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The Myth of 'Environmentally Sound' Management of E-waste:

A case study from computer recycling activities in Delhi, India

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List of Acronyms

AIKMM	All India Kabadi Majdoor Mahashagh
CPU	Central Processing Unit
EEE	Electrical or Electronic Equipment
EM	Ecological Modernization
EPR	Extended Producer Responsibility
ESM	Environmentally Sound Management
EU	European Union
GTZ	Gesellschaft für Technische Zusammenarbeit
ICT	Information and Communication Technology
IT	Information Technology
MNCs	Multi-National Companies
MoEF	Ministry of Environment and Forest
NEP	National Environmental Policy
NGO	Non-Governmental Organization
OECD	Organisation for Economic Co-operation and Development
PC	Personal Computer
PCB	Printed Circuit Board
Rs	Rupees
SD	Sustainable Development
TERI	The Energy and Resources Institute
UNCED	United Nations Conference on Environment and Development
USA	United States of America
USD	United States Dollar
WHO	World Health Organization

Abstract

The growing volumes of obsolete electronic product, or e-waste, have posed serious concerns on landfill spaces and the urgent need to recycling hazardous components in both developed and developing countries. The illegal shipment of e-waste from developed countries to developing countries has been often reported. In India, the growing stream of e-waste imported and domestically disposed, particularly computer waste has aggregated the environmental health problems at the bottom part of the informal recycling chain, while generating economic benefit and clean environment for the particular group of people. Hence the major focus of my study is to understand the structure of this disproportionate distribution of economic benefits and environmental health costs in the computer recycling chain in India. This paper initially characterizes the generation of and the flow of computer waste in and between developed and developing countries and examines specifically the flow into the formal and informal recycling chains in India. Then the paper analyzes the distribution of economic benefits and environmental health costs in the informal recycling chain in Delhi with a focus on power relations among socially and economically differentiated actors. Finally the paper attempts to investigate policy implementation on the uneven distribution of benefits and costs.

Chapter 1 Introduction

1.1 Indication of the Problem

In Organisation for Economic Co-operation and Development (OECD) countries such as European Union (EU) member states, the United States and Japan, there has been much discussion about electronic waste, or e-waste, since the early 90s. Of particular concern is the growing quantity of e-waste, the resulting limitation of landfill spaces, and the need to treat hazardous components during recycling. The high consumption rate of electronic products (e-products) has led to the generation of high volumes of e-waste as well as market saturation of e-products. This growing stream of e-waste has posed serious concerns on landfill spaces. For example, landfill space in Japan was reported to run out in 2008 with its enormous manufacturing base and limited natural disposal options (Elcina 2007). Consequently OECD countries have issued a series of environmental legislations on e-waste minimization by establishing the reuse and recycling systems. However, some types of e-waste such as computer transform into hazardous waste during the recycling process since they are produced with toxic materials including lead and mercury. Hence recycling of e-waste causes occupational health hazards as well as environmental degradation unless the production and recycling processes are implemented with environmental health concerns.

On the other side of the world, large quantities of e-waste have been shipped to developing countries. According to Levinson et al., e-waste is shipped from OECD countries into Asian countries and increasingly into African countries for the recycling and disposal purpose (Levinson et al. 2008). In China, approximately 72 % of global e-waste, or 36 million metric tons, is dumped on an annual basis (Chisholm and Bu 2007). In Nigeria, more than half a million computers enter in Lagos every month but only one in four is reusable (Wray 2008). Not everyone is concerned about this transport of e-waste. The former Chief Economist of the World Bank, for example, mentioned in a memo that "the economic logic behind damping a load of toxic waste in the lowest wage countries is impeccable' arguing that "people value a clean environment more as their income rise, if other things are equal, costs fall if pollution moves from rich to poor ones" (Anand 2004). Many of aid organizations in developed countries donate their e-waste to developing countries for the purpose of educational development projects on information and communication technology (ICT). Even the Institute of Social Studies (ISS) used to donate e-products to developing countries. ISS had donated three year old obsolete computers to universities in Ethiopia and Sudan, along with provision of ICT education and training (ISS, Personal Communication, 20 October 2008). International aid agencies such as the Rotary Club sponsored the transportation cost. The ISS has never taken back the donated computers when they were transformed into non-functional rubbish after another few years of use: the officer in charge of obsolete e-products said "We do not care about how these universities deal with them after the end of their use" (ibid).

