environmental supervision on recycling process	• Periodical report • Centralized administration in the Industrial Park • Hazardous waste management • Import quota allocation	EPB
	Free trade on materials market		no authority designated

SEPA: State Environmental Protection administration

AQSIQ: Administration of Quality Supervision, Inspection and Quarantine

CCIC: China Certification & Inspection Co,.Lcd, authorized by AQSIQ

QTSB: Quality Technical Supervision Bureau, AQSIQ's local department.

EPB: Environmental Protection Bureau, SEPA's local department

1) Before shipment

Implementation Details of the Registration Scheme Concerning Overseas Suppliers of Waste Material Imports, promulgated and implemented by the General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), make it mandatory for foreign enterprises. The importing enterprise, is required to be registered in the system, to ensure that imported wastes will comply with the environmental protection standards as well as other mandatory requirements and technical regulations of the state.

Solid wastes that can be used as raw materials may not be imported without consent in the form of an import license. The SEPA of China is the designated authority for the environmental management of solid waste import. Before shipment, it is responsible for the issuance of the: (1)

import license for restricted solid waste that can be used as raw materials; and (2) import license for automatic-licensing solid waste that can be used as raw materials. Local environmental protection Bureau enacts such licenses according to a series of National Environmental protection Standards. In addition, Environmental Impact Assessment for treatment process has to be conducted as well.

In order to strengthen the pre-shipment inspection work of import waste raw materials to the Mainland of China, AQSIQ authorizes a batch of Pre-shipment Inspection Organizations. The overseas supplier enterprise should apply for pre-shipment inspection with the local Authorized Pre-shipment Inspection Organization where the material are loaded or shipped. In case the loading or shipping place is not under the Named Countries and Regions, they can apply for the nearest Authorized Pre-shipment Inspection Organization by providing necessary inspection conditions. Waste raw materials that are not undergoing Pre-shipment Inspection and do not possess the Pre-shipment Certification are not allowed to enter into the Mainland of China.

2) During shipment

China Customs is a government agency that supervises and manages all arrivals in and departures from the Customs territory of the mainland of the People's Republic of China. Its specific responsibilities include revenue collection, fighting smuggling, Customs control, supervision and management of bond operations for processing trade, foreign trade statistics compilation, audit-based control and risk management, and port management.

When the imported old machinery and electronic products arrive at the destination port, the importer or its agent should handle the related customs clearing formalities by providing necessary documents and certificates. Local inspection and quarantine institutions should, upon acceptance of the report for inspection, check the documents and certificates, issue a Customs Clearing Note of Entry Cargoes, specify on the Customs Clearing Note of Entry Cargoes that they are old cargoes, and conduct inspection if necessary. Items of inspection involved in the arrival inspection of imported old machinery and electronic products include: box-opening inspection and inspections of safety, sanitation, environmental protection.

3) After shipment

First of all, all waste electrical & electronic products and materials processed by enterprises should be classified and registered for data saving. The information includes waste type, weight, quantity, technological process, and pollution treatment. All these data will be accessed and examined by the local environmental protection Bureau per certain period.

Secondly, integrated solid waste management at the industrial Park level t is promoted. Under centralized administration on e-waste recycling and reusing, it could

- achieve better control on materials flow, by regularly checking goods from both entrance and exit
- share environmental cost and minimize the environmental impact, by setting up advanced environmental equipments to treat massive hazardous wastes together

- also maximize the economic benefit generated from the whole waste recycling chain as its "loop" management" .

Thirdly, for those treatment plants which are capable of controlling air/waste/waste pollution, Local environmental protection Bureau will access their equipment and test performance based on National Standards of Environmental Protection; if equipment cannot reach national environmental standards, all these hazardous wastes have to be sent to the qualified plants that the local environmental protection Bureau designates.

In addition, the local environmental protection bureau will allocate annual import quota to each potential import, based on the annual assessment report. The more qualified treatment plants, the more quotas can be obtained. In other words, the local environmental protection Bureau expect to promote large, formal and qualified treatment plants to handle all imported import solid waste, and clamp down those informal, small scale working units.

However, it is found that no system or authorities continue monitoring after products and half-products approaching material market. All materials trade takes place under the principle of profit maximization.

4.3 The Ship-back Problem

With the transboundary movement of recyclable wastes, there are some problems of irresponsible export and distribution of waste containing hazardous substances and trash that is difficult to recycle. Generally speaking, the flows of foreign garbage into China and the incidents resulting in the return of waste consignments occur in two ways:

Firstly, there are shipments that are imported without passing through customs, so called smuggling. And some of the unidentified export items are believed to account for it.
According to the customs official in TaiZhou (interview guide), smuggling mostly happened in south ports of China, the most representative is Guangdong province. Police, Customs officials and local governments have worked together and applied enforcement methods, to shut down illegal recycling bases and so forth, in a bid to halt smuggling. But in Guangdong Province, illegal movement of e-waste remains rampant. It is reported that unusable CRT televisions being exported to Hong Kong as secondhand goods, but then smuggled into China or exported to the mainland after being dismantled in Hong Kong (Yoshida, *et al,* 2003).

Secondly, there are cases of prohibited imports items being falsely labeled as "second-hand goods for reuse or "waste papers", and they are sometimes contaminated with household rubbish.
Once these shipments are found, the execution depends. If there are only small amount of prohibited goods, importers will pay certain penalty. If the amount exceeds the amount regulated in relevant policies, the shipment will be send back to exporting countries, or send to the Police who is in charge of suppressing smuggling (Interview guide).

The biggest problem with back shipments lies in identifying who is responsible and where to return the shipments. In principle, if the goods are classified as hazardous waste by the Basel Law of exporting country then, the exporter (the generator of the waste) and, ultimately, the government of the exporting country has responsibility for return shipment. However, when the exporting country is not a member of Basel Convention or the goods in question is not defined as hazardous by the Law (e.g. cases that violate Chinese standards), the responsibility between exporter and importer has not been clarified. Or, in many illegal shipments, the country of export is unknown or the goods are labeled as having transferred from Hong Kong, which makes it difficult to ship the goods back to the country of origin (the generator of the waste).
In addition, there are also many shipments failing to subject to Chinese standards, but they are not in violation of exporting country's law. So they will not receive strict punishment in the exporting country even if their exports are shipped back by China (Yoshida, *et al,* 2003).

False labeling in the Netherlands (source and photo source: IMPEL, 2006)

In inspection week 4 of 2006, a lot of infractions and illegal shipments were detected in the Netherlands. In most of the cases used electronic equipment was loaded in second hand vehicles. The equipment is mostly declared as second hand goods and is – according to the explanation of exporters – still working. For example, a used truck was declared, loaded with personal goods and destined for Africa. Inspection inside this truck showed that it was loaded with televisions and Hi-Fi equipment. But the inspectors tested the televisions: more than 50% were not working anymore and were considered as hazardous waste.

The shipment has been returned to the exporter with the obligation to sort out the materials in working and non working apparatus. An official report has been made for this illegal shipment to the exporter and the shipping agent.

At the beginning of April 2006 the shipping agent contacted the inspectorate again. He told that the owner wants to export the vehicles through another port without sorting out the apparatus. After a firm conversation between the inspectorate and the owner, there is the impression that the exporter will export the material within the applicable regulations.

4.4 Gaps between Dutch and Chinese administrative and monitoring system

Any person or company who wants to ship waste from the EU to China, has to comply with regulations from both sides. As observed from above context, variation is obvious between the Netherlands and China in their approach to supervision and enforcement. States differ in the number of enforcement agencies involved, how they are organized, the kinds of shipment procedure and strategies applied, and the severity of sanctions available. Perhaps more central to this project are issues of compatibility of systems between the Netherlands and China. The key question here is whether the monitoring systems are compatible with each other. Neither the Dutch tracking system nor the Chinese system is capable of tracking a single shipment from origin to destination when the origin is in one country and the destination is in another. Sources of this inability emanate from:

- ***Different legal base***

The most significant difference is that there is no special regulation dealing with waste shipment so far in China. The EU has developed its waste shipment rules since 1993 (EUROPA, 2008). Around 1970, as environment pollution became visible, rules were initiated in the EU for waste management. With regards to electronic products, the EU has established a comprehensive body of environmental legislation, based on two Directives: WEEE and RoHS. As shipments increased between different member states, the EU intends to work towards more environment-friendly option. This means rules for shipment and treatments of waste were finally ready in 1993. Transboundary shipment of waste is regulated by the United Nations via the Basel Convention and implemented in the EU by the “Waste Shipment Regulations”.

Waste shipment management is not new for the EU, but it is still relatively fresh for Chinese government. Until recent years, China suffered intensive pressures from the media and other international organizations, as growing concern over how China will manage its increasing piles of waste electrical and electronic equipment (Bodeen, 2007). Central government departments have drafted a number of interrelated legislations since 1996, but no complete and integrated law is enacted yet considering waste shipment. A number of regulations, provisions, standards, notice and announcement are currently in operation to fulfil the obligations. However, as a result of growing interest in the WEEE recycling business from public and private sectors, there is a strong voice in the market for significant changes for China’s largely unregulated and environmentally unsound WEEE processing industry (Hicks, *et al.* 2005). The rationale behind these legislative and market developments is clear, driven by economic factors as well as the environmental and health impacts of WEEE recycling and disposal. Therefore, we can confirm that complete laws or regulations will come out to regulate this market sooner or later in China.

- ***Different conception of e-waste***

The EU WEEE Directive,contains a comprehensive and broad list of electrical and electronic appliances (table 4.3). Whereas China has no clear definition of WEEE from both, the official and

the academic circles. As seen in the table, each ministry has a different conception and understanding of e-waste, based on their own perspectives. This demonstrates no official consensus has been reached on the e-waste conception so far.

Table 4.3 Conception of e-waste in China and the EU

	e-waste in China	e-waste in EU
e-wastes category	• NDRC Draft: Waste (=not functioning) and used (=functioning, suitable for second-hand use) household appliances, including televisions sets, refrigerators, washing machines, air conditioners, computers. • SEPA Draft: Hazardous wastes as listed in the State list of hazardous wastes, or other applicable standards. • MII Measures: Electronic information products, i.e. products and their accessories manufactured by using electronic information technology, as listed in the Measures	Electrical and electronic appliances of the following types: • Large household appliances • small household appliances • IT and telecommunications equipment • consumer equipment, • lighting equipment, • electrical and electronic tools • toys, leisure and sports equipment • medical products • monitoring and control instruments • automatic dispensers

The most popular and widely accepted concept in China on discarded household appliances at present just includes discarded TVs, refrigerators, washing machines, air-conditioners and PCs. Discarded Household Appliances contain waste ones and used ones (NDRC, 2004). Waste ones refer to “those electric goods which have lost the function to use or after reasonable repair still cannot meet the safety and performance standard for reuse; used ones refer to those “which satisfy the requirements of safety and usage for reuse and could be sold and used as second-hand goods”.

- ***Distinct classification of e-waste***

Somewhat more problematic, according to most officials interviewed, are differences in e-waste classification. The shipment procedure in the EU depends on the substance’s impact on the environment, namely hazardous or non-hazardous, and it is categorized as amber list or green list. But in China, waste is viewed as a resource and income-generating opportunity. So the list of waste that can be imported must comply with the “Can Be Used as Raw Materials”. The inconsistent classifications of waste directly result in inconsistent waste shipment procedures between exporting and importing countries. When considering a real batch of e-waste shipped from the EU to China, several troubles emerge, for instance:

- ***Waste allowed to import but in the EU Amber list?*** Under this circumstance, which shipment procedure should be followed, the EU or China? Like category 2 (table 4.4).
- ***Wastes are neither in the green list nor in the amber list.*** How to deal with them? Are these shipments regarded as illegal activities? For instance, the whole product, is neither in the amber nor in the green list.

Table4.4: List of Restricted Import Waste Materials (consult from SEPA, 1996)

Category	Customs Code	Denomination	Classification in the OECD List
Category 2	2619.0000	Refinery (metallurgy) scrap	Amber
Category 6	Waste and scrap of metals and their byproduct		Green
	7204.1000	Waste and scrap of cast iron	
	7204.2100	Waste and scrap of stainless steel	
	7204.2900	Waste and scrap of other alloy steel	
	7204.3000	Waste and scrap of tin-plated iron or steel	
	7204.4100	Other waste and scrap: Turnings, shavings, chips, milling waste, sawdust, filings, trimmings and stampings, whether or not in bundles	
	7204.4900	Other ferrous waste and scrap (including used rail track)	
	7204.5000	Remelting scrap ingots (including used factory equipment, etc.)	
	7404.0000	Copper waste and scrap	
	7503.0000	Nickel waste and scrap	
	7602.0000	Aluminum waste and scrap	
	7902.0000	Lead waste and scrap	
	8002.0000	Tin waste and scrap	
	8103.1000	Tantalum waste and scrap	
Category 7	All mixed metal scrap, used electrical equipment and electrical products		Not listed
	7404.0000	Used wires and cables (copper)	
	7602.0000	Metal scrap and used electrical equipment (aluminum)	

In table 4.3 above, the distinction in definitions of e-waste from two control systems can be seen. It is found that no uniform interpretations of the Regulation exist on “waste or not”, “allowed or not allowed to send or receive green listed wastes”, and “second hand product or e-waste” etc. Also there are vague and unclear understandings on recovery and disposal, dispatch and destination countries. As a result, differences occur in the interpretation of other waste related regulations, like Metal scrap and used electrical equipment (aluminum) and mixed metal scraps, as mentioned by the Regulation.

- ***Large variety in tasks, competencies and jurisdiction of competent authorities involved***

There is a large variety in tasks, competencies and jurisdictions of organizations involved in the enforcement of waste shipment regulations. In China, enforcement of waste shipment regulations is laid down on several organizations, varying in tasks, competence and legal power. While in the Netherlands, enforcement is a primary concern of one national oriented enforcement authority, namely Ministry of VROM.

- ***Seldom cooperation during enforcement***

From interviews from both sides, it is found that little information was exchanged between two systems, unless severe illegal shipments were detected. The information refers to the information on problematic waste streams, involved companies, bottlenecks and leaks in (inter-)national waste shipment legislation and cooperation with Competent Authorities, ultimately to improve the effectiveness of enforcement and prevent illegal waste shipments. Although more and more interactions are promoted between high officials, slight improvement has been made in pragmatic shipment procedure. Information exchange, intelligence and international coordination between organizations involved in the enforcement of waste shipment regulations is found to be essential for better enforcement and to tackle cases of port hopping.

- ***Inability to track shipment, especially after shipment***

The most critical issue with respect to tracking ability across border is the inability to track the information "after shipment", because of inconsistent shipment-based recording system. Wang Chao, deputy Section Chief & Section 1 of clearance Customs Superintendent First Class, Shanghai PuDong International Customs, expressed:

> *Some information about oversea cooperation between different countries indicates another problem. Although a lot of communication and interaction between export and import countries are announced in the publications, no pragmatic data is shared because of different recording system. And little cooperation was observed in exporting and importing procedures. It seems higher officials get the opportunities to exchange information, without real improvement in practical. (Source: Interview guide)*

Although each country develops its own monitoring systems, they did not interact well with each other. This is one of the principal reasons why the information on imports is not linked to the information on receipt by facilities, the information on expected shipments is not connected to the information on actual shipments, and the information on one side of the border is not connected to the information on the other. China, for example, receives no information from Dutch authorities on actual shipments of Dutch waste to China. So when these wastes arrive at the border, apparently the same problem exists for Dutch authorities, as they did not get any information on further treatment in China.

According to the Waste Shipment Rule (EU Regulation EC 1013/2006), it is required for importers to provide a certificate before any shipment that they have the capability to handle and reprocess hazardous wastes in an environmentally sound manner; and that the importer has adequate facilities for treatment and disposal of wastes generated. However, on the one hand, as exporting countries, they do not have access to the information and data on what actually happens to the waste that is exported and when it reaches its destination. On the other hand, importing countries fail to complete the requirements of issuing a "certificate of environmental sound processing". They currently do not have a reliable means to establish the extent of environmental harm caused by such exports in the destination state.

- ***Language barrier***

It seems a very minor question, but translation of all relevant regulations from English to Chinese and vice versa is quite inconvenient in practice, given the huge distinction between those languages. As the Inspectorate of VROM, Carl Huijbregts said "I wish someone could translate more Chinese laws and regulations to Dutch, in order to help us understand clearly what the

requests are from the Chinese side". Language difference is not problematic itself; the problem is that the difference makes people less willing to communicate. In this sense, languages differences have built some barriers to communicate effectively during the enforcement, but it won't be problematic in the long run.

4.5 Conclusion

Administrative and monitoring systems exit to assure that pre-notification and consent take place for those who enter the system and the related information is kept for future uses. But administrative and monitoring systems which accomplish these goals do not necessarily accomplish the broader goals of:

- *Monitoring all transboundary shipments of hazardous waste*
- *Ensuring that all waste which should be shipped transnational is actually shipped, and*
- *Ensuring that the shipped waste is handled in the most environmentally safe manner.*

This chapter presents two distinct administrative monitoring systems from exporting country to importing country. With regard to international waste movement, neither the Dutch nor the Chinese system is capable of tracking a single shipment from origin to destination. Each country develops its own enforcement schemes and interpretations, which limits its ability to enforce domestic laws and shows less compliance with foreign regulations. These inabilities are due to several reasons discussed in the context:

- *Different legal base*
- *Different conception of e-waste*
- *Distinct classification of e-waste*
- *Large variety in tasks, competencies and jurisdiction of competent authorities involved*
- *Seldom cooperation during enforcement*
- *Inability to track shipment, especially after shipment*
- *Language barrier*

The critical point concerning the inability is to ensure "waste shipped is handled in the environmental safe manner". It can be concluded that incompatibility between two control systems certainly contributes to a high volume of "illegal activities". The bottlenecks and loopholes of the enforcement are significant factors, which will be discussed in the next chapter.

Chapter5.

Practical Problems from Stakeholder Perspectives

Previous chapters reviewed legislative frameworks, and gave an overview of current administrative and monitoring systems in both China and the Netherlands. This chapter summarizes the various practical problems of e-waste transshipment issues from stakeholder's point of view (Figure 5.1). In order to conduct a correct and complete analysis of the existing situation, several steps are following:

First of all, we have to answer two questions:

- ***Who are the main stakeholders and what roles do they play?***
- ***What are the main problems for each stakeholder in relation to the e-waste transshipment issue?***

Because the system analysis primarily focuses on the phase "waste-product", the stakeholders discussed in this chapter include: governmental bodies, exporters, refurbishers, recyclers, final disposers, manufacturers, academics and NGOs. The consumers are not part of the system, since they play a key role in another phase of "product-waste" in the whole chain, and they can hardly be regulated. Sections 5.1-5.7 will answer those two questions.

- ***What are the causes and effects?***

Secondly, based on previous study, the relations and hierarchy among all identified problems is expressed in the form of the problem tree in section 5.8. The aim of applying problem trees is to move beyond the statement of 'problems', which in practice are typically actual symptoms or effects, and to identify the fundamental causes of these problems, and the most important effects that they generate.

- ***What are motives behind their problems, considering from stakeholder's interests, resources, powers and attitude on possible changes?***

Finally, a stakeholder analysis is conducted in section 5.9, aiming at classifying their interests, resources, power, position, and finding out the possible motives for their behaviors.

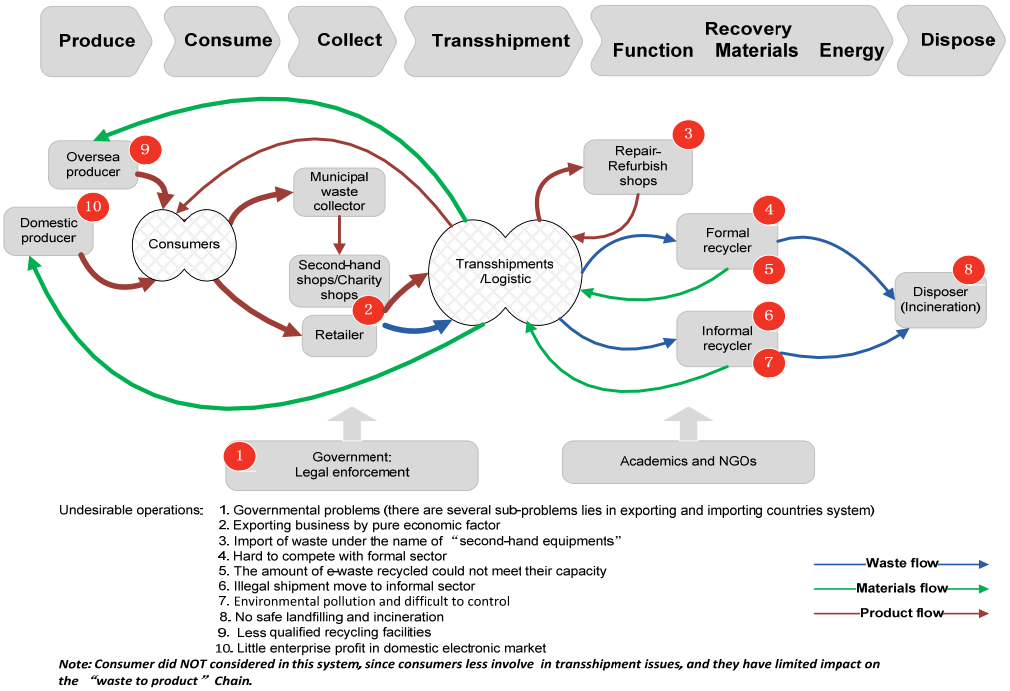

Figure 5.1 Schematic overview of the current e-waste transshipment situation

5.1 The EU Government Bodies

5.1.1 E U level

The EU network for the implementation and enforcement of environmental law is an informal network of the environmental authorities of EU Member States, known as the IMPEL Network. Although the EU commission has taken many initiatives to come to Directives and regulations with regard to electronic products, some significant loopholes were still exposed in the IMPEL-TFS seaport project.