The rationale behind shipping e-waste from developed countries to developing countries is that it provides economic benefits for certain actors on both sides. However, while creating economic and educational opportunities from the use of computer that become obsolete in developed countries, this transnational flow of e-waste also displaces the environmental health problems associated with treating e-waste with low-tech procedures. With the shipping of e-waste to developing countries, consumers of e-products and the companies that manufacture and sell these products in developed countries do not carry the burden of disposing of e-products. The burden is shifted to poor workers and marginal neighbourhoods in countries that import e-waste.

Responding these problems and concerns, there has been landmark legislation initiated in OECD countries. Also governments of developing countries have prepared policy guidelines to deal with the growing volume of e-waste generated both overseas and domestically. The Basel Convention, an international treaty that entered into force in 1992 with 170 parties to the Convention, regulates export and import of e-waste, but has not slowed the flow of e-waste across oceans.

1.2 Research Objectives and Methodology

This paper explores these issues in the context of computer waste in India. The objective is to 1) characterize and explain the generation of and the flow of computer waste in and between developed and developing countries, and the flow into the formal and informal recycling chains in India, 2) investigate how economic benefits and environmental health costs are generated and structured in the informal recycling chain in Delhi, and 3) critically analyze how the policies and policy processes in India affect the distribution of economic benefits and environmental health costs.

To achieve these research objectives, I implemented a case study of computer waste recycling in Delhi, India. India was chosen as geographical research area because India is cited in much research as one of the major sites of illegal e-waste import. India's capital New Delhi is reported to be a major final recycling destination for obsolete computers from India and imported illegally from other countries (Schwarzer et al. 2005). I chose to focus on computer waste for three reasons. Firstly, computer is one of the 'Grey goods' that transform into hazardous wastes when becoming obsolete, making the waste treatment more complex due to their toxic composition (Sinha 2007). Hence it poses heavier risks on environmental health that need to be strongly concerned. Secondly, the computer sector is the fastest growing information technology (IT) sector in India. Between 1995 to 2000, the Indian IT industry grew at a rate of 42.4% (Tata Energy Research Institute 1999 cited in Mundada et al. 2004). Thirdly the recycling chain for computer waste is visible in India. 'Computer' in this study includes both personal and desktop computer.

The paper draws on both secondary data from existing studies and primary data collected in interviews. Interviews were conducted with different actors in the recycling chain in and outside of India and a Dutch organization that specializes e-waste issues. To identify interviewees in India, I first chose to focus on the places in Delhi where the stakeholders of the recycling chain

operate their business. These locations were identified by a Delhi-based e-waste expert NGO called Toxics Link. I then set out to interview importers, repair/resell shops, traders, street vendors, dismantlers and extractors of raw materials. I did not visit smelters due to the difficulty and danger of finding them. I was noticed by many Delhi-based experts that smelters would be aware of their illegal activities and hence unwilling to take an interview. I was also warned not to visit them alone but with some organizations. For the time limitation, I could not find any organization that would help me conduct an interview. Also, outside of India, I conducted an interview with the Belgian company, Umicore, which imports e-waste from the Indian recycling sector for the recovery of metals, and with a Dutch e-waste expert organization called WASTE.

Semi-structured interviews were carried out with the relevant stakeholders mentioned above, both face-to-face and by telephone. In the case of interviews in India, I had a great assistance of translating local language into English by Indian young person. The choice of this young person turned out to be helpful in that most of interviewees seemed to enjoy the conversation without any fear or doubt of us being governmental officials. They easily revealed and discussed openly the illegal activities in which they are involved.

This paper draws on a qualitative analysis of the interviews. Quantitative data analysis was unnecessarily because this research paper does not aim at generalization of stakeholders' interests or environmental and health impacts, and was also not possible given the small number of interviews conducted (11 interviews). My analysis also included a review of Indian national law and policies regarding e-waste and computer recycling activities.

1.3 Research Questions

The research questions are 1) how the generation of and the flow of computer waste in and between developed and developing countries and the flow into the formal and informal recycling chains in India are characterized, 2) how economic benefits and environmental health costs are generated and structured in the informal recycling chain in Delhi and 3) critically analyze how the policies and policy processes in India affect the distribution of economic benefits and environmental health costs.

1.4 Limitations of Research Paper

The main focus of this study is to understand the structure of the distribution of economic benefits and environmental health costs in the computer recycling chain in India, based on the distributional justice, one dimension of environmental justice framework. Another dimension, namely procedural justice, which emphasizes the fairness in decision-making processes cannot be inspected in depth due to the limited period of my three-week field research. I was able to participate in the policy debate only once in India. The time limitation and the language barrier also constrained the number of interviews. Due to the need for translation, it took me two hours on average to conduct one interview. Furthermore, the names of some interviewees and the pictures

of the recycling activity sites are not revealed since I was warned not to do so by many of interviewees who are involve with illegal activities.