1) Vague legislation and interpretation issues

Although Waste Shipments Regulation has set a good example for all over the world, the grey areas exist as a result of waste classifications problems (IMPEL-TFS, 2006). For instance, the discussions on 'waste versus non-waste' and 'green listed waste versus non-assigned waste', do not stimulate an equal interpretation and enforcement.

2) Different enforcement in individual member states

Provisions of EU Regulations are directly incorporated into all Member States. Nevertheless the enforcement of waste shipment regulations is a competence of individual Member States, which

are not at the same level. The companies involved in these shipments usually have proven to be very sensitive to enforcement activities. If the enforcement in one seaport becomes strict, these companies quickly move their export activities to another port in another European country.
Differences in enforcement structures and enforcement between Member States will not lead to a European level playing field. But for an effective and efficient enforcement, competent authorities have to cooperate with other national authorities because of the simple fact that shipments of waste move across their own borders.

Besides, there are still some problems with collection and recycling stages.

3) Too low collection target in WEEE Directive

According to the WEEE Directive, a collection rate as 4 kg/inhabitant/year is set for European member states. But the present target of 4 kg is very easy to reach for most developed member states. Even for the newly joined developing member states, the volume is much lower compared with their collection capacity. Take the Netherlands for example, the figure 5.2 shows, and the e-waste collected only account for 25% of put one the market, and 30% of discarded volume.

Figure 5.2 Collection rate in the Netherlands (source: EERA, 2007)

The 4 kg is also feeble compared to the volumes that have been put on the market (15-20 kg), see figure 5.3. Notice, the registered collection and treatment rates of nearly all categories of WEEE are less than 33% of the total amount of equipment distributed to the market. In other word, it is unknown what is exactly happening to the other 67 % of the volumes.

EU 27 gives similar picture

Put on the market (kg/inh/yr)	Collected and treated (kg/inh/yr)	Accounted for (%)	Unaccounted for (%)
15 – 20	3 – 5	20-33	67 - 80

Figure 5.3 EU collection rate (source: EERA, 2007)

Without proper control on these missing counts, it will certainly generate trouble for the further management of transboundary shipment.

5.1.2 Member level: the Netherlands

The Netherlands, as one of e-waste exporting countries, is supposed to take exporter's responsibility, which is to keep good control on e-waste entry into and exist from Europe. However, Rotterdam for instance, is a hub port for waste movement within the EU and beyond,

and it is also where most violations are detected (IMPEL-TFS PROJECT, 2005).

The following problems are based on interviews with SenterNovem inspectors and findings from sea-reports of IMPEL-TFS inspections.

1) Insufficient resources in VROM and SenterNovem

VROM and SenterNovem are constituted under Dutch acts and as regulators for various waste trades which directly or indirectly affect the environment and general health. According to Mr. Huisman, an inspector from SenterNovem:

> *The critical bottlenecks for adequate and effective (international) enforcement of regulations are the lack of human and financial resources. There are only 4 inspectors in total in Rotterdam harbor, where 6 million containers go out from Rotterdam per year and 15% is waste.*

Rotterdam harbor is the largest European container transport port and one of the world's most important junctions when it comes to traffic of goods (port of Rotterdam website). Mr. Huijbregts stated, an inspector from SenterNovem, "To some extent, the growth in container transhipment in Rotterdam is a result of the increase in container traffic between Western Europe and Asia". This problem is also reflected in IMPEL-TFS report. Table 5.1 demonstrates that around 6 million containers pass through the port of Rotterdam per year. And 40% of all container traffic via Rotterdam either originates from, or is destined for an Asian port, mainly Singapore. 15% of them are waste shipments (IMPEL-TFS, 2006).

Table 5.1: Facts and figures Port of Rotterdam (source: IMPEL-TFS, 2006)

Facts and figures Port of Rotterdam (2002[5])	
Total quayside	80 km
Surface area	
▪ Commercial sites	10.500 ha
▪ Water and (rail)roads	3.500 ha
Containers throughput (TEU/year)	6.515.000
▪ Incoming	3.288.000
▪ Outgoing	3.277.000

Table 5.2 shows the competent organizations, together with general characteristics on their tasks and competencies, number of employees and their knowledge level with regard to waste shipment regulations. There are 14 inspectors in total, who are responsible for inspection activities in Holland. When we only take Rotterdam port into consideration, there are more than 6 million shipments per year, let alone other ports like Amsterdam, Vlissingen, Delfzijl and Moerdijk. Compared to amazing volume of shipment in and out of the Netherlands per year, 14 persons is far too few for the management and enforcement of the Waste Shipment Regulations.

Table 5.2 Involved organizations in shipment issues (source: IMPEL-TFS, 2006)

Organisation	Level	Grant permission	Enforcement Authority	No. employees EC regulation	Knowledge level
VROM inspectorate region South West	National	No	Yes	8 of 80	High
Senter Novem	National	Yes	No	6	High

2) Limited cooperation with police and custom networks

Except the environmental inspectorate, police and custom networks also play an important role in preventing illegal waste shipments. Limited number of police and customs officier become a bottleneck to monitor waste exports, particularly for illegal shipments. Support by the

environmental inspectorate is necessary regarding specific knowledge, but cooperation between those organizations is still problematic.

The cooperating organizations exchange information on a structural and on a case-by-case base. The following numbers of specialists work in the port of Rotterdam (table 5.3), who inspect millions of tons of goods per year. There is a limited number of customs officers and police officers involved in daily action, not tomention whether these people receive adequate training for the enforcement of WSR.

Table 5.3 Specialists working in the port of Rotterdam (source: IMPEL-TFS, 2006)

Specialists in the port of Rotterdam	Number
Customs	8
Police	2
Harbour Police	3
Railroad Police	2
Traffic Inspectorate	2

In addition, it is surprising to find that there are no designated customs officers for the entry of waste shipments into and out of the EU, since the Rotterdam harbor plays such a significant role in e-waste shipment (table 5.4).

Table 5.4 EU list of the custom offices designated for e-waste shipment (Source: EUROPA website)

List of the custom offices
designated for the entry of waste shipments into and their exit from the Community

pursuant to Article 55 of Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste

Member State	Post	Address, phone and fax no., e-mail	Import/export countries controlled
Luxembourg	Luxembourg	16, rue Eugene Ruppert L-2453 Luxembourg Tel +35 (0) 2 268478-310 Fax + 35 (0) 2 496438 transfer@aev.etat.lu	
Malta	None designated		
The Netherlands	None designated		

3) Lack of contacts with non-OECD countries

IMPEL-TFS only built an EU wide network. But the main destinations of waste shipment out of Europe, are Asia, Africa and other non-OECD countries. There is an obvious lack of contacts with Competent Authorities of these non-OECD countries. These contacts are essential to comply with international shipment rules, and to verify the final destination of the shipments. This is due to various pragmatic difficulties, like language barriers, passive responses of receiver countries, and other political reasons (Huijbregts, personal communication).

5.2 Exporter

- ***Exporting business by pure economic factors***

All discarded household appliances should be collected through municipal waste collectors, and moved to authorized recyclers (figure 5.4). However, according to EERA, ***"some 4-5 million tons of WEEE is discarded each year in Europe. But only one million tonnes comes back through the official take-back schemes,"*** notes Mr Zonneveld. "***We don't know what happens to the rest"***

(Beck, 2007). Illegal shipment in the Dutch case could be retailers or second hand/ charity shops, through the help of some illegal brokers

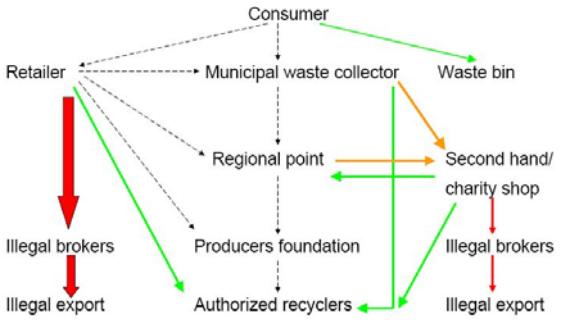

Figure 5.4 Real chain of discarded household equipment in the Netherlands (Source: VROM)

1) Retailers

Collectors play a very important role in most collection schemes. They collect the discarded equipments from customers and can hand them over free of charge to producers, or hand them to certain recyclers. However, interest is bound to be shown only if someone is willing to offer money for these discarded goods. Basically, these collectors do not have a license to treat the waste. But driven by economic factors, they sometimes may deliver white goods such as washing machines to shredder operators, while fridges, televisions and smaller equipment is often illegally exported to developing countries (Beck, 2007).

2) Refurbishers (Second hand/ charity shops)

With respect to recyclers, they mainly dismantle or shred the equipments and produce different hazardous and non-hazardous substances. For the most part, refurbishers have to guarantee that these hazardous components are delivered to appropriate treatment facilities. Non-hazardous material attracts much less attention, as most parts, for example, metals and plastics, have a positive value and hold a queue of global buyers. Under this circumstance, second-hand shops usually sell this material to the highest bidder and export it to Asia (Beck, 2007). Without proper notification procedure, these illegal shipments naturally flow into recycling facilities with the lowest costs that often cause the most pollution.

> *"The business is driven by pure economics. For the West, where safety rules drive up the cost of disposal, it is as much as 10 times cheaper to export the waste to developing countries. In China, poor migrants from the countryside willingly endure the health risks to earn a few yuan and are exploited by profit-hungry entrepreneurs." (Source: Bodeen, 2007)*

5.3 Chinese government bodies

At present, there is no single institution to supervise the whole e-waste stream including shipment, treatment and final disposal. The supervision of a single phase of the whole process is conducted by several domestic institutions.

5.3.1 National Government

The worsen environment everywhere lets central government gradually realize the heavy cost they have to pay for the previous economic driven policies. Keeping one eye closed to the management of e-waste import, on the one hand, it meets the huge demand for the economic development in the short term; on the other hand, it buries a seed of poison in the long term. After increasing attention was paid worldwide for "dumping yard-China", they start to prepare the laws, regulations, and policies concerning e-waste. Many initiatives were made to set up collection and recycling system for discarded electrical appliances and electronic products, but achievement is little. From national government point of view, the current problems lie on the following aspects:

1) Contradiction between the increasing e-waste amount and environment pollution during recycling.

Most e-waste in China comes from overseas, but the amount of domestic e-waste is on the rise (Bodeen, 2007). The number of small scale recycling enterprises engaged in the import e-waste scraping activities is far larger than the number of those getting the approval from the government authority (Tong, 2004). And those small recycling facilities care about maximizing their economic benefits, rather than environmental protection. Hazardous substances are discharged into the air, water and land, which exposes men, women and children to poison. It's a great challenge for the central government to achieve a balance between resource recovery and pollution prevention.

2) Contradiction between demand for the raw material and the ban of e-waste import

The primary goal of the Chinese state over the last two decades has been rapid economic growth. Indeed, raw material resources are required to feed this enormous economic growth, giving rise to a thriving market for secondary raw materials. In China, resources possession per person only accounts for 58% of the average of the world (Zhang, 2007). E-waste not only contains valuable materials, but also can be reused and resold as second-hand products after being repaired or refurbished. Comparing with other second hand resources, e-waste has much higher potential value.

However, because of heavy secondary pollution during the waste recycling process, import of secondhand home appliances, e-waste and crushed e-waste were prohibited in 1998, 2000 and 2002 respectively by SEPA. Only a limited number of e-wastes are allowed to be imported under certain preconditions. But some treatment plants are equipped with advanced technology and management, and they are actually capable of treating more e-waste without pollution.

During the interviews with many higher officials and government consultants, we found governments' attitude is positive to extend import list and open trade to some extent in the future, only if some conditions are ready, like better administrative and monitoring system is set up. Anyway, there are many advantages in e-waste international trade, except huge demand for raw materials:

- Waste substances are valuable secondary resources in the wrong place. If seen from another angle, e-waste recycling saves a lot of energy, resources, and cost, comparing with raw

material exploration and production process. Mr. Wen agreed that, the researcher from National Center of Solid Waste Management in China,

> *That means, waste is not a "waste", but it represents the new energy development alternative, instead of old fashion "mining new natured resources". And it can be a great resource if we use it properly. And some large scale recycling facilities with high efficiency is build up in Shanghai now. (Source: Interview Guide)*

- Besides, professor Li from Qinghua University was confident with the recycling technology development in China. The recycling capacity is ready, but further researches were still necessary to treat the pollution during the process.

> *For example, as we all know, Umicore are famous for its capacity to deal with circuit boards, but we can not say it is the best way to deal with circuit boards, we can only say its treatment process can reach environmental standards. And it is not certain whether it is the most efficient way to recycle and reuse the resource. In china, we can achieve very high recycling and reusing efficiency, but a lot of pollution is discharged during the procedure, which need further research. (Source: Interview Guide)*

- Employment of local people is not only a benefit for local economic growth, but also an important income resource for many poor people to maintain their family, especially for the informal recycling sector.
- Export of some E-waste may be a solution where treatment techniques are inadequate.

3) Jurisdictional gaps and contradictions in government department roles and responsibilities

The roles and responsibilities of government are ambiguous, with many jurisdictional gaps and contradictions. The "Foreign Garbage crisis" exposed the lack of coherency between Chinese government agencies, as it seriously impeded effective and quick response to a situation of emergency. Port Customs, AQSIQ and Ministry of Environmental Protection shirked responsibility for the e-waste crisis at its outset. The defined role of SEPA is monitoring after shipment, to ensure that waste is handled in an environmental way. AQSIQ is conducting entrance inspection, and quarantine according to environmental control standards. And Customs should take charge of entry inspection, duty collection, and clearance based on import permit, as well as for combating waste smuggling. Unfortunately, neither department considers itself responsible for preventing accidents. It was not until 2005, when more cases were confirmed, that the three ministries established a cooperative mechanism that involved the development of an inter-agency team that now holds regular meetings and has launched a reporting system and joint inspection system.

5.3.2 SEPA and local EPBs

- ***Local EPBs lack of legal power, and enforcement differ per areas***

China's government is organized in a largely vertical system, with territorial divisions at the centre, province, city, county, district levels. The organization of environmental protection reflects the basic features of the Chinese state (see Figure 5.5).

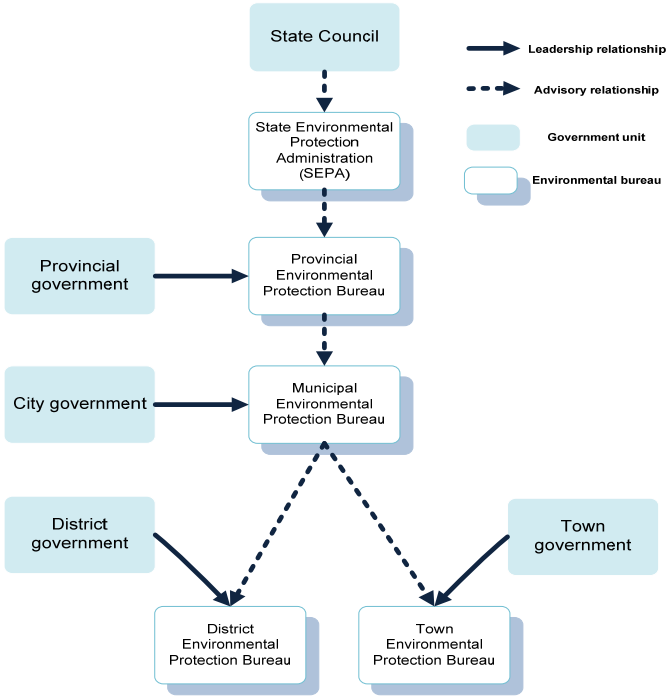

Figure 5.5 Chinese environmental protection bureaucracies (source: Jahiel, 2008)

SEPA, a government unit solely responsible for environmental protection, stays at the central level as the chief agency addressing the nation's environmental issues. SEPA is replicated as Environmental Protection Bureaus (EPBs) down through successively lower levels of the administrative hierarchy at the provincial, city, district, county and, in some places, township levels. Individual functional units within this system receive administrative guidance from their parent units above them. At the same time, they are also subject to the leadership of the local governments.

In all cases, however, it is the local government, instead of the higher levels of the environmental protection bureau, which provides environmental agencies with their annual budgetary funds, that approves institutional advancements in rank and determines increases in personnel and even the allocation of such resources as cars, office buildings and employee housing (Jahiel, 2008). Environmental organs so rely on local governments that they are supposed to take these governments' concerns into account when regulating industry. More importantly, local governments sometimes pressure EPBs to ease regulations in the interest of economic concerns. EPB dependence on local governments continues to be a fundamental structural barrier to consistent enforcement of environmental policy.

Incoherencies and inconsistencies between different levels of environmental departments, is also a common phenomenon among different government bureaucratic agencies. Poor communication both vertically between different government levels and horizontally between different bureaucratic agencies, results in an inability to create a clear Environmental Protection System. Government and agency action under such a system is often fragmented and ineffective

5.3.3 Local government

The local EPBs plays a very important role in enforcing national and local environmental policies. It is supposed to supervise the operation of those units which generate, collect, store, transport, utilize and dispose solid waste and hazardous waste. However, as EPB's position in Chinese institutional structure, its legal power and enforcement capacity are severely restricted by the local governments:

- ***Economic growth comes first***

Rapid economic growth has been the primary goal of the Chinese state over the last two decades. it was in 1992 that Deng Xiaoping delivered his Shenzhen speech, calling on localities to take risks to speed economic development. This kicked off a new burst of economic growth that reverberated throughout the Chinese countryside, creating numerous heavily pollution (Qian, 2007). Economic decentralization offered officials at the provincial level and below the means and incentives to develop their local economies (Shirk, 1993). The large majority of local leaders were either ignorant of environmental problems or believed economic growth was far more important.

> *In the case of e-recycling, Taizhou City's government officials clearly do not wish to cease the business, because it helps raise the average level of income in the short run which they could interpret as some sort of success in the reduction of poverty or unemployment. (Source: Government website of the Economic and Trade Commission of Taizhou City, Zhejiang Province, China 2005).*

In addition, since the central government's deep-rooted prejudice to evaluate lower-level governments' performance by economic growth figures, environmental policies that may negatively affect economic growth in the short run have been extremely difficult to enforce at the local level (Qian, 2007). As a result, even though the imports of various kinds of electronic waste has been banned or at least controlled in China, the enforcement of such policies remains poor.

5.4 Refurbishers

As there are many potential clients to buy second-hand computers, the refurbishers want to find a way to have access to more obsolete equipment. One access is to find equipment abroad. Although second-hand equipment is allowed to be imported, the problems still exist:

- ***Import of waste under the name of "second-hand equipments"***

According to the Basel Convention, the import of working electronic equipment is permitted (the computers must be tested, certificated and labeled before shipment), but if they are broken, they are considered as waste and therefore fall into the jurisdiction of the Basel Convention. The equipments is usually exported as "second-hand goods for reuse". Ultimately it was found that 50-90% of the material had been processed and should therefore have been considered as waste (Beck, 2007).

When refurbishers import such a batch of non-working computers, only part of the equipment or some components could be reused, and generate a lot of waste that will stay in the country. It is difficult to find an environmentally viable way for those wastes. Some of them are taken to the hazardous landfill sites, but other parts are stockpiled at the facility (Anahide, 2007).

5.5 Recyclers

Recycling includes sorting and dismantling, which is done manually or mechanically. Now there are two main difference scale recycling facilities in China for the treatment of E-waste: formal recyclers and informal recyclers

5.5.1 Formal recyclers

Formal recyclers are mostly middle or large scale recycling facilities, which obtain permission or even support from the government. These formal recyclers generally process the material with modern technologies and in an environmentally sound way. Competing with informal recyclers is still the biggest challenge for formal recyclers. They are facing two big problems:

1) Hard to compete with informal sector, as high recycling cost

Firstly, for the large scale recycling enterprises of e-waste, they invest a lot on advanced recycling and environmental protection facilities. So the investment and operation costs are very high.

Table 5.5 Costs and benefits from the collection, transport and recycling of four appliances in the informal and formal sector. (Source: Yang, *et al.* 2007)

	Costs				Value after recycling	Benefit without recycling costs
	Payment to owner	% of Value after recycling	Transport cost	% of Value after recycling		
Informal recyclers						
TV set	80	53%	5	3%	150	65
Refrigerator	120	60%	10	5%	200	70
Air Conditioner	120	60%	10	5%	200	70
Washing machine	60	50%	10	8%	120	50
PCs	120	80%	5	3%	150	25
Pilot project recyclers						
TV set	156	780%	14.5	73%	20	-150.5
Refrigerator	165	96%	38.7	23%	172	-31.7
Air Conditioner	308	308%	30.8	31%	100	-238.8
Washing machine	115	288%	19.3	48%	40	-94.3
PCs	150	75%	150	75%	200	2.7

Table 5.5 shows that informal sector makes profit from all five categories of product, while formal one only makes little profit from PCs. It is obvious that the payment to the customer accounts for huge percentage of total cost. The informal sector takes big advantages over this cost, since they have formed a long-time and mature trading network with customers (Wang, 2008). According to the report, formal recyclers collect the material not directly from households but from intermediate dealers (Yang, *et al.* 2007).

Most informal recyclers, carry out the recycling activities in their backyard in a relatively small scale. They simply use bicycle or tricycle to carry the e-waste home for recycling (Wang, 2008). Because of the crude working condition, their labor cost is far less than the formal workers. As a result, the total transport and labor cost for the informal recyclers are rather lower than their

formal counterparts.

Besides, the informal sector could freely recycle the waste as far as economic and technical possible. While due to the responsibility to the producers and other e-waste providers, the formal recyclers have to provide systematic and environmental system to treat the e-waste, which higher the recycling cost absolutely.

2) *The amount of waste recycled now could not meet their capacity*.
Taking Qihuo Tiande treatment plant as an example, it does not receive enough e-waste to process, and they are looking for more imported materials. Mr. Cai, Vice manager of TaiZhou Qihuo-Tiande Metals CO.,LTD, said :

> *We have quite high import quota for metal scraps, old machinery in Tai Zhou area even in the whole country, and that is because we cannot get domestic e-waste. As you known, the overwhelming majority of domestic e-waste is collected, traded, recycled and reused in the informal sector; it is quite difficult for formal enterprise to compete with them, like us. (Source: Interview Guide)*

Without effective take-back systems, necessary policy backup and subsidy, it's impossible to run the business successfully. This situation rather frustrates the investors' enthusiasm. This also contributes partly to the slow progress of large recycling enterprises. Some enterprises hold "wait-and-see" attitudes towards the development of take-back system and policies of e-waste.

5.5.2 Informal recyclers

At the beginning, most e-waste recycling businesses operated at a fairly small scale in China. Lacking supervision of local authorities, environmental standards and appropriate recycling technologies, most workshops followed very simple methods to operate in order to achieve higher return (Wen, *et al*, 2006). Presently, without effective formal take-back systems, the majority of the e-waste processing and recycling is still managed by the informal sector (Yang, *et al,* 2007). As a result, processes which do not promise to be profitable are avoided or are not carried out.

1) Illegal shipments move to informal sector
Most illegal shipment of e-waste could only flow into the informal recycling sector. There are no data available for the illegal imported e-waste, so there are no data that could indicate how many illegal e-waste flows into the informal sector as well. However, we could see it from another angle. For instance, table 5.6 shows the estimated employment creation in the Chinese e-waste recycling industry. There are around 98% of total recycling workers working in the formal recycling network. Besides, only 1 -2 % of over 5000 metal recycling enterprises are large or medium sized firms, mainly formalized by the government (Liu, 2008). Given the fact that informal recycling is an overwhelming majority in China, we can assume that most illegal shipments flow into this sector, which is outside governmental regulations.

Table 5.6 e-waste recycling in china (source: Duan, *et al,* 2007)

Stages	Employment		
	Formal	Informal	Total
Collection		440,000	440,000
Disassembly	400	125,000	125,400
Material recovery	15,000	125,000	140,000
Final disposal	600		600
		Sum	700,000

2) Environmental pollution and difficulty to control

Most chemical methods without any environmental protection were applied, such as open burning of wires to recover copper, chemical stripping using acid to recover metals from circuit boards or chips, and so on. Besides, they do "cherry picking", selecting valuable parts and dumping the rest. As a result, a series of problems occurred, such as environmental pollution, serious occupational health impacts to the operators and willful waste of resources. Moreover, it is complex to control and monitor them, as they are working independently and highly flexible.

Acid Stripping of Chips, Guyu story in China (Source: Puckett, et al, 2002)

Much of the work to remove chips from circuit boards is done for the ultimate purpose of removing precious metals. This is most often done by a very primitive process using acid baths. Although we could not test the actual chemicals, after consulting with metallurgical experts, we are confident that the baths were in fact aqua regia (a mixture of 25% pure nitric acid and 75% pure hydrochloric acid). This mixture and process was invariably applied directly on the banks of rivers and waterways.

Laborer heating aqua regia acid mixture along riverside chemical stripping operation to extract gold from imported computer chips. All waste acids and sludges are dumped into the river. The only protective equipments used are rubber boots and gloves.

5.6 Disposers

The part that can neither be recycled nor reused has to be disposed of. There are two solutions for final disposing: landfilling and incineration with or without energy recovery. There are different opinions concerning the extent of the problem of disposing e-waste.

When disposed of in a landfill, E-waste becomes a conglomeration of plastic and steel casings, circuit boards, glass tubes, wires, resistors, capacitors, and other assorted parts and materials. About 70% of heavy metals (including mercury and cadmium) found in landfills come from electronic discards. These heavy metals and other hazardous substances found in electronics can contaminate groundwater. (Source: The US EPA, 2001)

- ***No safe landfilling and incineration***

Even if e-waste is disposed in authorized landfill sites that may be well protected against leaching and strictly controlled, the risk is still exist as all waste landfills leak (Puckett, *et al,* 2002). Even the best 'state of the art' landfills are not completely secure and a certain amount of chemical and metal

leaching will occur, let alone those landfills without any permission.

Incineration is the process of destroying waste through burning. Because of the variety of substances found in e-waste, incineration is associated with a major risk of generating and dispersing contaminants and toxic substances. Studies of municipal e-waste incineration plants have shown that "*copper, which can be found in printed circuit boards and cables, acts a catalyst for dioxin formation when flame-retardants are incinerated "*(E-waste Guide website). PVC, which present in e-waste in significant amounts, is highly corrosive when burnt and also induces the formation of dioxins.

5.7 Manufacturers

5.7.1 Oversea producers

Many oversea producers, such as Motorola, Nokia, HP, Epson, etc., began to promote their own take back scheme voluntarily since 2000. As an interviewee from Nokia said, "*Such actions could benefit the image of the company in the mind of Chinese people…and it is also within the duty of Nokia as the corporate citizen of the world*." However, they met a barrier to implement their goals:

- ***Less qualified recycling facilities***

Motorola, Nokia, HP, and IBM, etc, as international producers have to dispose the e-waste they generate in their daily working in a proper way (Tong, *et al*, 2004). They searched for facilities that were qualified to do this job. At last they found the one for industrial hazardous waste disposal in Beijing, which can only do disassembling. The printed circuit board scraps have to be sent to Belgium for further processing. Other recyclable materials, such as glass, plastics, metals in electronic wires, and so on were sent to recycling enterprises in Hebei province and Zhejiang province (Tong, 2004). "If the new regulations on e-waste management come into enforcement, the business prospect will be much more brilliant, and we will consider investing on technological upgrading." said an employee from this recycling facility, "However, at present, only several manufactures in Beijing need such services, the domestic users have not take this issue seriously."

5.7.2 Domestic producers

The competition in the domestic electric appliance market is very intense in China. The profit per domestic electric appliance is usually trivial. Small or medium sized producers hardly compete in collection, treatment, recovery and disposal of WEEE, like other international big firms.

- ***Little enterprise profit in the domestic electronic market.***

Take mobile phone producers for an example, while foreign companies are excited about increasing profits, their Chinese counterparts are feeling the pressures of competition. The four major Chinese brands of mobile phones were all losing at the end of 2005, breaking a record in China's mobile phone history (People daily on line website, 2006). The lucrative mobile phone

market has become a paradise for foreign companies, and tiny part of the cake is left for the domestic brands.

But those companies who are to expand their market share outside China, they have noticed the regulatory transformation in waste policy overseas since early 2000 (Wen, *et al,* 2006). Take Haire for example, a well-known household electronic appliances producer in China, has set up its global strategy. It has cooperated with the China Consumer Electronics Institute to track and follow e-waste policies in target foreign market, and it actively participates in the construction of a national legal system on this issue in China (Li, 2005).

5.8 Problem tree analysis

The previous discussion results in an ‘image of reality', collecting various problems from all stakeholders involved in e-waste transshipment issues. In order to find out the fundamental causes of these problems, and the most important effects that they generate, “problem tree analysis” is applied here (figure 5.6).

The first step is to identify a focal problem, that is, to describe what stakeholders consider to be the key problem. Among all problems identified from various stakeholders, the problem that is the central of overall problems should be the focal problem. In the debates of e-waste shipments, the most attention was paid to the illegal waste shipped from developed world to developing world, and so it resulted in environmental contaminations. Therefore, the focal problem could be the “illegal shipment”, which means “illegal exporting business driven by pure economic factor” in the developed world, and “illegal shipment move to the informal sector” and “importing of waste under the name of ‘second-hand equipment’” in the developing world.

After formulating the focal problems, the next step is to identify the causes and effects of the problem. As a result of “illegal shipments move to informal recycling sector”, the direct effect would be “Environmental pollution and difficult to control”. It forms a vicious cycle: the more e-waste is shipped to the informal recycling sector, the fewer amounts of e-waste are recycled in formal sector, and the more pollution generates to the environment. Therefore, the “Environmental pollution and difficult to control” is the ultimate effect caused by these problems.

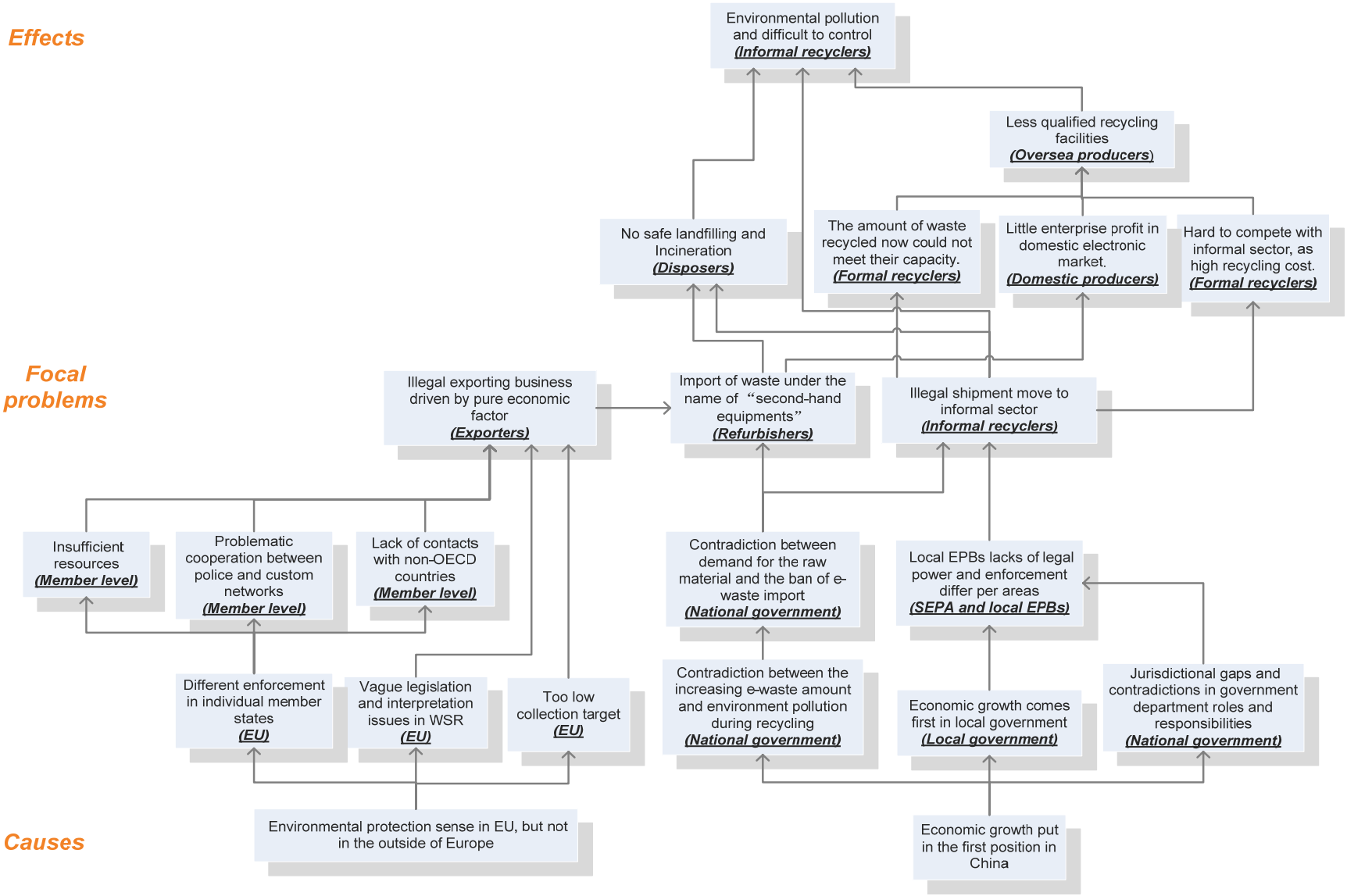

Figure 5.6 Problem tree analyses

When it comes to causes of focal problems, the second line from the bottom, shows the direct reasons of the current situation. From the EU side, there are three direct reasons, “Different enforcement in individual member states”, “Vague legislation and interpretation issues in WSR” and “Too low collection target” respectively. The last two could be regarded as the direct cause of exporting business, since they generate legislative grey areas for those illegal activities. And the first one “Different enforcement in individual member states” leads to the enforcement deviation from the EU legislations. Take the Netherlands for an example, it seems that exporter’s responsibility could not be fulfilled due to various reasons, such as “shortage of human resource”, “Problematic cooperation between police and custom networks” and “Lack of contacts with non-OECD countries”. No matter which one, they all indicate “combating with illegal shipment” is not treated seriously in exporting countries, so that work priority is not strengthened enough. Therefore, it is concluded that the root cause of “can’t ban illegal export”, is that it only shows “Environmental protection sense in the EU, but not outside Europe”.

From the Chinese side, the direct reason would be “Contradiction between the increasing e-waste amount and environmental pollution during recycling”, “Economic growth comes first in local government” and “Jurisdictional gaps and contradictions in government department roles and responsibilities” respectively. That is to say, in central government or local government, economic growth is primary, everlasting theme for them. The Environmental Protection Bureaus is the only one who cares about the environment, but mostly restricted by local government due to Chinese bureaucratic defects. Under this circumstance, it is concluded that “Economic growth is put in the first position in China” results in Chinese “e-waste heartland” position in the world.

5.9 Stakeholder analysis

After mapping the causal relationship within various practical problems, it is necessary to study further who cause these problems and why. The basic concepts on the stakeholder level are interests, resources, power and position. Together, these factors result in actions by stakeholders.

- *Determining the stakeholder’s **interests** in the analysis will help to get better understanding of the stakeholder’s position and possible ways to address his or her concerns. It could also explain the possible reasons behind the problems identified in previous discussion.*
- *The amount of and ability to mobilize **resources** is an important characteristic that will determine the power the stakeholder might put into supporting or opposing on the desired change.*
- ***Power** measures the influence they have over the project or policy, and to what extent they can help to achieve, or block, the desired change.*
- Supporter, opposer and neutral are three possible positions the stakeholder might take, facing the possible changes in e-waste shipment, which aims to reduce the environmental pollution generated by “transboundary shipment of e-waste”.

It may be the case that the following stakeholder analysis does not necessarily show a realistic picture of the range of stakeholders and their perceptions. Basically, there is very scientific and systematic way to conduct stakeholder analysis, including face to face interviews and group discussion with involving stakeholders, etc. However, because of the shortage of time and limited resources, only some of the stakeholders were interviewed individually. Based on the conducted

interviews, "Interest" and "Position" are concluded while "Power" and "Resource" are mainly based on literature research and common sense. For those stakeholders who have not been interviewed, the corresponding analysis is speculated from available data and updated information.

- ***EU commission***

Environmental regulation is evolving in Europe, EU Commission represents and upholds the interests of the EU as a whole, and it shows high awareness to protect environmental and human health EU wide. The European Commission is at the top of the institutional hierarchy. It drafts proposals for new European Regulations and Directives, implements its policies, as well as runs its programs and spending its funds. In other words, it enjoys absolutely high regulating power and obtains substantial financial resources, but partly implementing power, since all EU laws have to be implemented nationally by the corresponding governments. The problem emerged "*Different enforcement in individual member states*" is due to the limitation of European Commission's enforcement power in implementing its laws in individual countries.

> ***The European Commission has four main roles (source: EUROPA website):***
>
> - *to propose legislation to Parliament and the Council;*
> - *to manage and implement EU policies and the budget;*
> - *to enforce European law (jointly with the Court of Justice);*
> - *to represent the European Union on the international stage, for example by negotiating agreements between the EU and other countries.*

The WEEE Directive and Waste Shipment Regulation is relatively new, as WEEE Directive came into force on 2003 and new Waste Shipment Regulation came into force in 2007. In the first few years of the regulations, a number of technical, legal and administrative difficulties became apparent, such as "*Vague legislation and interpretation issues in WSR*" and "*Too low collection target*". However, it is noticed that The European Commission has announced revised proposals around the scope of the WEEE Directive in Jan, 2009. The revision proposes a series changes, including "clarify the scope and definitions" and "change the collection target from the current 4kg/ capita per year (one size fits all) to a variable target that takes into account the economies of individual member States" (EUROPA, see http://ec.europa.eu/environment/waste/weee/index_en.htm). These improvements demonstrate that European Commission has high ambitiousness to control e-waste flows and regulate e-waste shipment channel.

- ***Local level: the Netherlands***

For the national implementation of the EU Regulations and Directives, it is the responsibility of the ministry of VROM to enforce them in the Netherlands. However, the outcomes of the inspections show that enforcement of waste shipment regulation is far from sufficient. There are "*Insufficient resources in VROM and SenterNovem"* and *"Limited cooperation with police and custom networks".* The ministry of VROM has the ability to mobilize monetary and human resources to fulfill its implementing power, but the amazing shortage of resources demonstrates that government's awareness is obviously insufficient. And little attention is paid to the e-waste pollution problems which generate in the downstream countries. This indicates Dutch ministry is

only interested in environmental protection in the Netherlands.

With regards to regulating e-waste transshipment channel, through personal communication with Mr.Huisman, an inspector from SenterNovem, he agreed:

> *"The sending countries should take more responsibility for preventing illegal shipments. But with more development in receiving countries, they can take more responsibilities. And from Dutch side, we try to cooperate with Chinese officials and satisfy their requests concerning e-waste transshipment issues".(Source: Interview Guide)*

- ***Exporter***

In the developed countries, recycling is confronted with higher disposal costs, increased public concern about the health and environmental impacts of waste disposal (Tong, 2004). Whereas, recycling in the developing world is labor-intensive with low value added, and more important is the less regulated disposal on e-waste. As a result, the so-called "pollution haven" hypothesis points out "the higher the costs of disposal caused by the increasingly strict environmental regulations in developed countries, the higher the incentive of recycling industries to move to the less developed world, where environmental restrictions are not severe" (Tong, et al, 2004).

Since lower disposing fees are the primary interest for exporters in developed countries, shipment of waste to developing world is regarded to be driven particularly by more economic motives. However, generally exporters do not possess any strategic resources or stay at any position in the legal hierarchy. They depend on the local governments, and are highly influenced by relevant regulations. Strictly regulating illegal e-waste shipment is definitely a nightmare for them since their countless grey incomes are cut.

- ***Chinese central governments***

China's economy has grown tenfold since 1978, and its focus on economic development has led to widespread environmental degradation. However, Chinese government has made serious efforts to move gradually from pure economic growth to a more sustainable development. For instance the newly enacted environmental regulations "Circular economy law" and "cleaner production law", signal the country's willingness to address its environmental problems. And there is no doubt that the Chinese central government could exert strong leadership on policy making and enforcement, especially in centralized state government.

E-waste has made a great contribution to fast economic growth in the beginning, but the destructed environment has made central officials aware of the importance of sustainable development as well. ***"****Contradiction between the increasing e-waste amount and environment pollution during recycling****"*** suggests that, environmentally sustainable growth rate remains a serious challenge for the country. The amazing demands for resource in China also trigger the contradiction "*between demand for the raw material and the ban of e-waste import*". From legislative perspective, importing of e-waste is overall banned now. E-waste is a valuable energy resource to mitigated domestic resource shortage, but it should be used under appropriate conditions. Without setting up sound recycling industry in domestic market, opening the importing list only means aggravating ***"****Contradiction between the increasing e-waste amount and environment pollution during recycling****".*** In addition, many departments involved in e-waste

administrative and monitoring system without distinct division, results in "Jurisdictional gaps and contradictions in government department roles and responsibilities".

- ***SEPA and local EPBs***

The mission of SEPA is "*Prevent and control environmental pollution, protect nature and ecology, supervise nuclear safety, safeguard public health and environmental safety, and promote the harmony between man and nature*" (MEP website). At the national level, the responsibility to combating with illegal e-waste transshipment and generated environmental problems, rests primarily with the Ministry of SEPA. SEPA experienced a broad expansion of power, budget and human resource, to enforce regulations in the late 1990s as environmental protection grew in importance for the central government (Zissis, 2008). And in March 2008, SEPA was finally elevated to full ministerial status, named "Ministry of Environmental Protection (MEP)". This big step to elevate SEPA to full ministerial status, could finally makes environmental perspective will be consistently heard when the State Committee discusses and drafts regulatory policy and directives.

However, this move will have little immediate effect on the environmental enforcement ground game, since MEP does still not receive any greater control over local EPBs. Local EPBs monitors environmental conditions at the local level, but "*Local EPBs lacks of legal power and enforcement differ per areas*". The MEP maintains a supervisory role, and the EPBs have to report to local governments for budget and resource support. The incoherencies and inconsistencies both between different levels of government and within government bureaucratic agencies, limit the ability to develop and implement a sound Environmental management system. Mr. Hu, a Director of Environmental Development Centre of State Environmental Protection Administration, National Center of Solid Waste Management (NCSWM), SEPA, said:

> *Generally speaking, local EPB is not supervised vertically by SEPA, but has to report to local governments for budget and resource support. Confronted by vast economic profit, local government can hardly think much of environment. (Source: Interview Guide)*

- ***Local governments***

Because of the priority on economic growth national wide and the way of evaluating lower-level governmental performance, local governments always let "*Economic growth comes first*". Either from "improving local people's income" or "personal political development", no incentives are created for local authorities to pay attention to environmental degradation. Especially, local governments actually play key role in enforcing environmental regulations, since it is them who afford the daily operation cost in local EPBs.

Besides, the mission of local government is supposed to improve the local living standards. But during the particular period or in particular regions, "improving living standards" equals to "improving people's income" to some extent. In some extremely poor regions, how to survive and how to feed families becomes primary concern, even though it has come alongside an environmental pollution. To ban all relevant illegal e-waste shipments and treatment in those regions, it is quite difficult to get support from local officials.

- ***Refurbishers***

As China is still a developing country, the extent of economic development differs in different regions. There is a gap in the standard of living between the city and countryside or the different income families. Because of unbalance of economy development, there are plenty of markets for used electrical and electronic products, aiming at the customers with low income level. Driven by economic profit in such a huge market, the refurbishers want to find as many obsolete equipments as possible, and one of those supply streams is from abroad. Although it is difficult to estimate how much import is taking place, many businesses do import from Europe or are looking for opportunities to do it in the future. In addition, "second-hand equipments" are allowed to ship to China, thus there are many illegal "*Import of waste but under the name of 'second-hand equipments'*".