1.5 Organization of Research Paper

Chapter two presents the conceptual framework for this research. In the next three chapters, I first characterize and explain the generation of and the flow of computer waste in and between developed and developing countries, and the flow into the formal and informal sector in India, as an example of developing countries. Then I investigate how economic benefits and environmental health costs are generated and structured the informal recycling chain in Delhi. And in the last chapter, I critically analyze the causality of benefits and costs distributed unequally among actors, including policy process, from the environmental justice framework. In so doing, I focus on what kind of the power relations affect the benefit-cost structure.

Chapter 2 Analytical framework

2.1 Sustainable Development Framework

Many scholars have intended to solve e-waste conflicts following a mainstream sustainable development (SD) concept that harmonizes economic development and environmental and social sustainability. Some recommend the solution of building recycling technology and/or knowledge partnership that will reduce environmental and health impacts without reducing attractiveness of recycling business (Mundada et al. 2004,Innocent Chidi Nnorom and Osibanjo 2007,I. C. Nnorom and Osibanjo 2008,Sinha-Khetriwal et al. 2005,Widmer et al. 2005). Their argument is premised on continuous pursuit of capitalism and industrialization while preserving the environment. Indeed, this approach has been advocated in international development fields too. For example, United Nations Conference on Environment and Development (UNCED) promoted the linkage with business and industry in the Agenda 21, stating that "A positive contribution of business and industry, including transnational corporations to sustainable development can increasingly be achieved by using economic instruments such as free market mechanisms in which the process of goods and services should increasingly reflect the environmental costs of their input, production, use, recycling and disposal subject to country-specific conditions."[1] (The United Nations Division for Sustainable Development 1992: 30.3)

The mainstream SD concept is embodied in the ecological modernization (EM) approach that is based on the fundamental principle that "economic growth and the resolution of ecological problems can, in principle, be reconciled" (Hajer 1995: 248 cited in Blowers 2003). It advocates the following components: incorporating environmental issues into production and consumption processes including recycling and waste minimization, regarding the market as efficient and responsive and placing the responsibility of environmental services on the private sector, formulating environmental policy through the partnership of state and business and making cooperation or partnership through negotiative forms of decision-making between them (Blowers 2003). However, according to Blowers, there are limitations in applying EM to environmental problems (ibid). Firstly EM only applies to specific process in specific country and hence it distracts attention from ecosystem complexity. Secondly EM ignores the impacts of externalities on other places imposed by certain industries. Lastly but most importantly, EM disregards the analytical and practical importance of inequality in the relationship between society and the environment which affect uneven impacts of environmental change over space and time.

2.2 Environmental Justice Framework

By contrast, environmental justice approach emphasizes distributional implications of environmental change with a focus on broader social justice

issues. The principle of the claim is that low income persons and communities bear a disproportionate share of the burden of environmental health costs in the form of toxic waste, health risks and jobs that are unsafe, while many of the rich have benefited (Foreman 1998, Kraft and Scheberle 1995, Ringuuist 1997 cited in Anand 2004,Blowers 2003). With regard to low-income populations, the main issues addressed by environmental justice can be divided into two dimensions: distributional and procedural justice (Anand 2004). Distributional justice reveals the inequitable distribution of burdens on differentiated group of people and community, focusing on the right of low-income and minority populations not to face unevenly distributed environmental health costs (ibid). In fact, as argued by Hallowes and Butler, environmental justice is not simply realized through fair distribution of benefits and costs but "goes to the heart of how power relations define and re-produce development itself", involving who benefits, who loses, and who did it (2002). This question of who is relevant because environmental injustice is created and configured by multiple relationships. On this point, Hallowes and Butler indicate that environmental justice may be placed in the socio-political contexts, demonstrating that "environmental justice obtains where relations between people, within and between groups of people, and between people and their natural, cultural, social, political and economic environments are fair and equal […]" Distributional justice, hence, intends to tackle the inequitable distribution of benefits and costs by confronting multiple power relations exercised in different settings and focusing on 'who does it'.

On the other hand, the other dimension of environmental justice, namely procedural justice is also important to consider because it uncovers unfairness in decision-making processes and policy formulation. This dimension focuses on advocating the need for the public policy to be premised on mutual respects for all people, equal participation on the basis of fairness and no distorted presence of the privileged insights in agenda setting process.

Considering the current situation surrounding computer waste in India, I believe that the environmental justice approach encourages me to investigate how economical benefit and environmental health problems are generated and distributed among differentiated group of people and what kind of power relations affect the structure of distribution. Further, it allows me to explore how the current policies and policy processes in India challenge uneven allocation of benefits and burdens.