The interest that refurbishers expressed are obvious: they want to receive more material to refurbish, if possible of high quality and for free. And they have obtained some advanced technologies on how to repair or upgrade the electronic equipments. Restricting illegal transshipment of e-waste means less valuable materials could be collected for refurbish, which definitely is bad news for them.

- ***Formal Recyclers***

The concerns the formal recyclers seem to process the material with modern technologies and in an environmentally sound way. Formal recyclers often possess a medium or large sized plant, comply with national environmental standards, and recycle permission from government. Thus generally they have built good network of relationships with local governments. Moreover, equipped with advanced technology and equipments, they often got expert knowledge and skills that forms the organizations core competence. However, the actual situation happened in China is that "*Hard to compete with the informal sector, as high recycling cost*". The major reason of high recycling cost is that not everything can be recycled, mostly because the cost would make the process non-viable.

Another reason of high recycling cost is "*The amount of waste recycled now could not meet their capacity*". Waste reusing and recycling industry relies on economic of scale. During the interview, Mr. Cai also said:

> *Our factory is built with very high expenses, considering our equipments. The production scale of the e-waste collected from domestic channel is not sufficient at all. So we have to find production source abroad."(Source, Interview Guide).*

Thus, standardizing e-waste transshipment could certainly mitigate their current dilemma, only if those e-wastes are flow into formal channel other than informal channel again.

- ***Informal recyclers***

Informal recycling provides jobs and livelihood to mostly poor and rural migrants. They only concern about fast money to maintain their daily life, health problem probably included as well. But the dismantling methods fall greatly behind the advanced technologies: no special equipments, only manual dismantling operation. Without effective governance, only free market

forces determine which transformation processes are applied to obsolete products. As a consequence, most "*Illegal shipment move to informal sector*", which direct result in "Environmental pollution and difficult to control".

However, the absolute majority (98%) of the labor forces among the whole recycling industry in China, are employed in informal structures. Therefore, the informal sector plays an important role in the management of e-waste. With the focus of on poverty reduction, improvement of quality of life and environmental sustainability, an apparent attention should be paid to informal recycling sector and its potential input towards progress in achieving these goals. Although the production scale of informal recycler is very small and decentralized, the amazing scale of informal recycling sector in China enables this group to certainly influence the policy making process. The success of new policies changes greatly depends on how to deal with informal recycling sector.

In addition, informal recycler is one of direct beneficiaries from illegal e-waste import. Regulating on e-waste transshipment means the loss of income, thus it could predict that informal recycling sector would be one of the toughest powers among all stakeholders.

- ***Disposers***

The landfill sites are managed by the municipality or by EPBs, who have expectations to reduce final disposing fee. According to the precautionary principle and the fact that e-waste is regarded as hazardous waste in any case, the fractions should be treated carefully and environmental friendly. However, there is "*No safe landfilling and incineration*", because of the exponentially growing amount of e-waste and the cost of hazardous landfill sites (Puckett, 2002).

For those authorized disposers, no special interest is showed in e-waste transshipment issues, simply because no viable profit is involved in the final phase.

- ***Oversea Producers***

In developed world, the social, environmental and ethical aspects have gained more and more impact on business activities. And in Europe, EPR is widely applied and shifts the management of the problem upstream. The producer is responsible for the environmental impact of the product from cradle to grave. Thus, they have made efforts to ensure their products did not generate negative environmental impact during the whole life cycle, especially when they become e-waste. However, "*Less qualified recycling facilities*" in China could meet their requirements.

As those international electronic producers with worldwide reputation, corporate social responsibility is now often considered as a strategic business tool. But as profit-driven organizations, their essential focus is still to maintain their market, and pursue for more benefit. According to the new EPR regulations, the producers will play a key role in the e-waste recycling system. They provide significant input into the whole e-waste management systems and outcomes. Together with their great social network, they possess of many strategic resources during the implementation.

Regulating e-waste market would have very positive impact on their business, since some qualified recycling facilities would come forth. And the most important of all is that processing in China could save part of the recycling cost, due to lower labor cost and loose environmental regulations in developing countries.

- ***Domestic producers***

Due to intensive competition in Chinese electronic market, domestic producers are at a disadvantage compared with those international producers. Thus, they often complained "*Little enterprise profit in domestic electronic market*", given the fact that they are profit-driven organizations as well. Those domestic producers generally obtain medium to large sized companies, and have paid considerable taxes to local government per year. So they have good relationships with local government, which could influence local policies to some extent.

EPR regulatory approach would greatly influence the domestic electronic industry. Because the EPR principle will urge electronic enterprises to the development of technology fast, Promote green design, and encourage the consumers to discard their old equipment for upgrading. All of operations will increase research and development costs, even increase operation cost more than 20% (Wen, *et al,* 2006). If new regulations applied, profits margin in domestic manufacturing would be squeezed to a large extent.

However, like oversea producers, domestic producers also enjoy the resource of "Involvement in strategy implementation" and "good social network with governments", thus they obtain certain power during decision making process.

- ***International NGOs***

Greenpeace is a famous non-governmental international organization for the protection and conservation of the environment. Greenpeace has a worldwide presence with national and regional offices in over 40 countries, which are affiliated to the Amsterdam-based Greenpeace International. Generally, they utilize nonviolent direct action, lobbying and research to achieve its goals.

Greenpeace paid a lot of attention on "e-waste dumping" problem in China, and launched several activities towards this issue. For instance, Green Peace sponsored "2004 international conference of electronic waste and extended producer responsibility in China" in April, 2004. It aimed at promoting discussion about the issues of e-waste and extended producers responsibility among government officials, NGOs, corporations, academic institutes and the media.

With regards to e-waste transshipment problems, Greenpeace hold the belief to ban all e-waste Exports:

> *"All industrialized countries of the world should become self-sufficient in managing their own hazardous wastes so that they will not victimize other peoples, particularly in developing countries, but moreover so that they will realize an immediate incentive to eliminate such hazards at the source.*
> *Developing nations should be given the tools and training necessary to develop preventative waste management strategies". (Puckett, 2002)*

- ***Chinese academics***

"Think tanks" are organizations serving as "outer brains" of the government (Zhu, 2006). They have played an important roles in the policy making process of western countries, since World War II. Western scholars have emphasized "non-profitability and independence from government, political parties, and interest groups as defining features of think tanks" (Shambaugh, 2002). Strictly speaking, no organization in China fits this description.

However, organizations that serve as policy researchers and advisors to the Chinese government have existed for decades. Among them, on-campus policy research organizations grew as an emerging category of governmental think tanks with college scholars, exerting influence over China's policymaking process. Concerning e-waste project in China, Prof. Li from Qinghua University, is absolutely one of the top consultants for Chinese government on e-waste issue. He expressed:

> *As technology development and supervision is strengthening, the e-waste will become a more and more important energy source. The e-waste import is used to be restricted as environmental pollution. If we hold more advanced technology, and control systems improve, it may be open a little in future. (Source: Interview Guide)*

- ***International academics: Solving the E-waste Problem (StEP) initiative***

StEP is such an initiative of various UN organizations with the overall aim to solve the e-waste problem. Working with prominent members from industry, governments, international organizations, NGOs and the science sector, they initiate and facilitate approaches towards the sustainable treatment of e-waste (StEp website). StEP conducts research on the entire life-cycle of electronic and electrical equipment and their corresponding global supply, process and material flows.

"The best of two World (BO2W)" project which this thesis follows, is a pilot project initiated by StEP. It is meant to contribute to the solution of e-waste transshipment problems, and seeks to safe and eco/energy-efficient reuse and recycling practices around the globe in a socially responsible manner.

"We strongly support the StEP initiative as a way to foster cooperation among stakeholders, develop needed infrastructure at a global scale, optimize interfaces between manual, mechanical and metallurgical recycling and recovery processes."

- Hugo Morel, Executive Vice President of Umicore Precious Metals Services

Figure 5.7 evaluations from StEP's member (Source: StEP website)

They play more and more important role to in research and policy making process all over the world. Huisman explains the role of academics in a recycling system: *"provide proof for overall objective and framework, before setting rules*".

Here is the table summarized all stakeholders and their interest, resource, power and position (table 5.7). The information gathered below does not necessarily confirmed by each stakeholder, but it is analyzed from previous problem identification and stakeholder analysis. Given the practical limitations, it is quite difficult to provide accurate and objective information, the table below aims to provide a qualitative analysis on involving stakeholders' characteristics.

Table 5.7 stakeholder analysis table

	Interest	Resource	Power	Position
EU commission	Protecting environmental and human health EU wide.	Highest position in hierarchy (formal power) Financial resources	Very strong regulating power limited implementing power	positive
Dutch governmental bodies	Minimizing environmental pollution caused by e-waste in the Netherlands	Position in hierarchy (formal power) Financial resource Substantive Human resource	Regulating power Strong implementing power	positive
Exporters	Lower disposing fee	No strategic resource	Low, Influenced by policies	negative
Chinese central government	Maintaining economic growth, but is paying more and more attention on environmental issues	Highest position in hierarchy (formal power) Substantive financial resources	Very strong regulating power Less implementing power	positive
SEPA and local EPBs	Reducing environmental pollution in China	Position in hierarchy (formal power) Limited financial resources Limited human resources	Regulating power Limited implementing power	positive
Local governments	Maintaining local economic growth	Position in hierarchy (formal power) Financial resource Human resource	Strong implementing power	negative
Refurbishers	Receiving more material to refurbish	Possession of knowledge and skills	Low. only co-operate, cannot intervene	negative
Formal recyclers	Processing the material in an economic visible and environmentally sound way	Good network of relationships with local governments; Possession of knowledge, skills and equipments	Medium, Responsible for project outputs but can be dismissed for non-performance	positive

Informal recyclers	Maintaining job and livelihood	The amazing scale of informal recycling sector in China; Involvement in strategy implementation.	Strong. Regulation success greatly depends on their performance.	negative
Disposer union	Reducing final disposing fee	No strategic resource	Low, Influenced by policies	ntral
Oversea producers	Maximizing profit, but environmental awareness is rising	Good social network; Involvement in strategy implementation.	High, provide input into system and outcomes	positive
Domestic producers	Maintaining profit	Good relationship with local government; Involvement in strategy implementation.	medium, intervene local policies	negative
International NGOs (Greenpeace)	Protecting environment world wide	Access to media.	Low, provides information but does not have directly impacts	positive
Chinese academics	Protecting environment and human health	Provide consultant service for Chinese governments	Medium, exerting influence over policymaking process	positive
International Academics (StEP)	solving the e-waste problem	Provide consultant service	Medium, exerting influence over research and policymaking process	positive

5.10 Conclusion

Aside from the gaps of legislations and management systems discussed in previous two chapters, the e-waste transshipment is an extremely complicated issue, based on the analysis in this chapter. First of all, there are a lot of stakeholders playing roles in e-waste life chain, and each one has his own problems concerning current e-waste situation. With the help of problem tree analysis, the focal problem is identified as illegal e-waste shipment, which generally flows from illegal exporter in the developed country to informal recycling sector in the developing countries. The most direct effect is the severe environmental pollution in the developing countries which is very difficult to control.

Secondly, the problems of stakeholders exist in different levels: government level, enforcement level and operation level, from the EU committee to competent authorities in member states, from Chinese central government to local EPBs. Exporters, recyclers and producers all play significant role in the chain.

Thirdly, each problem results from each stakeholder's unique factors (interest, resource, power, and position). These factors impact with the stakeholder's perceptions and behaviors. It is found out that many stakeholders are driven by economic profit involved in handling e-waste, although the reasons vary from stakeholder to stakeholder. For instance, exporters are aware of the visible price difference concerning recycling e-waste in the EU and China. But informal recyclers in China just want to maintain their family so that they pay less attention to the environmental pollution and healthy damage. Besides individual economic interests, e-waste management issue does not ranked high in the governmental agenda either.

Last but not least, the positions of the stakeholders in regulating e-waste shipment channel are diversified too, therefore their expectations may conflict. For example, illegal e-waste shipment was regarded as important sources of income for informal recyclers but as nightmare for Greenpeace.

Facing the extensive and complicated e-waste issue, stakeholder analysis could be seen as part of an iterative process for improvement of policies and institutions. It allows problems and objectives to be analyzed in detail, and changes to be made as new stakeholder revelations and creativity come to the fore.

Chapter 6

Conclusion and design requirements

6.1 Conclusion

The research objective is leading to the following research questions, which will be answered in this thesis. The main research question is summarized as follows:
What should the e-waste transshipment channel look like, given the legislative, systematic and practical problems concerning transboundary movement of waste?

Before answering the main research question, empirical conclusions are made based on the findings at three levels (legislative level, system level and practical level). Based on the finding in previous chapters, expectations on long-term situation and desire requirements are briefly illustrated. The answers to the main research question are further elaborated in the last two chapters.

The detailed findings are shown below, followed by research questions:
For the theoretical level:

- **What are the worldwide developments in international waste shipment rules, concerning new environmental standards?**
- **What are main regulations on the transfrontier shipments of waste in the EU and China?**
- **What are the gaps between the EU and Chinese legislative frameworks, concerning the e-waste that can be shipped?**

In the theoretical research, we reviewed recent developments in transshipment rules concerning

e-waste at both the international and the regional levels. Basel convention and OECD Council Decisions are the two most widely accepted international regulations. The "environmentally sound management of e-waste" was considered to be a basic condition for allowing or prohibiting a transboundary movement of e-waste. Specifically, in Europe all waste shipments are subject to the Waste Shipment Regulation, which incorporates into the list of waste annexed to the Basel Convention and OECD Council Decisions. OECD and European regulation systems mainly serve to delineate controls procedures based on the purpose of shipment (namely for recovery or disposal), the status of destination (namely inside or outside of OECD countries), and the classification of waste (namely "amber list" and "green list"). It is noticeable that the e-waste is distinguished by its chemical properties in those regulations, namely hazardous or non-hazardous waste. On the contrary, as the biggest waste importing country, China incorporates the Basel Convention into its own position. They tell the difference of e-wastes by "whether it can be used as raw materials". In other words, e-waste is recognized and evaluated in different way compared to other exporting countries, which actually reflects different cultures, perception and motives.

In the EU, protecting environment is ranking high on the political agenda. Particularly for electronic products, several initiatives have been taken to come to Directives and Regulations, which aims at stimulating good environmental performance. The recycling of e-waste has increased in recent years as a result of higher disposal costs, increased public concern about the health and environmental impacts of waste disposal. The general perception on recycling is that it can result in resource conservation. On the other hand, recycling in the developing world also increases sharply, which is, however, thought to be driven particularly by economic motives. The most important incentive is the large domestic demands for cheap and qualified materials during the industrialization since the open and reforms begun in late 1970s. Therefore, we could conclude that both parties established domestic regulations, which not only comply with international shipment rules, but also is driven by their own consideration. There is not right or wrong about the regulation, but the distinct ways to regulate e-waste shipment do result in many practical problems during the implementation phase, especially in the transbounday shipment case.

A further comparison of some key legal elements in the EU and China reveals that e-waste elements are often inconsistent and difficult to evaluate. China applied an exclusive method to eliminate the unwanted shipment, which means only waste belonging to the lists is allowed for import. While the EU details the hazardous and non-hazardous components, but ignores the cases that contain the whole WEEE or part of WEEE. In addition, e-waste could be easily exported for "recovery", which often under the name of "reuse, repair, and second-hand product". The difficulties to match two parties' regulations in legislative level, have generated many gray areas for millions tons of missed e-waste.

For the systematic level:

- ***What management and control systems have been developed by the EU and China, concerning waste transborder movement?***
- ***What are the gaps between two administrative and monitoring systems?***

In the systematic research, the thesis further maps out two administrative and monitoring

systems in the Netherlands and China, which are characterized by three stages, before shipment, during shipment and after shipment. Each country has developed its own administrative and monitoring system based on its principal regulations and policies.

First of all, due to different legal base discussed in the previous part, the main question during the shipment is: different category of e-waste and inconsistent interpretations of e-waste materials. It is found out that no official consensus on e-waste definition has been reached so far in Chinese legal work. The three main ministries who are in charge of e-waste have given three definitions on e-waste. While in the EU legal base, it introduces a comprehensive and unified list of WEEE. Under this circumstance, confusion is easily generated when considering the inconsistent interpretations of e-waste. For instance, some materials are allowed to import to China according to Chinese regulations, which is prohibited in EU list.

Secondly, institutional inefficiency also interferes with the communication between importing and exporting countries. There is large variety in tasks, competencies and jurisdiction of competent authorities involved. This mainly generated in China, since several and different levels of organizations involved in e-waste management. And there is seldom cooperation during the enforcement from both sides, unless severe illegal shipment is detected. However, information exchanges and international coordination is actually the solid base for an efficient and effective enforcement.

Last but not the least, the critical issue is the inability to track shipment, especially after shipment. As result of different reporting procedure and recording systems, the information on imports are not linked to the information on receipt by facilities, the information on expected shipments are not connected to the information on actual shipments, and the information on one side of the border are not connect to the information on the other. In addition, the information “after shipment” is missing to ensure that e-waste has been ended environmentally. As authorities in exporting countries, they generally do not have access to the information on what actually happened in destination. And authorities in importing countries, they do not have reliable means to examine the environmental harm generated.

To sum up, it is found out that neither Dutch system nor Chinese system is capable of tracking a single shipment “from cradle to grave” when the e-waste generation is in one country and the treatment is in another. These inabilities are due to several reasons discussed in the context, and most critical points lies on that each country develops its own enforcement schemes without compliant with foreign regulations.

For practical level:

- ***Who are the main stakeholders and what roles do they play?***
- ***What are the main problems for each stakeholder in relation to the e-waste transshipment issue?***
- ***What are the main causes and effects, among all problems described?***
- ***What are the stakeholder’s interest, resource, power and position on regulating e-waste shipment?***

The third step yields an 'image of reality', presenting various problems from all stakeholders involving in e-waste transshipment issues. With the help of problem tree analysis, the focal problem is identified as "illegal shipment from the EU to China". The most negative impact is "severe environmental pollution" happening in informal recycling sector in China, and is difficult to control. The fundamental cause lies on two relevant parties. The EU has made strict environmental regulations and shown high environmental protection awareness in their own territory, but pay less attention to the pollution in other places caused by their own wastes. Chinese government should responsible for its "e-waste heartland" position in the world as well, since economic growth has been always put in the first place in China. It is just like an old saying ***"It takes two to tango"***. In this sense, it is not difficult to understand why there all so many illegal e-waste shipments although they have strictly banned in both importing and exporting countries.

After mapping the causal relationships within various practical problems, stakeholder analysis is conducted to study further their interests, resource, power and interests, which result in actions by stakeholders. Both Governmental bodies could exert the strong leadership on policy making, but their enforcement is quite poor. In the EU case, EU's limited enforcement power is due to EU's specialty, namely enforcement has to be done in individual member states. Taking the Netherlands for instance, their shortages in either resources or cooperation with other departments, shows that they do not have interests in what happened to the e-waste shipped out of their territory. In China case, the ministry of SEPA and local EPBs are responsible for combating with illegal e-waste transshipment and generated environmental problems. However, Chinese inconsistent bureaucracies make local EPBs subject to local municipalities' supervision, whose primary interest is local economic growth rather than environmental protection. Besides, it is also found other stakeholders are mostly driven by profit interests, although reasons vary from one to another. Exporters want to reduce the recycling cost, informal recyclers want to maintain their family, formal recyclers want to have more materials to recycle, oversea producers want to find a profitable and environmental visible way to treat their products, etc. Although each stakeholder cares about his own interests, none of them are necessarily means conflicting with more environmental friendly way to manage e-waste. And diversified interests could provide further incentives for them to improve the current situation.

In addition, each stakeholder has his own position toward the possible changes of e-waste transshipment channel. On one hand, regulating e-waste shipment is regarded as "threat" by many stakeholders. For those organizations which could get direct or indirect benefit from "illegal shipments", they basically would be negative or extremely negative on the possible policy changes. The organizations got huge profits from "illegal shipments" are: exporters and informal sectors. Although domestic producers do not get profit from illegal activities, possible policy changes will reduce their slight profit further. Local governments are not direct benefiter either, but the "illegal shipments" do stimulate the local economy which is their expectation.

On the other hand, e-waste transboundary movements imply some opportunities, since e-waste means valuable resource which has been put in the wrong place. "The hardware of recycling e-waste" seems ready soon in developing countries, as a result of technology innovation, environmental awareness rising, or raw materials demand, etc. Many large scale recycling

facilities are equipped with sufficient technology and funds, but "software" is still missing. "Software" here refers to the transparent monitoring system, sound recycling industry, broader "import list", etc. Not only formal recyclers expressed their hopes for national government to increase the e-waste resource, but also Chinese officials hold positive attitude towards opening some trade in an appropriate manner in the future.

No matter e-waste is a "threat" or an "opportunity", the basic precondition is a transparent and effective monitoring system. With traceable shipment channel and proper monitoring system, it could both eliminate the "threat" and grasp the "opportunity". Because each stakeholder tends to takes care of his own interests without a holistic vision, a cooperative system dominated by governmental bodies is very necessary. According to Huisman's findings (2005): "*Basically, one has to realize that recycling of electronic products requires multi-stakeholder cooperation to actually meet the societal goals of electronics recycling*". In next section, several design requirements for the desired long-term situation are listed, which aims to connect all the stakeholders playing a role in e-waste management system.

6.2 Design requirements

"Green e-waste shipment channel and monitoring framework" is a concept that represents the infrastructure and the processes, which e-waste goes through from the discarded end-of-life equipment to the renewed product or to the clean raw material or to the final disposing. The infrastructure and the processes include collection, transshipment, refurbishment, recycling and the final disposing. The primary concern for e-waste treatment should be environmentally sound, socially responsible and economically sustainable.

Based on all barriers identified in previous chapters, there are several design requirements for "Green e-waste transshipment channel" and its "monitoring framework".

1) ***Prevent illegal shipments upstream.*** Only exporting countries could collect the most of their generated e-waste, and ensure that all these e-wastes flow into the formal channel and will end in a responsible way.
2) ***Reduce illegal shipments, by standardizing shipment procedure and cooperate in reporting system.*** It is able to track e-waste shipment from exporting countries to importing countries, especially the information after shipment.
3) ***Develop sound recycling industry downstream.*** To deal with imported e-waste or domestic e-waste, a qualified, advanced, and environmental sound recycling facility is urgently needed in importing countries. This is the basic and first step to explore the valuable resources in the e-waste.
4) ***Transparency of the process, namely transparency of three flows: money, material, and environmental impact.***
5) ***Extended producer responsibility is the basic solution to prevent pollution.***
   Pollution prevention does not just mean recycling waste already produced, rather it means producing less hazardous waste and generating less waste in the first place.
6) ***Reuse, recycle and dispose of e-waste in an environmentally safe manner.*** It includes encouraging reuse, sound recycling, and minimizing landfilling.

In addition, different stakeholders have different interests, resources, power and positions. Therefore the common ground is crucial to gather all stakeholders and let them play role in the new system. Even though the expectations on new system are not the same for all stakeholders- NGO's are likely to have environmental and social interests while processors will see rather the economical motivation, the goal of making good use of e-waste remains the same. The "good use" means economic profitable and environmental sustainable way.

Based on their specialties, sufficient incentives have to be designed for them to corporate them into new systems. There are general strategies:

1) Maintain the support of those stakeholders who are currently supporters

- Maintain the support of **governmental bodies***,* since they are holding the biggest power and are also interested in the new changes.

2) Increase power and leadership of the supporters

- Increase the power and leadership of **producers**, and let them become the system operators.
- Increase the benefit for **formal recyclers**, to hold them accountable by granting import permissions and allocating import quota to them.

3) Convert the neutral stakeholders into active supporters (i.e., convince them to support the policy and increase their power and leadership where necessary).

- Let **refurbishers** and **disposers** also found their own benefit, and convert them to be supportive on the new changes

4) Convert the opponents to supporters

- Convert the **local government** to support the environmental policies by evaluating their performance also by environmental awareness, except local economic figures.
- Provide **informal recycling sector** with steady income source, protective working environment, and educate them to raise their environmental awareness.
- Help **local producers** to be more competitive in electronic market, by taking more social responsibility.

5) Weaken the benefit and power of the opponents

- Reduce **exporter**'s benefit by strong penalty and disqualify their export permit if necessary.

In order to demonstrate each pair of problems and objectives, a table format is chosen to deliver the final outcomes, instead of an objective tree. The proposed objectives for each problem, as well as incentives created for each stakeholder to cooperate with new model (table 6.1).

Table 6.1 summary of the problems of current situation and corresponding proposed objectives

	Stakeholder	Problems	Proposed objectives	Incentives
Legislative level	EU and China	Different legal base on e-waste transshipment	• Reach international consensus on which goods can be transboundary shipped.	Combating illegal e-waste export & import
	EU Commission	Vague legislation and interpretation issues in WSR	(See legislative level)	Be a responsible exporter
		EU made regulations, but enforced in individual member states	(See systematic level)	
		Too low collection target	• Set more scientific collection target • Municipalities, retailers, second-hand/charity shops and end-users should be addressed in WEEE legislation	
	Member level: the Netherlands	Insufficient resources	Stronger priority on e-waste shipment project	
		Problematic cooperation between police and custom networks	(See systematic level)	
		Lack of contacts with non-OECD countries	(see systematic level)	
	China National Government	Contradiction between the increasing e-waste amount and environment pollution during recycling.	• Regulate e-waste collecting and recycling channel • High environmental awareness	Sustainable development
		Contradiction between demand for the raw material and the ban of e-waste import	Knowledge and technology	
		Jurisdictional gaps and contradictions in government department roles and responsibilities	Clarify the individual responsibility.	
	SEPA and local EPBs	Local EPBs lacks of legal power and enforcement differ per areas	SEPA should gain more authority and capacity. and local EPB should be supervised directly by SEPA	Sustainable development
	China Local	Economic growth comes first	Learn to promote environmental protection by using	To evaluate lower-level governments' performance by

	government		economic drive	environment awareness too.
Systematic level	The Netherlands and China	Administrative and monitoring system do not match each other	• Systemize and rationalize trade procedures for transboundary movements of wastes, especially after shipment. • Exchange of information among enforcement authorities • Cooperative inspections must be strengthened nationally and internationally	Combating illegal e-waste export & import
Practical level	Exporter	Illegal shipment	• Grant export permission by producer foundation too. • Stronger penalty	• Strong penalty • Disqualified exporting permit
	Refurbishers	Import of waste under the name of "second-hand equipments"	Collect, refurbish the local e-waste first.	There is huge potential reusing market in China too
	Formal recyclers	Hard to compete with informal sector, as high recycling cost The amount of waste recycled now could not meet their capacity	Hold formal recycling facilities accountable for environmental soundly treating.	• exporting license • allocate importing quota based on performance
	Informal recyclers	Environmental pollution and difficult to control	Formalize these companies, otherwise diminish them.	• educate potential health risk • provide steady income resource • diminished by competent authorities
	Disposers	No safe landfilling	• No landfilling in the long term • do not mix with other hazardous waste in the middle term	financial subsidy
	Oversea producers	Less qualified recycling facilities	Apply EPR, be the system operator of "Green e-waste transshipment channel"	• Corporate social responsibility is a strategic business tool. • providing a "Green Image" to the customers • Reduce high recycling cost by designing environmental products.
	Domestic producers	Contradiction between implementation of EPR and enterprise profit.		

Note: Stakeholder: positive position; Stakeholder: neutral position; Stakeholder: negative position

All elements in “Green e-waste transshipment channel” and its “Monitoring framework” will be further elaborated in next section. Since legislation is made based on human behaviors and hardly being influenced in a short period, the design work is primary focus on systematic and operational level. And further recommendations rather than specific measures are proposed in the last chapter.

Chapter 7

Design the Desired Long-term Situation

This chapter won't continue the discussion on "what is going on now", but instead shows a desired end state, what the situation should look like in the long term, based on the gathered knowledge from conclusion of empirical research and design requirements in chapter 6. The proposal is that the desired long-term situation be achieved through a "Green e-waste shipment channel" with "monitoring framework" (Figure 7.1).

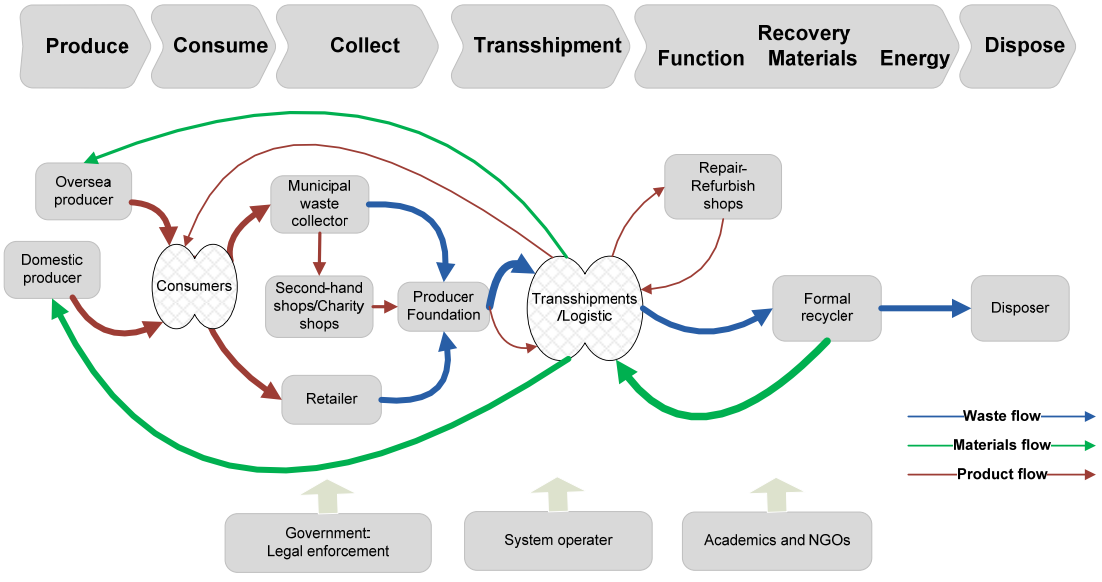

Figure 7.1 the green e-waste transshipment channel

It is noticeable that this chapter is focus on practical channel design and monitoring framework than legislative design. The discussion starts from the "Green e-waste shipment channel", which interprets new role should be played by each stakeholder in each phase of e-waste transshipment chain. And the monitoring framework for the channel is followed, to illustrate governmental bodies, system operators as well as academics and NGO's role in the framework. In addition, a particular emphasis is given to reporting system, which plays a very important role in monitoring framework. QiHuoTianDe treatment plant in TaiZhou was selected as an example, to further illustrate how reporting system should work in recycling phase.

7.1 Green e-waste transshipment channel

7.1.1Collection-export phase

The stakeholders involved in "collection-export" phase are almost the same as in the current system, but some of them might play a more, or a less important role. In addition, municipal waste collectors, regional points, and producer foundation are incorporated into this phase in order to facilitate the discussion. Although consumers play a role bringing back their e-waste, it is not their main activity in our research and they are hardly regulated. The identified way of collection in chapter 5, which is not included here is waste bins. Since e-waste is different from traditional household waste, they should be collected in a more professional way instead of waste bin. Therefore, it is suggested that available municipal waste collection points should not included in the new system. The collection-export phase is illustrated in figure 7.2.

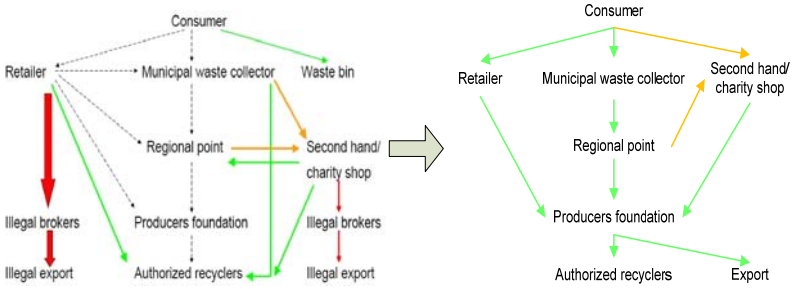

Figure 7.2 Comparison between previous and current collection system in the Netherlands

The collection system involves both private consumers and corporate consumers. There are three ways left to collect equipment from consumers: retailers, municipal waste collectors and second-hand/charity shops.

- ***Retailers***

In the current system, retailers play an important role in the e-waste take-back system. This solution seems convenient for consumers, as they can bring back their old equipment when purchasing a new one. And the retailers are supposed to take back equipment that the user wants to discard, irrespective of the age or brand, as long as the equipment is of the same type as the ones sold. Besides, consumers could get some discount on the new equipment as currently

done by some distributors, since they bring the old one back. But the consumer should have the possibility of bringing back the equipment without the obligation of purchasing a new one. Especially for corporate consumers, it is encouraged to sign a contract, so as to ensure a large volume of equipments could be taken back effectively. Business to business solutions must be facilitated, in order to minimize the amounts stored at collection points.

In addition, the direct link should be established between retailers and producers, so as to save part operation cost and transportation cost.

- ***Municipal waste collectors***

The study on the easiest and most convenient way to drop-off the waste showed clearly that the private consumer would prefer a pick-up service at his/her house (Anahide, 2007). To complement the take-back by the user, the municipality already plays an important role in collecting the discarded equipment from the private users to the collection sites.

The municipal waste collector should also promote the formal collection Channel. For instance, information sheets on the containers could explain to the consumer where to dispose old equipments and why it is important. A list of the contact way and of the type of equipment collected could be written on the back of the invoice received from the municipality.

- ***Second hand/charity shops***

The second hand/charity shops provide service for private users as well as corporate consumers. And the internal communication system with this large consumer base could be utilized to inform how the computer should be properly collected. Thus, if possible, corporate consumers should have their goods brought directly to refurbishers. The government, as one of the biggest corporate consumers, should lead by example, having most of its discarded equipment taken to second hand/charity shops.

Many corporate consumers may request that the data of discarded equipments have to be erased. To guarantee that reuse won't compromise the confidentiality of the former owner, the second-hand / charity shops should systematically use professional software to erase the data on computers. If the users still don't trust it, the data could be destroyed by only destroying the hardware, which would make the reuse of other parts possible.

- ***Collector at regional point***

The entrepreneurs on the regional point should be trained, especially because they might dismantle some components and sell different metal fractions. Since their activities are in between collection and recycling, they could be considered as dismantling facilities and follow the same standards.

- ***Producer foundation***

The principles of producers' responsibility should be supported, but it is believed that producers cannot do it alone and could fulfill their obligations fully if given sufficient scope. Although producers have set up take-back systems for WEEE from private households, the greater part of

these volumes (67-80 % of what has been put on the market) does not end up in these systems (Zonneveld, 2008). In other words, the majority of the WEEE is missing. The sources of these unaccounted volumes lie in (Zonneveld, 2008):

- *The major leakages at municipal sites and retailers, and*
- *Consumer behaviour*

E-waste is currently traded by Municipalities and retailers without verifying whether the parties involved comply with the rules and regulations. For these reasons, it is proposed to register approved authorized parties involved in green waste channel. Municipal waste collectors, retailers, regional points and second hand/ charity shops should build a direct link to producer foundation. They have to provide proof that e-waste has all been submitted to producer foundations, and then the producer foundation is responsible to transfer all collected e-waste to authorized recyclers or authorized exporters. In this way, important leakages can be stopped, and producers can be supported in fulfilling their responsibility. This means that the responsibility should be expanded to other stakeholders i.e. mandatory involvement of other stakeholders.

- ***Exporters***

Exporters are directly involved in many illegal shipments, therefore administration and supervision on this group seems extremely important.

Firstly, exporters should obtain the export permission by producer foundation too.

Export of certain parts of e-waste to other countries, depends on producer foundation's decision, which should fully comply with current EU waste shipment Laws and supervised under competent authorities. Or it is necessary to grant extra export permissions only to those brokers managed by producer foundation, besides other permits from competent authorities. In this way, illegal shipments could be diminished to a large scale.

Secondly, intensify penalty, and disqualified exporting permit

In addition, the uncovering illegal transboundary movements of hazardous wastes may exist at every stage of the process: before customs inspections in the country of export, before customs inspections in the country of import, illegal recycling of the wastes, and so forth. However, there are cases that go unpunished or are punished lightly. Thus, it is necessary to strengthen penalties against violators, if governments would work cooperatively and promote the exchange of information. For severe and large scale illegal exporters, disqualification their exporting permits and a black list are necessary measures.

7.1.2 Recycling- disposing phase

- ***Refurbishers***

Collect, refurbish the local e-waste first.

Household appliances in China have already entered the new upgraded period in an all-round way after the first consumption upsurge in the eighties of last century (Li, 2005). The actual replacement period of urban residents' large-scale household appliances has already reduced to 5 to 6 years. Particularly for electron consumer goods such as the mobile phone, computer, etc. would change once in 1 to 3 years even shorter (SEPA). Moreover, the overstocked electronic

products of every market, enterprise, administrative institution, stand-by product, etc., have provided the abundant source of goods for second hand market (Li, 2005).

Therefore, it is suggested that China should firstly try to take advantage of what the country has and what people need. There is huge potential reusing market in the country, which should be fully developed before importing. In this way, there will be less demand for second-hand equipments from abroad, which may contribute to e-waste smuggle, since most illegal shipment always shipped under the heading of "second-hand equipments for reuse".

- ***Formal recyclers***

For formal recyclers, since e-wastes flows into "Green e-waste channel", the amount of waste flowing into their sector could meet their capacity sufficiently. With regard to the high recycling cost, government could subsidize them to a certain amount, as well as set reasonable recycling and recovery quotes. The key point is to *hold them accountable for environmental soundly operations by:*

- State should support the construction of large scale recycling facility. Recyclers are licensed by the PROs and competent authorities. They need to maintain quality controls to keep their license which is reviewed every two years. This also applies for subcontractors of a business.
- Allocate the importing quota based on the facilities' performance in last year.
- The recyclers have the responsibility to treat the e-waste in an environmentally sound manner and recover as much material value as possible, and try to eliminate, the quantity that goes to the incinerator or landfill.
- Provide information on the precise amount of e-waste processed, on the origin of the e-waste and on the destination of waste residues.
- Set recycling and recovery quotes. Treatment requirements to be developed by producers, competent authorities and recyclers jointly.
- Export of residues only if there is no suitable technology in China, for instance some hazardous components. If components are send to other countries, at least get information on how it will be treated there and choose responsible recyclers.

- ***Informal Recyclers***

The first priority is to ensure that the e-waste that goes through the "Green e-waste shipment channel" is processed in a sound way. Unsound processing should be avoided in the informal recycling sector first. For those poor people who are involved in dangerous working conditions and only aims at maintaining their families, a steady income and protective working environment would be an attractive incentive. The general strategy is to *formalize these companies, otherwise diminish them.*

- Educate informal and small processors about Best Practices, and inform them about the potential health risk.
- Provide them with steady income, and protective working environment.
- If they are not willing to participate, their activities should be diminished by competent authorities.

- ***Disposers***

Firstly, no landfilling in the long term

E-Waste management practices comprise of various means of final disposal of end-of-life equipment which have different impacts on human health and the environment. Genrally, state-of-the-arte recycling technologies should be promoted intensively, which comply with high environmental and occupational health standards. Take landfills for instance, in the long-term situation, almost no material should be landfilled.

Secondly, do not mix with hazardous waste in the middle term.

However, in the mid-term, before an integral recycling system is place, waste should not be land filled with some hazardous e-waste components, for instance batteries, capacitors or condensers. Those hazardous components could be preserved in a safe way, kept airtight container for instance, until new technology or manner is ready to treat them without environmental pollution. And local government should subsidize disposers to cover a reasonable part of disposing fee.

Generally, special designed landfills for hazardous waste, is extremely expensive, which should obtain certain financial subsidy from government. This is also why recyclers have the incentive to try and recover as much useful material from waste as possible, to lower the cost of final disposal.

7.2 Setting monitoring framework for the channel

Stakeholder analysis carried out in previous chapters, found that most stakeholders are driven purely by economics, regardless of environmental impact generated from e-waste business. And they are dependent on one another as well, so they should be coordinated with certain rules. This can be done by other parties who are not part of the infrastructure or businesses of the Channel, but have great power and high interests on this issue. They play or could play crucial roles such as regulating, managing, or informing.

Three ways to improve the current system to meet the targets of the “Green e-waste shipment channel” are proposed and described here:

- *A legal enforcement - from the governmental bodies*
- *A managing process - from a system operator like a Producer Responsibility Organizations (PRO)*
- *A facilitative process - from StEP or other NGO’s*

7.2.1 Governmental bodies

International trade in recyclable wastes is being administrated and monitored by both importing and exporting governmental bodies. Each country should not only develops its own shipment procedure, but also complying with foreign regulations. That means any exporters or importers could only comply with two one of regulations and procedures, which prevents many obstacles for the trade and also reduce grey areas for illegal activities. In addition, the “after shipment” is

the phase that is the most significant but also the most attention paid to. Without the feedbacks from importing countries, the administrative and monitoring procedure could never be completed.

- ***Systemizing and rationalizing trade procedures for transboundary movements of wastes, especially after shipment.***

The transshipment procedure should be systemized and rationalized, and it could be simplified but also function effectively. For the overlapping information provided by importers and exporters, a common internet data base is very necessary to build up and open access for all involving competent authorities. And working priorities should be allocated on "after shipment" phases to confirm that environmentally-friendly practices are being used. By the internet-based reporting system, the foreign recycling and disposal facilities are required to report on whether or not exported recyclable wastes have been recycled.

- ***Exchange of information among enforcement authorities***

Insufficient communication among the competent authorities can result in delays to complete necessary procedures, and there is thus a need for closer liaison in order to eliminate the questions on both sides at the earliest possible stage. Annual international conference, training, forum and so forth could be used to facilitate a shared understanding of the procedure.

- ***Cooperative inspections must be strengthened nationally and internationally, in order to prevent the recurrence of similar illegal shipments. Like IMPEL has set a good example.***

The IMPEL-Seaport project is proven to be a good example of a network on European scale. Also the way information and experiences exchanged in daily circumstances by the IMPEL and IMPEL-TFS networks is seen as "best practice" in this field (IMPEL-TFS, 2006). The network like IMPEL has promoted the thought to start a worldwide initiative for such a project.

7.2.2 System operators

Finally, the organizational aspects of the monitoring system who responsible for the data collection, data handling, must be considered during the design process. Ideally, the organizations responsible for the monitoring program should be independent (Ter Keurs, *et al,* 1986), in order to avoid a situation where they have an interest in a certain output. Governmental bodies and institutes cannot be considered independent of the decision-makers and managers. There is always a doubt that governmental bodies will present results in a way that places their own policy in a favorable light. In practice, complete independence is not realistic, if only for financial reasons (VOS, 1999).

In European countries, the reporting system could be managed by an independent auditing and control mechanism, the Producer Responsibility Organizations (PRO) or "system operator", to ensure sound management. Shifting of problems to upstream is currently taking place in China as well. The latest news shows that the "Circular Economy Law" is expected to be adopted by the Standing Committee at the beginning of 2009 (Li, *et al,* 2008), in which EPR will be officially adopted. The "Green e-waste shipment channel" could provide the infrastructure for a proactive e-waste management initiative from the industry as part of Extended Producer Responsibility

(EPR). Producers therefore, are nice candidates to take this responsibility, because:

- *Due to omissions in the regulations, as well as to differences of interpretation of e-waste and shipment, they are jeopardizing the functioning of a good global market for the collection and treatment of e-waste.*
- *E-waste tends to flow to the least cost solutions, without compliance with related legislations on health, environment and safety.*
- *Moreover, the differences in interpretations create an unnecessary administrative burden for governmental bodies.*
- *Like other international businesses, the e-waste recycling industry also desires a harmonized set of rules and regulations that will benefit from economies of scale.*

The principle of EPR requires continuing accountability of producers in the whole life cycle of their products. This is an absolutely key point to solve e-waste problems upstream. Because this policy makes them financially responsible for end-of-life waste management, producers would have a strong financial incentive to design their products with less hazardous and more recyclable materials. There are also many incentives for producers to be interested in finding a sound solution for e-waste.