2.3 Applying the environmental justice framework

In the analysis, I pay attention mainly to four elements of the environmental justice framework: social and spatial implications of unequal distribution of benefits and costs, multi-level of causes and multi-scale impacts in space and time.

Firstly the social context of unequal distribution of benefits and costs needs to be analyzed. Some radical environmental justice theorists are often criticized as overlooking social aspects by emphasizing ecological issues (Blowers 2003). It is pointed out that many of them constitute of elitist and middle class people's intention to prevent environmental damage for their own

pleasantness, diverting polluting projects to disadvantaged communities (ibid). Beside, these disadvantaged communities are not homogeneous but have socially differentiated backgrounds such as lower caste, minority in religion and migrants that affect the distribution of benefits and costs. Hence in order to avoid exclusion, broader social differences among actors need to be reflected upon.

Secondly it is certain that there are disadvantages experienced by specific places and communities that are exposed to environmental health risks (ibid). Ruiters describes the relation between the spatial characteristics and capital inequality (2002). Capital tends to have superior command over space for example through taking advantage of labour's relative immobility caused by the severely limited spatial options. Hence economic difference within and between countries could relocate capital to lower intensities of class conflicts and to less-organized communities, creating permanent instability and uncertainty which undermines the institutional base for long-term arrangement of stability (ibid). Given that capitalist dynamics for example in information technology industry generate spatial configuration and produce injustices, it is important to stress how and why special characteristic of Delhi is taken advantaged of for benefit generation.

Thirdly the environmental health effects in one locality need to be considered as a result of causes at multi-levels (Blowers 2003). Under the globalization of the economy, the production, the consumption and disposal of consumer technology such as computer are now diffused in many parts of the world and within countries (Iles 2004). Hence regional, national and transnational causes of the generation of environmental health problems are important to investigate.

Lastly the effects of environmental change over space and time need to be touched upon. There is a possibility that the current polluting activities transmit environmental effects down the generation crossing the spaces (Blowers 2003). With relation to community management of resources, Leach et al. (1999) also established the assumption of community-environment relationship whereby the environment is non equilibrium and variable in space and time and it could result in contingent and dynamic change caused by historical process involving dynamic interactions among differentiated actors in the community. Hence the environmental effect needs to be concerned in the wider spatial and time terms.

Chapter 3
The Generation of and the Flow of Computer Waste

3.1 The generation of computer waste

3.1.1 The growing volume of computer waste

Electronic waste, or e-waste, defined as "various forms of electrical or electronic equipment (EEE) that have ceased to be of any value to their owners", is currently becoming one of the fastest growing waste stream in the globe (Widmer et al. 2005: 438). Widmer et al. (2005) estimate that approximately 20 million PCs became obsolete in 1994 and that this figure was expected to increase to over 100 million PCs per year by 2004 in the world. Further 500 million PCs reached the end of their lives between 1994 and 2003. The growing volume of computer waste is caused by the ever shorter life of PCs and the increasing growth in the number of PCs in developing countries.

One retailer owner that I interviewed stated that his customers purchase new computer in the cycle of two to three years as software and hardware developments encourage consumers to regularly upgrade (Personal Communication, 30 July 2008). According to him, consumers find technical incompatibility of hardware (e.g. computer and its in-built components) with new system of software which continues to get innovated by software companies. For example, while the software, Microsoft Windows 98, requires for the hardware, P III CPU (Central Processing Unit) in PCB (Printed Circuit Board), the Windows Vista requires a P IV CPU because P III CPU is too slow for the Windows Vista. Therefore this rapid software innovation developed by software companies obviously has a direct impact on the short life of hardware, leading to increasing volume of obsolete computers. As long as technological innovation continues, consumers with financial asset for purchasing new PCs elsewhere keep on disposing of older ones, and the total amount of obsolete computers increases in the global scale, even in developed countries with high market saturation of PCs[2].

In addition to the shorter life-span of PCs, the increasing volumes of PCs in developing countries affect the growth of computer waste (PC-waste) stream. The top scoring countries in PC growth per capita between 1993 and 2000 are occupied with developing countries (Empa 2008). For example, the PC growth of China and India is six times and three times respectively higher than the world average[3]. Considering the fact that PCs have the certain period of the life span, they will surely face the high amount of PC-waste sooner or later.