- *The social, environmental and ethical aspects require more and more attention in business activities. Corporate social responsibility is now often considered as a strategic business tool.*
- *Other motives to be involved in the e-waste issues include providing a "Green Image" to the customers, which may have positive impact on sale.*
- *The cost to recycle and recover e-waste so as to meet environmental standards, makes the process non-viable (discussed in table 5.5). This point will create powerful incentives for manufacturers of electronics to reduce such costs by designing products that are clean, safe, durable, reusable, repairable, upgradeable, and easy to disassemble and recycle.*

High cost is generated in recycling hazardous components (source: Anahide, 2007)

The major concern of processors is that not everything can be recycled, mostly because the cost would make the process non-viable. The principal problem is the recycling of monitors, owing to the presence of CRT screens.

"Due to their lead content, existing glass recyclers cannot include CRT screens in their process and an environmental sound and financial feasible recycling process is not available so far" (Zumbuehl, 2006).

Another problem is the plastic, which makes 23% of the weight of desktop personal computer. Because it contains Brominated Flame Retardants (BFR's), the usual plastic recyclers can't include it in their process, e-waste recyclers having therefore difficulties to find a buyer.

1) What to monitor?

Based on a conceptual model of system, the relevant inflows, operations and outflows have to be identified and distinguished. An important distinction of objects and parameters is that among, flow variables, compliance with standards & regulations, as well as the special requests from stakeholders (figure 7.3). Flow variables describe the features of flow itself, including substance

flow, financial flow, and the environmental impact generated. Standards and regulations are set by governments to constraint certain procedures and technology. All parameters are learnt from filed works in QiHuoTianDe recycling plants in Taizhou, and Dr. Jaco Huisman's personal recommendations. Besides, the system would incorporate the expert knowledge unique to each party and address their specific concerns.

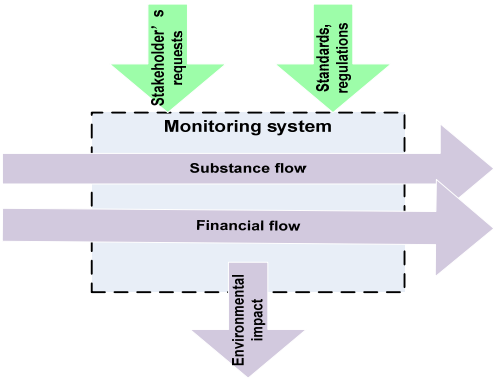

Figure 7.3 the terminology of target and parameters in the system

- *Substance flows*

In a substance flow analysis, the inflow and outflow of a specific substance (chemical element or compound) or group of substances is recorded in quantitative terms together with processes of transformation and pathways of disposal. The main parameters include: previous sector (e.g., seller, Custom), input fraction, output fraction, weight, technology used, and next sector (e.g., purchaser, landfill).

This mass balance principle is most commonly used in substance flow studies, and can be viewed as a form of descriptive statistics. In this way, inflows and outflows are balanced for every node, as well as for the system as a whole, unless accumulation within the system can be proven.

- *Financial flow*

It refers to the data that can be obtained from trade and production statistics. It aims to measure the economic significance of e-waste to the national and local economies and assess performance of e-waste management in achieving economic objectives. In addition, a number of measures exist that could be used by various agencies to keep track of cost and revenues, thereby to make organization's profit transparent. The main parameters include: cost, revenue, and tax, etc.

- *Environmental impact*

It assesses the possible impact–positive or negative–that a proposed process may have on the natural environment. Based on the nature of e-waste, it contains both hazardous and non-hazardous components. Special attention have to be paid to those hazardous component, such as the treatment technology and final destination, until we can ensure that they are all treated in a safe way and no pollution would be generated.

However, hazardous substances are often not recognizable at first because they are "concealed"

in specific components. The Appendix 1 has summarized all hazardous components in e-waste, and required operation on them. It is quite helpful to identify all potential hazardous components before starting dismantling.

- *Stakeholder's request*

Most of the time, the stakeholders just follow the normal shipment procedure and satisfied with current e-waste treatment control, but there might be other special requests from some clients. For instance, confidential components have to be destroyed completely, to protect patent right and data security. This situation happens mostly when a batch of e-waste is sent from an electronic equipment producer, or large corporations. The e-waste supplier has special interests on some components, either hazardous or non-hazardous, so that the relevant parties have to provide qualitative and quantitative information on such components.

- *Standards and regulations*

Any e-waste shipment process is subject to a number of standards or regulations. With regards to some procedures, technologies, and materials, there are many standards of practice to follow. It is quite necessary to regularly verify by means of inspection whether parties comply with the standards and regulations.

2) How to monitor

The PRO should manage at least the collection and the processing part of the Channel. Each of these stakeholders should have a contract with the e-waste system operator. The contract with participants should be different for each stakeholder, according to their roles. The monitoring targets and parameters may also vary between stakeholders. In the beginning, the system operator could choose the participants, which allow them to monitor e-waste of the channel and ensure the sound handling of it. But the final goal is to improve the standards of other stakeholders so that they can join the Channel. Moreover, cooperative workshops or training programs should be carried out regularly, to help participants understand the channel and get the latest operation standards.

The system should also create access to the government and public. The PROs should keep accessibility and transparent to the government, to report compliance to the related environmental, health and safe regulations.

3) Reporting system

E-waste policy-making, planning and management relies largely on processed information, not raw data. This continuous data flow requires well-considered methods for data handling. It could be used effectively if held in a computerized reporting system. A fundamental principle is to hold all data as they were collected, in their original form. This allows flexibility in the way data can be processed (e.g. filtered, aggregated, transformed), and ensures all calculations are reproduced from source data incorporating all revisions.

WF_RepTool is this kind of software product: not only storage and analysis of the data, but also presentation and publication of the results.

> *WF_RepTool and WF_RepLists are software products: programmes and background data sources that the WEEE Forum has developed to allow its members – more than 40 WEEE take-back systems in Europe – and their treatment partners to determine in a transparent, traceable manner WEEE treatment results, including results over the entire treatment chain. This software allows them to classify and calculate the use of components and fractions in the final treatment processes.*
> *Furthermore, the WF_RepTool:*
> - *Defines a structure for calculating the recycling and recovery rates achieved on the basis of the same data structure and an agreed classification of treatment technologies*
> - *Reports the treatment results to the authorities in a uniform manner*
>
> *(Copied from WEEE Forum website)*

However, WF_RepTool may not be widely applied since it is grounded in the European WEEE legal framework. As one month field work in the TaiZhou treatment plant in China, several improvement can be made to adapt WF_RepTool to Chinese conditions(see table 7.1).

Table 7.1 some improvement recommended on WF_RepTool

	WF_RepTool	Improvement
Operational languages	English	Chinese
Basic unit	batch	Batch & work area
Waste codes	EU waste codes	Customs codes
Information tracked	Substance flow	Substance flow, financial flow, environmental impact.
Application	Treatment plant	The whole shipment chain

First of all, the translation of the EU version into a Chinese version is a primary task, as seldom people in China could understand English operation guide. Adapting into local language could eliminate the language barrier, which certainly contributes to a broad acceptance. A particularly important goal must be the creation of a user-friendly interface and understandable output displays to ensure the usability of the decision tool.

Secondly, the barriers to apply WF_RepTool in China are far more than language problems. As we can see from the interview guide undertaken in TaiZhou Qihuo-Tiande Metals CO.,LTD, the basic unit to track and monitor the substance flow is the work area instead of the batch used in WF_RepTool. Every work area plays a very important role in the whole dismantling chain, but also relative independent from each other, which can be regarded as a black box with their inflows and outflows. In this sense, work area is a very good option to check mass balances once certain period with no focus on specific components. Because many batches come and go each day, which are always mixed, it would create many extra troubles to run the “batch” mass balance check. However, when there is a request to track one batch of e-waste particularly, the batch is obviously a better unit. Only in this way can we get detailed information on each component separated on each dismantling step. Therefore, it is recommended combining both units, and keeping it flexible when making a statistic analysis.

Thirdly, countries name wastes in their own way. There is a simply way to solve the confusion. It can simply utilize the Basel waste codes which are already widely used, or reach some consensus

on the waste codes after workshops. The essential prerequisite for a modern e-waste monitoring system is a uniform code that incorporates international “best practices” and applicable international agreements.

Fourthly, only substance flow is monitored in WF_RepTool. However, all relevant variables should be incorporated into the system. Financial flow can be recorded by the cost and revenues on each component. This economic model has been conducted by one of my colleague Wang Feng (Wang, 2008). Environmental impact can be assessed by distinguishing hazardous and non-hazardous waste, and keep on tracking hazardous components until it can ensure that it is treated in a safe way.

Finally, WF_RepTool focuses on the monitoring system of treatment plant, but a treatment plant is just one phase of the entire industry “loop” chain, that is from raw materials to manufacture, distribution channels, consumption, use, collection network, recycling and reusing plant, and turn back to raw materials. Therefore, a data manager should be selected from each parties involved in this “loop” chain, to record the information within that party. An internet website located on one central server and accessible by all partners would be a critical component of the cooperative monitoring system. Data, either collected from field operation or from official governments, should be routed from each country into a peer review holding file in the project’s central server. After the potential data are recorded and corrected, they should be added to the common database, which could then be accessible through the internet for the global scientific community and the public, or which could be held as proprietary for use only by the collaborating partners. In this way, we can achieve the real “mass balance check” of flow variables along the whole chain, satisfy the constraints assigned by stakeholders or governments, and the most important is to clarify and make transparent the movement process.

7.2.3 Academics and NGOs

1) Academics

Currently, the universities and other research institutes play more and more important role in delivering support to pilot projects. Especially in China, universities are acting as consultant for governments, instead of professional consulting companies. As consulting body could help:

- *Make sure that the participants of the Channel know and understand the objectives of the Channel.*
- *Define the standards for the participating stakeholders.*
- *Give information to the participants of the Channel on best practices and best available technologies.*
- *Build Knowledge Bridge on a national and international basis.*
- *Promote business links between stakeholders of the channel or of the framework of the channel, such as collecting information for the government to establish legislation.*

2) NGO’s

NGO’s could provide different services, such as:

- *Build educational centres to educate independent entrepreneurs based on their role*
- *Public awareness raising and communication*

- *Pressure for eco-design and benchmark European standards for manufacturers.*
- *Raising awareness among collectors, recyclers and consumers of the potential dangers of recycling and dumping old and broken appliances. This can contribute to building new attitudes toward e-waste.*
- *Being a watchdog. They could raise media's attention for cases of misconduct acts.*

7.3 Treatment plant Case Study

After presenting an overview of the whole e-waste transshipment channel and its monitoring framework, let us also zoom in on one particular phase called "recycling". In order to help convey the proposed methodology, this section introduces a single monitoring example applied to the TaiZhou Qihuo-Tiande Metals treatment plant. Reasons to concentrate on this phase include:

Firstly, the previous sections focus on the theoretical design of the monitoring framework. But a monitoring framework is highly practical thing, it needs a case study to show "what to monitor", "how to monitor" and corresponding "reporting system". QiHuoTianDe recycling plant is a nice case study to show the application of monitoring system, and provide exact way of data collection process.

Secondly, as found in chapter 4, the phase "after shipment" is the most significant phase but raises little attention. Therefore, a case study in a recycling facility could demonstrate an excellent example on how to monitor the imported e-waste after arriving in China. It especially emphasizes the importance of the treatment of hazardous components.

Thirdly, a recycling facility is one of the most important stages on the whole transshipment channel, because it directly shows whether e-waste has been treated environmental safe.

Last but not least, one of work priorities during the field works in TaiZhou, is consigned by WEEE Forum to gain more practical experience on the current reporting system applied in Chinese facilities. Therefore, the case study also includes the research outcomes of current reporting tool, and suggestion on how to apply WEEE report tool in China.

After presenting pertinent background information on the plant, this study proposes a baseline monitoring system should be applied for "recycler" phase of the whole "monitoring frameowrk".

7.3.1 Current situation in TaiZhou Qihuo-Tiande Metals treatment plant

Tai Zhou Qihuo-Tiande Metals Co.Ld was one of biggest recycling enterprises in China to recover metals from waste. A land area of 140 thousand sq-meters, store area 10000 sq-meters, demolition workers over 3000, and annually processed scrap metal more than 200 thousand tons. The treatment process means the recycling of E-waste, including dismantling, smashing, separating etc.

Most work is manual work. Only a few are conducted by machinery. Most workers can carry out their works with high efficiency and proficiency. The division of labor is excellent too, due to vast diversity in the processing Workforce and repetitive sieving process. Each work area is assigned one type of raw materials. Several half-products can be separated and sent to other work areas, and several products can be collected and send to storage houses (see interview guide). We can see, for instance, residues from separation and mixed fractions are sieved several times before being discarded. The recycling efficiency is quite high. It can reach 99% almost.
There is advanced equipment to deal with waster gas exhausted, and waste water treatment. For some hazardous components that are out of their capacity, they have to be sent to the location that local Environmental Protection Bureau designated.

When it comes to current substance flows in treatment plants, the current reporting procedure is demonstrated in figure 7.4. At the entrance of each work area, there is a small room, which is responsible for recording each batch of goods in and out of the work area, checking the mass balance per day, and report these data to the central administration system too.

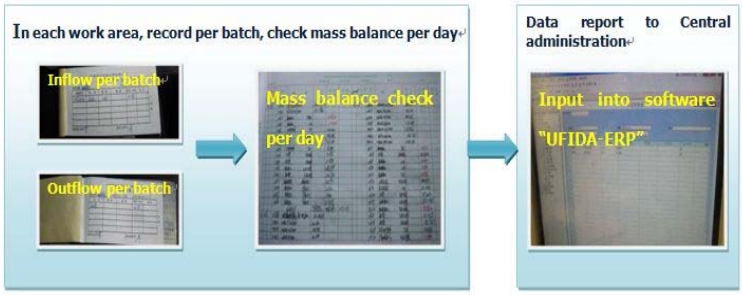

Figure 7.4 Current reporting process in the plant

The record of substance flow is only available for the enterprise itself, they only have to submit a paper report to the local Environmental Bureau every three months. The software applied now is only for individual enterprise' use. It is not accessible for second party to supervise, and lacking common platform in the recycling and reusing industry.

7.3.2 Example of the "recycling facility" in the "Green e-waste shipment channel"

In order to demonstrate an example of a "recycling facility" in the "Green e-waste shipment channel" described in section 6.1, a batch of dismantled DVD Players is taken as an example, to show the tracking trip through the treatment plants. First of all, we assume this batch of DVD was sent from AER Worldwide Company, which provide electronic distribution and e-waste recycling services around the world. Thus there are some extra requests from the clients except formal control system.

The treatment process is one of the most important phases along the e-waste stream, since its significantly contribute to environmental objective: to ensure that all wasted have been treated in an environmentally friendly way. Thus, the general objective for the monitoring system was

formulated as: *"The ability to monitor the substance flow, money flow and environmental impact, with a sufficient statistical power and confidence, and show compliance to the relevant regulations and clients requests."*

First of all, some important flow variables are listed in table 7.2

Table 7.2 Flow variables measured in treatment plant

	Incoming flow	Outgoing flow
Substance flow	Materials Types	Types and amounts of resale component
	Volumes	Types and amounts of recycling material
	Destination & sellers	Purchaser destinations
	Composition, Subassemblies	Landfill & incineration
Financial flow	Material cost	Material revenue (reuse)
	Labor cost	Component revenue (recycling)
	Transport cost	Customer revenue (optional: from OEMs)

From an environmental point of view, a DVD player contains several hazardous components: Capacitors, battery, circuit boards, liquid-crystal display (LCD), and power cables. Therefore, it is not only required to pay special attention to those components when disassembling the product, but also keep tracking those hazardous component until we can be sure that there is no danger to the environment any more.

From stakeholders' point of view, take AER Worldwide Company for example, a treatment plant in China could be one of the recovery and recycling companies in AER Worldwide's supply chain. And this company has strictly requests on a report version compliant to ISO 14001. As a recovery and recycling company has to provide (for detail information see Appendix 2):

- Acknowledgement of receipt
- Teardown report
- Certificate of destruction report (aluminum, plastic, for instance)
- Settlement summary

To sum up, besides the flow variables, the treatment plant has to make an acknowledgement receipt when they received the materials. It has to keep on tracking each component separated on each dismantling step, and make recording. In addition, a certificate of destruction report is submitted at client's request. Finally, a complete settlement summary can be made.

Elaborating the full dismantling tree of the DVD Player, could guide the following reusing and refurbishing steps, and tell where and when to collect data. The set of hazardous components are highlighted in this figure 7.5.

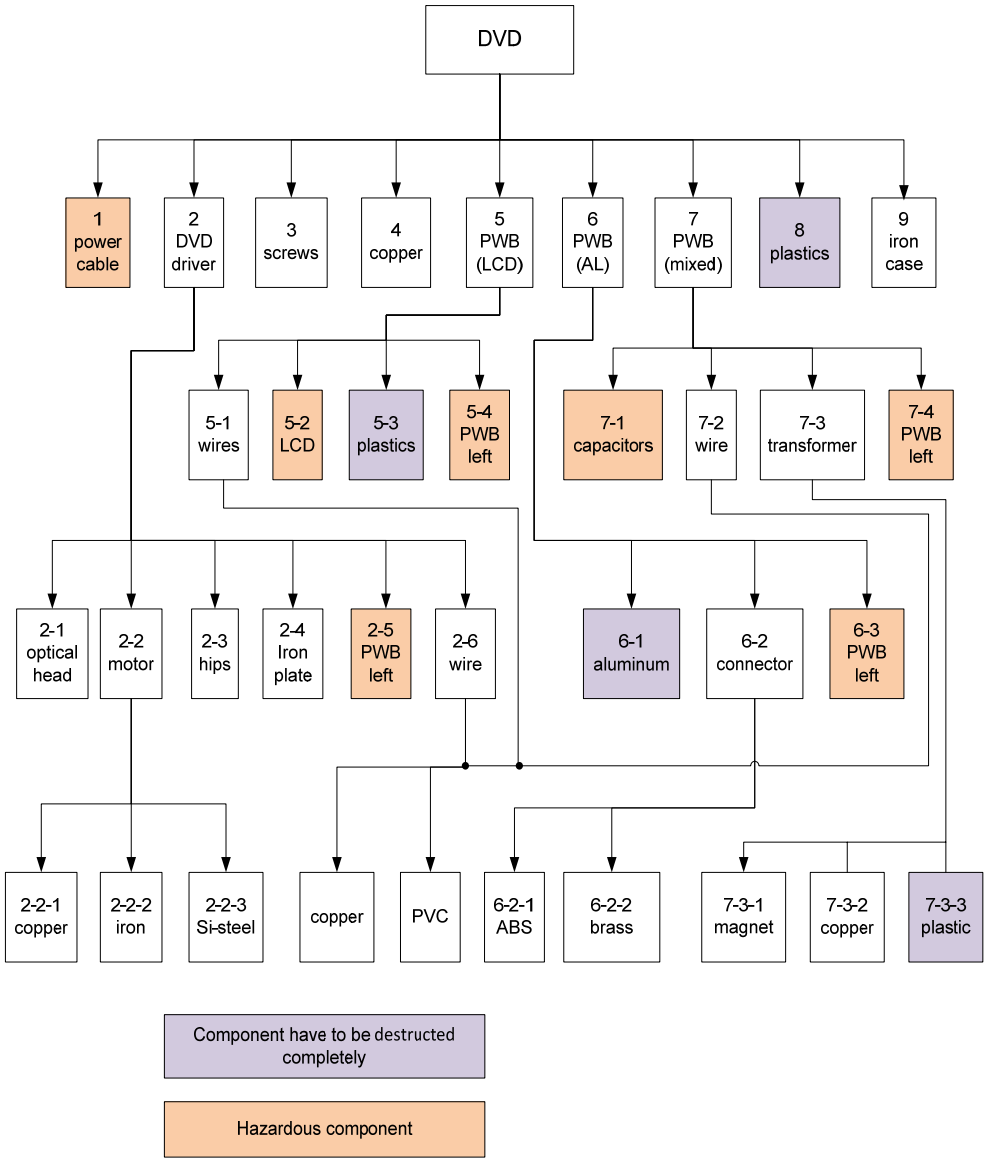

Figure 7.5 the full dismantling tree for DVD players (Wang, 2008)

As seen from Figure 6.5, data collection methods could be selected correspondingly (table 6.3). The more detailed description on design monitoring strategies and selecting methods is given in Appendix 3, which is based on the lessons learned from transboundary river management case (Tidwell, *et al,* 2001).

Table 7.3 data collection methods

	Incoming flow	Outgoing flow	Collection methods	operator	Time
Substance flow	Materials Types	Types and amounts of resale component	Recorded	Auditing department to local EPB	Per each dismantling step

	Volumes	Types and amounts of recycling material	Report	Reporting system operator	
	Destination & sellers	Purchaser destinations			
	Composition, Subassemblies	Landfill & incineration			
Financial flow	Material cost	Material revenue (reuse)	Record	Auditing department	Per trade activities.
	Labor cost	Component revenue (recycling)	Report	Reporting system operator	
	Transport cost	Customer revenue (optional: from OEMs)			
Environmental impact		Non-hazardous component	report	Reporting system operator	
		Hazardous component	Registratio-n and inspector	Local EPB	
Stakeholder's requests	Acknowledgement of receipt		Send receipt	Auditing department to AER	When receive the goods
		Teardown report	report	Reporting system operator to	As soon as finished all process
		Certificate of destruction report	Send report, video, picture	Auditing department to AER	When destruct the component
		Settlement summary	Send summary	Auditing department to AER	As soon as all components handed appropriately
Standards &Regulation			Inspection	Local EPB	Per month

Please notice, for environmental impact, a distinction can be made between hazardous component and non-hazardous components. For non-hazardous components, it can be recorded until the next purchaser, or we can neglect them at process steps, as there is no need to pay particular attention. But for hazardous components, it is compulsory to track them until we can ensure that they are handed in a safe way. A DVD player contains several hazardous components: Capacitors, battery, circuit boards, liquid-crystal display (LCD), and power cables. From Figure 6.5 we can see exactly when these components can be separated. Capacitor, battery and power cable

have to be send to certain factories that local environmental protection bureau designated. For circuit boards (that is PWB presented in figure 6.6), the most safe way is to ship them to Umicore, for instance, one of few factories in the world capable of dealing with circuit boards. And no good method is available to treat LCD, thus keeping them in a safe storage is the best way at this moment.

As soon as data have been collected, the trained system operators should transmit them in near real time to central storage and processing locations, or they could be periodically uploaded by investigators from the producer foundation who visit the field sites. It is very important to hold periodical education programs for system operators in recycling facility, to get the latest news and learn the system update. All available data would then be reviewed, interpreted and evaluated with the aid of stakeholders' workshops. The reporting system plays key role in the "Green e-waste shipment channel". Therefore, consensus is built around a common understanding of how the system operates. A consistent model and database is developed to aid in managing shared resources.

7.4 Evaluation of design work

This chapter presents a summary of the stakeholders' role in the "Green e-waste shipment channel" and "monitoring framework". Generally:

- The Channel is environmentally sound, reducing the amount of illegal shipments, and promoting proper way to treat e-waste.
- The Channel is economically sustainable, mainly through a financial mechanism. It offers incentives for all stakeholders to directly or indirectly to involve in the channel.
- The Channel fulfils a social role, for example creating safe jobs and protecting the health of its workers.

More specifically, the assessment of the proposed works is conducted, compared to the objectives set in chapter 6

7.4.1 Viability of design work

1) ***Prevent of illegal shipments in the upstream.***
   Prevention of illegal shipment in the upstream means that majority of e-waste generated in exporting countries should be collected through formal channel. An effective collection channel is the primary condition to realize this target. It is implemented by registering all parties involved in collecting-exporting phase, strong penalty to illegal shipment, etc.
2) ***Enhance the tracking ability by standardizing shipment procedure and exchange information.***
   The channel emphasizes on the communication and cooperation between competent authorities in exporting and importing countries. And it helps respecting national and international regulations, which is positive for the government.
3) ***Priority is set to develop sound recycling industry in importing countries***

This is the basic and first step to explore the valuable resources in the e-waste. Several actions are proposed, such as regulating informal recycling sector, subsidizing formal sector, and reducing hazardous disposing way.

4) ***Reporting system is designed based on three flows: money, material, and environmental impact.*** It aims to provide comprehensive and pivotal information among e-waste shipment flow. Especially, it provides a detailed example in recycling phase, which is the most important part to ensure environmental soundly treating manner.

5) ***In the optimal situation, the flows are coming from reliable upstream and going to reliable downstream.***
In order to ensure that nothing goes out of the system, once discarded electronic equipment enters into "Green e-waste shipment channel", only authorized stakeholders of the channel should handle it.

6) ***Emphasis the producer's importance and give room for its development.***
Producers are supposed to take more responsibility in e-waste management, thus in green channel, producer's foundation and system operators play very important role in e-waste collection and treatment.

7.4.2 Constraints of design work

This section focuses on the desired long term situation, namely "what should be done", instead of "how to realize them". A qualitative blueprint is drawn, rather than the specific programs. Because of limitations of time and practical experience, there are still some important design constraints which have not been taken into consideration:

1) ***The concept of EPR has become firmly established in the EU, but it may be difficult to apply EU's experience in developing countries due to social, economic and culture differences.*** For instance, it is difficult to establish where the responsibility lies for smuggled products, with the producer or with the importer.

2) ***Producers, and therefore the system operator, might have an incentive not to encourage reuse.*** Possible reasons behind this fact are that the image of the product can potentially be damaged by the second-hand seller, and negative impact on the new product: the longer the equipment is in circulation, the longer the new sale is delayed. But reuse has higher priority than recycling in 3Rs, namely reducing, reusing, recycling.

3) ***The new system is in favor of big processing companies.*** Hence, the smaller ones may be excluded. In this way, competition in the market will be reduced, which is not good for reducing the cost and technology development.

4) ***Although incentives are set for each stakeholder, there is the temptation not to be honest about the process.*** There is a possibility that some of the stakeholders might receive material from somewhere else for better profits. The materials are easy to keep balanced by just filling in the materials coming through the "Green e-waste shipment channel", without reporting the actual incoming materials (and a part of incoming materials may be from unknown channel). No system can 100% assure that all the participators act accordingly. Due to the fact that dealing e-waste based on our system is profitable for all the stakeholders, the majority will obey the regulations which can be recognized as a success.

Chapter 8

Recommendations for Further Study

Looking back on current international agreements, Basel Convention suggests that “Minimizing international movement of hazardous waste”. The original intention for this principle is to prevent irresponsible e-waste transshipment to those poor regions, and environmental damage so incurred. However, after analysis, it seems inevitable to ship e-waste across borders, in order to find a more environmentally sound way. It is not possible for every country to be capable of dealing with hazardous waste, since most countries do not have many processors, modern facilities and best available technology. Under this circumstance, it is highly recommended for potential importing and exporting countries to “develop sound recycling industry in downstream countries” and “Enforce exporter responsibilities in upstream countries” before any trades. Although the corresponding recommendation is limited in the EU and China, the evolving model of the e-waste transshipment could be adapted to other countries, by taking into account the different context and needs. The general blueprint for global e-waste transshipment development is shown in Figure 8.1.

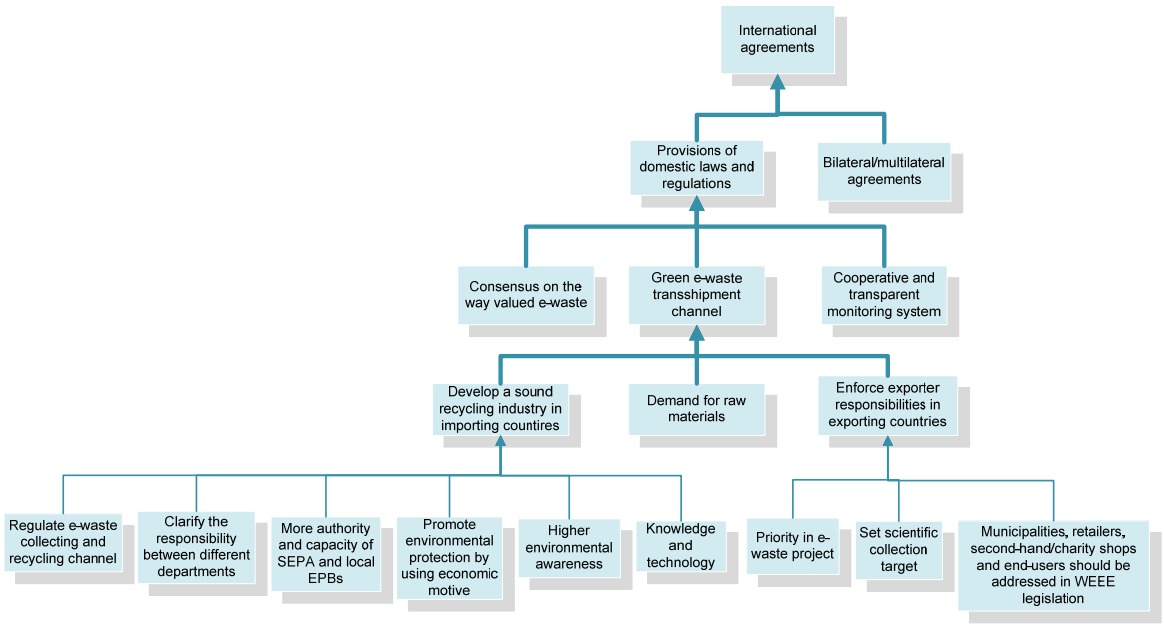

Figure 8.1 Blueprint for generalized e-waste transshipment

In previous research, the up-bottom method is applied to describe the "current situation" to the "desired situation". However, it is noticeable that the reality is on the opposite, that is the initiatives of people lead to a final legislation. Legislation is constantly changing, based on the behavior of the groups. So this chapter aims at mapping out the evolving process of e-waste transshipment from bottom to up, and propose recommendation based on current status.

8.1 Recommendations for the EU and China

In the bottom, the fundamental idea is to develop sound recycling industry in the downstream countries and prevent the illegal shipment in the upstream. Several basic necessary conditions to achieve those two objectives, as well as current development status in China and the EU are listed below:

8.1.1 Develop a sound recycling industry in downstream countries, e.g. China

Making e-wastes recyclable is considered as a sustainable development strategy in future. Effective recovery of e-wastes is important not only for environmental development, but also for rational utilization of natural resources. As a result of huge resource demand and low labor cost in China, the primary task is to develop a sound recycling industry. The specific recommendations include:

- ***Regulate e-waste collecting and recycling channel***

Given the fact that majority of e-wastes are processed in informal sector with huge amount of environmental pollution generated, the most urgent condition for a sound recycling industry is to regulate the e-waste collecting and recycling channel. Up till now, this thesis focuses on the transshipment channel from EU to China. However, the current dilemmas in Chinese domestic

e-waste market include:

- The formal e-waste collection channel does not exist, whether through collector or retailers.
- Financial support to formal collection-recycling facilities is uncertain. Payment system of E-waste treatment cost is the key factor of the establishment and operation of sound recycling system. SEPA sent questionnaires to many involving stakeholders concerning financial scheme, but final decision is not made yet.

The solutions to these problems are left for further research.

- ***Clarify the responsibility between different departments***

It is expected that the national government will become more of a regulator and less of a promoter. That means a stronger group of regulators with more employees and fewer overlapping jurisdictions. They could impose rules and standards that will be more evenly enforced.

- ***More authority and capacity of SEPA and local EPBs***

Although SEPA was updated to Ministry of Environmental Protection in 2008, it should be granted with more authority and capacity to enforce the uniform regulations. Local EPB should be supervised directly by SEPA, excluding the impact from local government. Only in this way, it is possible for an agency to set uniform nationwide standards, monitor performance across hundreds of manufacturing sectors and gain reliable compliance in a country.

- ***Promote environmental protection by using economic motive***

In addition, the central government should also change its deep-rooted prejudice to evaluate lower-level governments' performance by economic growth figures only. In the way to the sustainable development, local environmental policies and officials' environmental awareness should also be evaluated at the same level as economic figures.

- ***Higher environmental awareness***

Public environmental awareness needs to be enhanced, to realize the health and environment risks if e-waste are not treated properly. It is expected that Academics and NGOs should play more and more important roles in educating and raising public environmental awareness, based on their knowledge and access to the corresponding media.

- ***Knowledge and technology***

The needs for knowledge and technology are not the same. Formal recyclers have a fairly good knowledge on waste management but are looking for advanced technology which could provide more economically viable solution for some components. Smaller informal recyclers, on the other hand, have needs to be informed of the best practices and the reasons why they should be applied, for example why screens should not be dumped. Note that the shortages of mature technology could be made up in a relative short period, by direct investment on technology innovation or technical transfer from developed countries that have the technological expertise.

8.1.2 Enforce exporter responsibilities in upstream countries, e.g. EU

Environmental degradation is a global issue, and developed countries should play more active roles and take more responsibilities in controlling and monitoring exports. An environmental sound treating manner in the downstream would be much easier, if e-waste is collected and controlled within the formal channel in the upstream. This could be achieved by setting a more

reasonable recycling target, and addressing the role of municipalities, retailers, second-hand/charity shops and end-users in WEEE legislation.

- ***Priority on e-waste shipment project***

The developed countries should be aware that they can not survive if the environment in developing countries is severely contaminated, simply because we are in the same earth. In order to prevent the disasters caused by e-waste or at least stimulate cooperation on international level, political awareness and support from EU and high national management level is necessary. To emphasize e-waste shipment projects, more resources are required, including labor forces, information tools, and most importantly, budgets.

- ***Set scientific collection target***

The accountability of what is happening to e-waste should be the main focus of improvement. Thus it is proposed to raise the collection target, or re-set the target in a more scientific way. For instance, it is based on the ratio between the collection rates and the amount that has been put on the market (percentage). And on new mandatory WEEE collection target by 31 December 2008, the new target is proposed to set at 65% of the average weight of products placed on the market in the two preceding years.

- ***Municipalities, retailers, second-hand/charity shops and end-users should be addressed in WEEE legislation***

Making it compulsory for consumers to submit e-waste to approved and authorized parties, this would positively influence the collection rate of consumers. In addition, the legislation should also regulate the role of municipalities, retailers and second hand/charity shops, to submit e-waste to approved authorized treatment and recycling operations, which should comply with the Directives and all other relevant national legislation on Health, Safety and Environment.

8.2 Generalized recommendations (International)

- ***Demand for raw materials***

Please notice, “develop a sound recycling industry in downstream countries” and “prevent the illegal shipment upstream” are the basic and necessary conditions for any country no matter it is importing/exporting or not. Besides these two conditions, the demand for resource is also very important to activate the international e-waste trade. One of the main reasons for China being the biggest world e-waste dumping center is the huge domestic demands for raw materials to meet booming development. This is also why African countries could not reach as large importing scale as China, although they are developing countries with low labor cost and loose environmental standards as well.

- **Consensus on the definition of e-waste**

Equipped with “sound recycling industry in importing countries”, “demand for raw materials” and “responsible exporting countries”, all above three components could further promote a consensus between exporting countries and importing countries for valuing e-waste resources.

- Clarify the distinctions between recyclable wastes, hazardous wastes and used goods. And reach international consensus on which goods can be transboundary shipped.
- Especially to harmonize differences in definitions of hazardous wastes. One option is the Basel waste classification system, which is widely accepted.

Besides, it is necessary to further establish Cooperative and transparent monitoring system (detailed recommendation see chapter 7), which is able to track e-waste in an appropriate way according to the definitions of hazardous waste in all involving countries. Based on an international consensus and a common monitoring system, both countries could build "Green e-waste transshipment channel" further. Given the opportunity to combine advantages from both sides and realize "ideal level of e-waste dismantling", the channel should be embedded in international legal environment finally, e.g. provisions of domestic laws and regulations, or even some bilateral or multilateral agreements. Regulatory action might be needed to change certain forms to allow the certain e-waste trade. Ultimately, it might even influence the international agreements.

However, no matter what end-of-pipe solutions, the answer to the e-waste crisis is not to find new downstream hiding places for the waste, but t move upstream to prevent the problem at its manufacturing source. If producer could design their products with less hazardous and more recyclable materials, it would no longer be deadly and destructive to human health and viable ecosystems. Likewise, if clean production could be applied without hazardous inputs and processes, it would be possible to prevent the worst of the high-tech environmental nightmare in the upstream. By the application of Extended Producer Responsibility, it makes producer financially responsible for end-of-life waste management, so as to create strong financial incentive for them to prevent pollution and reduce resource and energy use in each stage of the product life cycle through changes in product design and process technology.

8.3 Recommendation for Bo2W project

The main strength of the Chinese e-waste recycling system is the efficient manual preprocessing, called "basic dismantling" in Bo2W research. And the main strength of western recycling system is their best available technology, especially to deal with hazardous components. The idea behind BO2W is to reach "complete dismantling", namely to optimize the interface between manual pre-processing and further treatment by assessing the optimal dismantling depth. However, considering the possible development in future, there might be some topics for further study:

1) Whether "complete dismantling" is economic viable?

Bo2W project is quite ambitious to achieve the most environmental friendly but also cost-effective way of e-waste treating manner, namely "complete dismantling". It refers to manual processing in China firstly and then shipping hazardous components back to qualified plants in the EU. However, as technology development in China, there would be more and more technologies available to deal with those hazardous components. As long as these new technology could reach Chinese environmental standards, the recyclers do not have any incentives to ship hazardous parts back to EU, although their efficiency might be lower than EU's best practices.

Then the problem becomes whether the "complete dismantling" scenario proposed by BO2W is still economic viable and could be widely accepted. To answer this question, it needs to further calculated the economic viability of each step of the process, including logistics, and to know

exactly how profitable “complete dismantling” could be, and which dismantling alternatives could be more social, environmental and economic viable.

2) Other driving forces for high environmental standards?

The current research have proved that “complete dismantling” could gain the most economic and environmental benefit, compared with Chinese “Basic dismantling” and EU’s “shredding” scenarios. Environment-wise, Bo2W is searching for an option which has higher environmental standard than current options. Given the fact that the biggest interest to recycle e-waste is raw materials, obviously no driving force to pursue higher environmental standards for stakeholder involved. Therefore, the further research should investigate appropriate reasons to convince central governments or stakeholders involved to work for higher environmental standards.

3) How to keep playing intermediate role?

The original attention for Bo2W project is to combine western best available technology and eastern manual operation. Assuming technology delay is very easy to catch up in China, then one question is rising how Bo2W could project keep playing an intermediate role between developing world and developed world. In other words, BO2W project should adjust appropriately to the changing situation. For instance,

- Bo2W could set some small scale pilot projects of “environmental soundly recycling of e-waste” in China, to display a good example to Chinese recycling industry as well as governments.
- Bo2W could also show another high efficient recycling alternative for enterprisers in developed countries, compared with their traditional mechanic shredding way.
- Bo2W could facilitate dialogue between producers and recyclers on how best to design their product and achieve the highest recycling efficiency, given the fundamental solution to e-waste crisis rests with producers.

4) How to extend the research to other developed and developing countries?

Given the fast developing pace in China now, it is predictable that China would not enjoy as many recycling advantages as before, since labor cost may rise and environmental regulations may improve. Under this circumstance, more and more e-waste would search for next “China”, which is poor developing countries but also demands for raw materials, e.g. India and Vietnam. Then the Chinese case would be a perfect lesson, and BO2W could play an important role to generalize successful experience to other developing countries, as shown in Figure 8.1.

References

Anahide, B. (2007). The green e-waste Channel: *model for a reuse and recycling system of electronic waste in South Africa*, Master thesis, University of Lausanne.

Arensman, R. (2000) R*eady for Recycling? Electronic Business*, The Management Magazine for the Electronics Industry

Basel convention website www.basel.int

BASEL CONVENTION and UNEP, *The Basel Convention At A Glance*, available at: http://www.basel.int/convention/bc_glance.pdf

B. Billatos, N. Basally (1998). *Green Technology and Design for the Environment,* Taylor & Francis, Washington, DC, 1998, pp. 3–90.

BCRC (2005). I*nvestigation on E-waste Import and Soundly Environmental Management in China*, Beijing, Regional Center for Basel Convention - BCRC.

Beck, M. (2007) *Mission impossible? Illegal e-scrap shipments and the issue of enforcement,* Recycling International, March 2007

Bodeen, C. (2007) *China's E-Waste Nightmare Worsening, ABC News, available at:* http://abcnews.go.com/International/wireStory?id=3883026

Bodeen, C. (2007). *In 'e-waste' heartland, a toxic China, International Herald Tribune*, published on November 18, 2007, available at: http://www.iht.com/articles/2007/11/18/asia/waste.php?page=2

Brigden, K., Webster,J., Labunska, I. and Santillo, D. (2007) *Toxic Chemicals in Computers Reloaded,* Greenpeace, Research Laboratories Technical note 06/07.

Canneman, W (2008), *Riding the waves-shipping waste from Europe to China*, Waste management world, January-February 2008.

Cheng, E (2007), China: *E-waste and environmental colonialism,* Green left on line, available at: http://www.greenleft.org.au/2007/715/37118

China Customs Statistics, available at: http://english.china-customs.com/customs-statistic/

Council Regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the European Community, OJ L 30, 06.02.1993, p. 1–28

Council Regulation (EC) No 1013/2006 of European Parliament and of the Council of 14 June 2006 on shipments of waste, in force since 12 July 2007, OJ L 190, 12.07.2006, p. 1-98

Cullen, P.(1990) *Biomonitoring and environmental management*, Environ. Monit. Assess. 14, 107–114.

DECISION OF THE COUNCIL C(2001)107/FINAL (2004) *CONCERNING THE CONTROL OF TRANSBOUNDARY MOVEMENTS OF WASTES DESTINED FOR RECOVERY OPERATIONS*, AS AMENDED BY C(2004)20. Download from: http://www.oecd.org/dataoecd/37/49/30654501.pdf

Dietmar, R. et al. (2005).*The recycling and disposal of electrical and electronic waste in China - legislative and market responses,* Environmental Impact Assessment Review 25(5): 459-471.

DTI Report (2005). *WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT (WEEE): INNOVATING NOVEL RECOVERY AND RECYCLING TECHNOLOGIES IN JAPAN.*

Duan, H. Eugster, M. (2007) *Employment analysis of WEEE recycling and disposal in China*, Internal working paper of EMPA, St. Gallen.

EERA, available at: www.eera-recyclers.com

Eugster, M. et al (2007). *Design for environment: a method for formulating product end-of-life strategies*, PhD Thesis, Department of Mechanical Engineering, Stanford University, 2000, pp. 19–144.

E-waste guide, available at: http://ewasteguide.info/hazardous_substances

EU (European Union) (1998) *Proposal for Directive on Waste Electrical and Electronic Equipment*. Brussels, Belgium: Commission of the European Communities.

EU-China News(2005). available at: http://zz04w1.chinaw3.com/newsletters/200507/001_en.htm

EUROPA, Waste shipment, available at: http://ec.europa.eu/environment/waste/shipments/legis.htm

Hellawell, J. A. (1991). *Development of a rationale for monitoring*, in F. B. Goldsmith (ed.), Monitoring for Conservation and Ecology, Chapmann and Hall, London, pp. 1–14.

FAO/DANIDA document (1999) *Guidelines for the Routine Collection of Capture Fishery Data*, FAO FISHERIES TECHNICAL PAPER 382, DANIDA, Food and Agriculture Organization of the United Nations.

Gaulon, B, *et al* (2006) *Recyclism & blue melon - a creation ecology - e-waste workshop,* available at: http://www.bluemelon.org/images/d/d7/EWaste_2.0_eng.pdf

Gmunder, S. (2007). Assessment of optimal manual dismantling depth of a desktop PC in China based on eco-efficiency calculations, Master Thesis. Swiss Federal Institute of Technology Zurich.

Goldsmith, F. B. (1991). *Monitoring for conservation and ecology*, Chapman and Hall, London.

Gray, J. S.; Calamari, D., Duce, R., Portman, J. E., Wells, P. G. and Windom, H. L.L (1991) *Scientifically based strategies for marine environmental protection and management*, Mar. Pollut. Bull. 22, 432–440.

Greenpeace, available at: http://www.greenpeace.org/international/press/reports/toxic-chemicals-in-computers

Grimble, R.; Chan, M.K.; Aglionby, J.; Quan, J. (1995). *Trees and trade-offs: a stakeholder approach to natural resource management*. International Institute for Environment and Development, London, UK. Gatekeeper Series 52.

He, W.Z, et al (2006). *"WEEE recovery strategies and the WEEE treatment status in China*", Journal of Hazardous Materials B136 (2006) 502–512

Herrmann, R. and Stottlemyer, R. (1991). *Long-term monitoring for environmental change in U.S. National Parks: a watershed approach*, Environ. Monit. Assess. 17, 51–65.

Huisman, J (2006)."*StEP Project: the best of 2 world, eco-efficiency of manual dismantling of domestic e-waste in China with control on over all environmental relevant fractions*", phase 1 report.

IMPEL Project Report1, *IMPEL-TFS Threat assessment project: the illegal shipment of waste among impel member states*, Jill Dando Institute of Crime Science, University College London, Environment Agency England and Wales, 2005.

IMPEL-TFS VERIFICATION - 2 PROJECT REPORT (2006), *IS WHAT YOU SEE, WHAT YOU GET?, PROJECT REPORT*, DECEMBER 2004 - MAY 2006

IMPEL-TFS SEAPORT PROJECT II (2006) *INTERNATIONAL COOPERATION IN ENFORCEMENT HITTING ILLEGAL WASTE SHIPMENTS, available at:*
http://www2.vrom.nl/docs/internationaal/eindrapport_europees_zeehavenproject.pdf

Jahiel, A.R (2008). *The Organization of Environmental Protection in China,* The China Quarterly, No. 156, Special Issue: China's Environment, pp. 757-787

Kojima, M. (2005) *International Trade of Recyclable Resources in Asia*, Institute of Developing Economies, Kyoto University.

Li, J.H., Tian, B, Liu, T. and Liu, H. (2006) Status quo of e-waste management in mainland China, J Mater Cycles Waste Manag (2006) 8:13–20

Li, J.H. (2005) *Report on the survey of the import and the environmentally sound management of electronic waste in china,* Asia – Pacific Regional Center for Hazardous Waste Management Training and Technology Transfer (BCRC China)

Lin, C. K., et al (2002).*Globalization, Extended Producer Responsibility and the Problem of Discarded Computers in China: An Exploratory Proposal for Environmental Protection,Georgetown International Environmental Law Review*, 14, 3:525-576, 2002.

Liu, M.H, et al. (2008). *Research on extended producers' responsibility in China,* available at: http://www.cn-hw.net/article/33/sort068/2008/200811198571_3.shtml

Liu, X., M. Tanaka, et al. (2006). *Electrical and electronic waste management in China: progress and the barriers to overcome*, Waste Management Research 24(1): 92-101.

Liu, Y.L (2008). *Recycling and Waste Management, Case Study of China E-waste Recycling Industry,* Worldwatch Institute, available at:

Maher, W. A.. and Norris, R. H. (1990) *Water quality assessment programs in Australia deciding what to measure, and how and where to use bioindicators*, Environ. Monit. Assess. 14, 115–130.

Mreschar, R.I. (2002) *Cleaning the Rhine: An incredible human achievement*, cleanganga, available at: http://www.cleanganga.com/articles/mar3.php

National Development and Reform Commission (NDRC) In China (2004), available at: http://en.ndrc.gov.cn/

NDRC (2004). Available at: http://en.ndrc.gov.cn/policyrelease/t20050620_8228.htm

Organization for Economic Cooperation and Development (OECD)*, Emerging Risks in the 21st Century: An Agenda for Action, Paris:* OECD Publications Service, 2003, p. 6.

People Daily on line, available at: http://english.peopledaily.com.cn/

Port of Rotterdam, available at: http://www.portofrotterdam.com/cn/home

Puckett, J. et al (2002). *Exporting Harm The High-Tech Trashing of Asia,* The Basel Action Network (BAN) and Silicon Valley Toxics Coalition (SVTC).

Qian, Y.J (2007). *Is Electronic Waste Recycling Sacrificing the Environment for Economic Efficiency? China's Taizhou City as a Case Study,* Insights Volume 1, Number 1 (spring, 2007), pp 41-52.

Schmeer, K. (1999). *Guidelines for Conducting a Stakeholder Analysis*, A Partnerships for Health Reform Publication, pp.3

SenterNovem, available at:
http://www.senternovem.nl/Waste_Management_Department/organisation/Index.asp

SEPA(1996). *Supplementary Provisions to the "Interim Provisions on the Administration of Environmental Protection regarding the Import of Waste Materials,* available at: http://english.mep.gov.cn/Policies_Regulations/regulations/Solid_Waste/200710/t20071022_111646.htm

Shambaugh, D (2002). *China's International Relations Think Tanks: Evolving Structure and Process*, the China Quarterly Vol. 171 (2002), pp. 575-96

Shirk, S. (1993).*On the issue of decentralization of the Chinese economy-The Logic of Economic Reform in China*, Berkeley, University of California Press.

Slocombe, D. S. (1992). *Environmental monitoring for protected areas: review and prospect*, Environ. Monit. Assess. 21, 49–78.

Spellerberg, I. F. (1991). *Monitoring ecological change*, Cambridge University Press, Cambridge.

Streicher-Porte, M.; Yang, J.(2007). *WEEE recycling in China. Present situation and main obstacles for improvement,* Proceedings of the 2007 IEEE International Symposium on Electronics and the Environment pp. 40-45.

Silicon Valley Toxics Coalition (SVTC), Global e-waste crisis, available at: http://www.etoxics.org/site/PageServer?pagename=svtc_global_ewaste_crisis

Taizhou Municipality website, available at: http://www.zjtz.gov.cn/ksp/english/

Taizhou EPB, available at: http://www.tzepb.gov.cn/

Ter Keurs, W. J. and Meelis, E. (1986). *Monitoring the biotic aspects of our environment as a policy instrument*, Environ. Monit. Assess. 7, 161–168.

The US environmental protection agency (2001) *Is California Ready for the Challenge*, *REGION IX, Computers, E-Waste, and Product Stewardship,* p. 13

Tidwell, V.C., et al (2001). *Integrating Monitoring and Decision Modeling Within a Cooperative Framework: Promoting Transboundary Water Management and Avoiding Regional Conflict,* SANDIA REPORT, SAND2001-0756.

Tong, X. (2004), *Global Mandate, National Policies, and Local Responses: Scale Conflicts in China's Management of Imported E-waste*, Dept. Urban and Regional Planning College of Environmental Sciences, Peking University.

Tong, X. et al (2004), *Transnational Flows of E-Waste and Spatial Patterns of Recycling in China*, Eurasian Geography and Economics, 2004, 45, No. 8, pp. 608-621.

Tsui K, and Wang Y.Q (2002). D*ecentralization with Political Trump: Vertical Control, Local Accountability and Regional Polarization*, Hong Kong: Department of Economics, Chinese University of Hong Kong, Working Paper, No. 145, 2002.

UNCTAD-UNESCAP Workshop Unedited background paper (2005), *Exchanging National Experiences among the Principal Exporting Developing Countries - Environmental Requirements and Market Access for Electrical and Electronic Goods,* available at: http://r0.unctad.org/trade_env/test1/projects/taskforce.htm

UNCTAD-UNESCAP Workshop (2005). *Exchanging National Experiences among the Principal Exporting Developing Countries - Environmental Requirements and Market Access for Electrical and Electronic Goods,* available at: http://www.unctad.org/trade_env/test1/meetings/ctf2/Unedited%20Background%20Paper.pdf

UNEP (2005) *E-waste, the hidden side of IT equipment's manufacturing and use,* Environment Alert Bulletin, available at: http://www.grid.unep.ch/product/publication/download/ew_ewaste.en.pdf

VOS, P., Meelis, E. and Ter Keurs, W. J. (1999). *A framework for the design of ecological monitoring programs as a tool for environmental and nature management,* Environmental Monitoring and Assessment 61: 317–344, 2000.

Wang, F (2008) *Economic conditions for developing large scale WEEE recycling infrastructure based on manual dismantling in China,* Diploma Thesis for Master Programme of Industrial Ecology in TUDelft.

WEEE Directive, available at: http://ec.europa.eu/environment/waste/weee/legis_en.htm

WEEE Forum, available at: http://www.weee-forum.org/index.php?page=home

Wen, X.F., et al (2006), *An Agenda to Move Forward E-waste Recycling and Challenges in China*, Department of Environmental Science & Engineering, Tsinghua University, Beijing 100084, China

Wikipedia, available at: http://en.wikipedia.org/wiki/E-waste

Yang, J.X et al (2007), *WEEE recycling in China- Present situation and main obstacles for improvement,* IEEE 2007, pp40-45.

Yoshida, A, et al (2003). *The Transboundary Movement of Recyclable Wastes to China*, In Collected Summary of Papers made at the 2003 Annual Meeting. 116–117. Society for Environmental Economics and Policy Studies.

Yoshida, A. (2004), *Chapter 3 China: the world's largest recyclable waste importer.* DE-JETRO. International trade of recyclable resources.

Zhang, J.L (2007) *The Management of Imported Solid Waste in China*, a china environmental health project research brief.

Zonneveld, N. (2008). *Response to stakeholder consultation on review of the Directive 2002/96/EC* , Review of Directive 2002/96/EC (WEEE), B-1049, Brussels, Belgium.

Zissis, C (2008). *China's Environmental Crisis*, Council foreign relationship, available at: http://www.cfr.org/publication/12608/

Appendix 1 E-waste and hazardous components

Hazardous component	Description	Application and usage	General operation
Capacitors and resistors	They can contain poisonous PCB, solvents, or acids that are hazardous to water.	They may often be found on circuit boards and near motors, pumps, or power supplies.	All electrolyte capacitors containing hazardous substances that are higher or wider than 2.5 cm, as well as capacitors containing PCBs must also be disassembled and disposed of. They must not be damaged during disassembly.
Mercury and Mercury switches	Mercury is a poisonous heavy metal.	Mercury can occur in mercury switches and relays, gas discharge lamps and certain batteries. Mercury switch can be found in freezer covers and the lamp socket.	Mercury switches must be carefully searched for and removed without damaging them.
Batteries	Batteries are portable sources of electric current. It may contain poisonous heavy metal: Cadmium, Lead, Lithium, Mercury, and Nickel.	It can be found in laptop computers, power tools, and portable hi-fis, cell phone, computers, video recorders, electric toothbrushes and shavers, etc.	
Circuit boards		Circuit boards can be found in all kinds of electric appliances from mobile phones up to dishwashers. They are found in especially large sizes and high numbers in many appliances for communications technology and consumer electronics such as in	

		computers, television sets, and video recorders.	
Toner cartridges	Toner is powder. It can contain various chemical substances such as pigments (for example, sooty particles), solvents, and synthetic resins.	Toner cartridges may be found in laser printers, copy machines, and fax machines.	Toner cartridges and photoconductive drums should generally be disassembled without being damaged and collected separately.
Plastics that contain brominated flame retardants	Brominated flame retardants reduce the flammability of plastics. However, they may contain toxins and release them in the case of a fire.	They can be found in many electric appliances, more often in electric tools and electronic communication devices.	It is difficult to recognize plastic parts containing hazardous substances. This is why division of hazardous and environmentally compatible plastic parts is barely possible. With suitable technical procedures however, it is possible to recycle plastic containing brominated flame retardants. The flame retardants must first be destroyed to do so.
Asbestos (components containing asbestos)	They are heat-resistant and fireproof. Asbestos fibres can cause severe lung diseases when inhaled.	Asbestos has often been used to produce heat-resistant components and insulation. Typical examples are toasters, irons, heating appliances, electric ovens, electric blankets, hair dryers, and night-storage heaters.	
Picture tubes (cathode-ray tubes)	Cathode-ray tubes consist of high quality special glass. This glass however, contains hazardous substances.	Cathode-ray tubes are the most important components in television sets and computer monitors.	Cathode-ray tubes can implode, that is explosively burst when damaged. When this happens, the toxic luminous coat is released as

			dust. This is why cathode-ray tubes must be vented correctly.
"Ozone killers" –Chlorofluorocarbons (CFC)	Chlorofluorocarbons are organic compounds that contain chlorine, and fluorine, and carbon. Once released into the earth's atmosphere as gases, they damage the ozone layer		
Gas discharge lamps	Gas discharge lamps can contain toxins and problematic substances in the filler gas and luminous coating (such as mercury and sodium).	They are used for ceiling lights, aquarium covers, tanning beds, and exhaust hoods. Special types may be found in LCD screens, copy machines, and scanners.	They need to be disassembled without being damaged and given to a specialist waste disposal company. Under no circumstances should gas discharge lamps end up in the glass recycling container.
Liquid crystal displays (LCDs)	LCDs contain numerous organic chemicals ("liquid crystals") between two sheets. Some of them can be harmful to humans and the environment.	They increasingly replace common cathode-ray tubes in television sets and computer monitors.	LCDs must be disassembled if they are larger than 100cm2. They must not be damaged during disassembly.
Power cable (external electric cables)	Power cables consist of several copper cables with a plastic sheath. These cables are encased together with an extra plastic sheath.	All electric appliances that need "current from the socket" have an external electric cable, often called a "power cable" for short or "electric cable".	
Ceramic fibres – synthetic mineral fibres	not all synthetic mineral fibres present a health hazard. The important thing is whether the fibres released are able to enter the lungs. It can be great differences between types.	In the form of mats, synthetic mineral fibres are often used for heating and acoustic insulation. They may be found in electric stoves and dishwashers for example.	

Radioactive components	Radioactive appliances and components must be labeled with the required hazardous material labeling, a black "propeller" on yellow background	Radioactive components in waste electronic equipment are a rare occurrence. They can be found for example in older smoke detectors (ionisation chamber smoke detectors) and in certain laboratory and medical appliances.	Do not open or disassemble components and appliances that are labelled "radioactive". They must be given to specialist waste management companies.
Photoconductive drums containing selenium and cadmium	On older models, the coating can contain compounds containing cadmium (yellow) or selenium (silver-grey). Both substances are hazardous to health.	Photoconductive drums can be found in laser printers, copy machines, and fax machines. They serve to transfer the toner to the printing paper. They are usually assembled into the toner cartridge. They can also be found inside the appliance.	Photoconductive drums containing selenium and cadmium must be collected separately and given to a special disposal company.

Appendix2 Manifest model

To: customer@ABCCo.com
Subject: Acknowledgement of Receipt
Date: 5/6/2005 10:28:16 -0700

Dear AER Customer,

Attached is an Acknowledgement of Receipt of materials picked up from your facility and delivered to AER Worldwide in Fremont, CA.

PO# 83427
Date Recd 5/6/2005
7,847 Lbs.
3 Pallets

Please feel free to call or respond to this e-mail if you have any questions.

Regards,

AER Worldwide Receiving
receiving@aerworldwide.com
(510)300-0500

AER worldwide
THE ELECTRONICS LIFECYCLE RESOURCE

PO #: 18312
Date Received: 7/10/2006
Company : ABC Company
Department: 123456789

Teardown Report

Product	Gross (lbs)	Tare (lbs)	Net (lbs)	Sell/ Spec $	Return	Cust Price	Ext. Price
Trash	546	0	546		0%	0.000	0.00
Cost Code: I	Subtotal:		546				0.00
Disposition:	Subtotal:		546				0.00
Aluminum Cont	2	0	2	0.350	60%	0.210	0.42
Batteries/UPS Systems	2	0	2		60%	0.000	0.00
Breakage: High Grade	60	0	60		60%	0.000	0.00
Breakage: High Grade	137	0	137		60%	0.000	0.00
Breakage: Low Grade	258	67	191		60%	0.000	0.00
Cardboard	30	0	30		60%	0.000	0.00
Monitors for Recycling	155	45	110		60%	0.000	0.00
Paper	20	0	20		60%	0.000	0.00
Plastic-Mixed	20	0	20		60%	0.000	0.00
Steel	611	0	611	0.030	60%	0.018	11.00
Steel	149	0	149	0.030	60%	0.018	2.68
System for T/D	0	0	0	0.100	60%	0.060	0.00
System for T/D	989	45	944	0.100	60%	0.060	56.64
Wire	541	409	132	0.946	60%	0.568	74.92
Wire	1	0	1	0.946	60%	0.568	0.57
Cost Code: M	Subtotal:		2,409				146.23
Pulling Boards	289	57	232	2.449	70%	1.714	397.72
Cost Code: R	Subtotal:		232				397.72
Disposition: Destruction/Recycling	Subtotal:		2,641				543.95
Devices for Listing: CPU's	1	0	1			0.000	0.00
Devices for Listing: Modules	7	0	7			0.000	0.00
Devices for Listing: Passives	2	0	2			0.000	0.00
Cost Code: D	Subtotal:		10				0.00
Disposition: Resale	Subtotal:		10				0.00
Grand Total:	3,820	623	3,197				$543.95

ABC Company				Settlement Date:	2004/4/5
123 Maple St.				Customer Ref #:	
Anycity, Worldwide				AER P.O. #:	15989
				Date Received:	2004/2/26
Attn: John Smith					
		SETTLEMENT SUMMARY			
Process Value Summary					
Quantity	**Unit**	**Description**			**Amount**
600	lbs.	Teardown Report Revenues			$X.XX
		IC Listing (Please see following)			$X.XX
		Hardware Listing (Please see following)			$X.XX
600	lbs.	Total Net Weight Received			
				Total Value:	$X.XX
Process Charge Summary					
Quantity	**Unit**	**Description**		**Unit Charge**	**Amount**
	lbs.	Monitors (CRT's and Flat Panels) and Batteries		$X.XX	$X.XX
	lbs.	Packaged Miscellaneous Electronic Scrap		$X.XX	$X.XX
	lbs.	Loose, Unpackaged, Sorted Misc. Electronic Scrap		$X.XX	$X.XX
				Total Charge:	$X.XX
				* Total Payment:	$X.XX
		* Special note: The cost of processing and transportation exceeds the value of the material.			
Please review the summary of settlement for P.O. 15989. Enclosed is our check number _____ for the amount of $X.XX, in settlement for metal and component bearing material, which was picked up and processed by AER Worldwide.					
Thank you once again for the opportunity to be of service.					
Best Regards,					
André Weiglein					
President					

CERTIFICATE OF DESTRUCTION

July 27, 2004
ABC Company
123 Maple St.
Any City, Worldwide
Attn: John Smith

AER P.O.#	CUST. REF#	MATERIAL DESCRIPTION	NET WEIGHT (LBS)
83427	N/A	ALUMINUM-CONT	8
		BOARDS FOR REFINING	196
		BREAKAGE: POWER SUPPLY	47
		CONNECTOR BOARDS FOR REFINING	41
		MONITORS FOR RECYLING	20
		PLASTIC-MIXED	9
		PULLING BOARDS	30
		STEEL	5,558
		TRASH	25
		WIRE	9

This is to certify that destruction of proprietary scrap has been completed. This material, listed above, was received on June 14 of 2004 from ABC Company. All products are processed and destroyed in compliance with all state and federal environmental rules and regulations.

Sincerely,

Andre' Weiglein
President

Appendix3 Design/develop cooperative monitoring system, based on Kura River management

Given the fact that, developing nations lack the infrastructure to establish and operate comprehensive monitoring networks; in other cases, data are collected but not shared across national boundaries. Cooperative monitoring is the means to allow diverse parties engaged in the decision process to explore the shared information in the context of the problem they seek to solve. Cooperative monitoring shows many advantages. The most important one is the data collected, which are necessary to ground policy decisions in reality. Acquired information can provide baseline information for long-term resource management, enhance understanding of soundly environmental processes, and verification of progress toward shared goals. Cooperative monitoring also provides a physical and social infrastructure for international scientific and political collaboration (Tidwell, 2001).

This section describes a framework that could help prevent conflict over and promote international and regional cooperation on transboundary e-waste issues. Central to this approach is to design the monitoring system in a collaborative way (Figure 6.2):

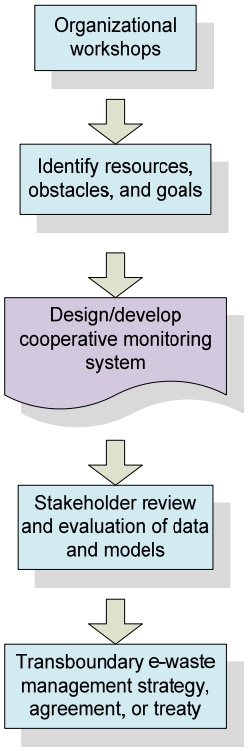

Figure Process of cooperative monitoring

Cooperative monitoring is aimed at build both transboundary databases and transboundary cooperation and collaboration. Therefore, it begins with communication, which would be realized by a series of workshops attended by stakeholders involved. Initial workshops would allow participants to express their own perceptions on e-waste issues, such as problems, concerns, and goals. The outcomes of the initial workshops would be to a joint monitoring system and to organize the resources for program implementation, which will be fully elaborated in next section. Later workshops would allow participants to modify and improve methods. Over time, Monitoring and statistical analyses of collected data could identify gaps in the monitoring system, allowing for appropriate revisions to the transboundary e-waste policies, even up to international agreements or treaties ultimately. Because global e-waste stream is a constantly changing system, the monitoring system and related agreements must also be dynamic. As new data and understanding of the system become available, the parties must revise the model accordingly. Likewise, if necessary, keep treaties and international agreements updating as well.

The cooperative nature of all these steps and the repeated meetings of participants could contribute to the development of a strong foundation of trust, which could foster other transboundary cooperation too.