3.1.2 Implication of the growing volume of computer waste

The growing quantity of PC-waste could cause negative impacts on PC-waste management including the lack of landfill spaces and environmental health problems without reducing consumption and/or promoting reuse and recycling practices. As long as consumers have the financial affordability, they keep on purchasing new PCs for replacing old PCs that is incompatible with innovated software systems.

In addition, so-called 'Grey goods' including PCs and printers transform into hazardous wastes during the recycling process due to containing hazardous substances that are toxic by nature (e.g. lead and mercury). 500 million PCs comprise about 2,872,000 ton of plastics, 718,000 ton of lead, 1363 ton of cadmium and 287 ton of mercury (Widmer et al. 2005). Further, the complexity of assembly seems to literally make disassembly complex, generating potential risks for occupational health. Dismantling process cannot be automated and hence must be labour intensive. In the recycling centers of FUJITSU in Japan, for example, skillful workers operate disassembling manually[4]. Hence the growing volume of PC-waste could pose the huge impacts on environmental health if not treated in a safe and environmentally sound manner.

3.2 The transnational flow of computer waste to and in India

Then, where and how is globally consumed and disposed PC with hazardous substances treated and by whom? From the survey on market saturation of PCs in 2002[5], most of the consumers in developed countries are expected to dispose old PC and purchase another PC sooner or later. And the load of PC-waste flows from developed countries into India along with other e-waste, as pointed out by many authors (Agarwal et al. 2003,Mundada et al. 2004,Widmer et al. 2005). Actual data on PC-waste import to India is not available due to the informal nature of the trading by containers. However the survey by IMRB International shows that, among the total e-waste traded in India in 2007, or 144,143 megaton (MT), 50,000MT was imports including PC-waste[6] (2008). Despite of the developed countries' state-of-art regulations on e-waste shipment, then, how does it get to India?

EU has been referred by many authoritative bodies as a pioneer of environmental legislation on e-waste such as the WEEE Directive that complies with the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) that regulates export and import of PC-waste. India has also ratified the Basel Convention. However there seems to be several loopholes in the Basel Convention that enable illegal traders to smuggle it out to and in India. Firstly its scope is constrained to waste but does not cover second-hand goods for reuse (Levinson et al. 2008). This means that developed countries can export and India can import second-hand PCs for reuse including donation-purposed ones. Secondly it substantially allows for transboundary movement of PC-waste when "required as a raw material for recycling or recovery industries in the State of import" (Aricle 4, 9 (b) of the Basel Convention) (Arts and Gupta 2004). To better understand how PC-waste is exported and imported, I first

look at the case of the Netherlands as one of the EU member countries that export and then demonstrate the findings from an interviewee in India, one of the developing countries that import.

In the Netherlands, only reusable PCs are allowed to be exported, in accordance with the Basel Convention. According to the survey implemented by the IMPEL (European Union Network for the Implementation and Enforcement of Environmental Law) in 2006, however, 20% of the total number of international waste shipments detected at terminals in the ports of Amsterdam takes place illegally in that second-hand goods turned out to be non-working and hence hazardous waste when tested during the investigation[7] (Nijssen and Kraan 2006). One of the reasons of leakage of illegal shipment is that only a small percentage of containers are being checked (WASTE, Personal Communication, 2 October 2008). Interesting comments from WASTE is that brokers who claim to be refurbishing in the Netherlands seem to operate an informal system interwoven with a formal system. Producers of e-products are required to establish collecting systems to ensure collection and recycling. However, in some cases, brokers buy second-hand PCs from companies as well as from retailers who must take back obsolete PCs from consumers when a consumer buys a similar new product. The Dutch Ministry of Housing, Spatial Planning and Environment discovered that 11% of the total retailers inspected[8] handed over e-waste to brokers and that 28% of the total brokers inspected were involved in illegal exports (2007). This implies that the current regulations are not effective enough to prevent illegal shipment of e-waste including PC-waste.

On the other side of the world, illegal import is operated by formal companies but using informal schemes too. In an interview at Nehru Place in Delhi, one of the biggest electronic products market in Asia, a middle-aged gentleman of the importing business revealed the process of importing computers illegally. He purchases large volumes of working and non-working PCs through direct contract with companies mainly in South Korea and sometimes in EU, Australia and U.S.A. 'Companies' that he mentioned can be the refurbisheres in the case of the Netherlands. At the time that they are shipped into the ports of India, he pays bribes as roughly equal to the purchasing cost to a custom officer, who in turn changes the label of containers filled with obsolete computers from 'obsolete computers' to 'second-hand computers'. He imports approximately 2,000 computers every month from South Korea and sells off to dealers in Mumbai and Kerala. These cases from the Netherlands and India uncover the crucial loophole in the Basel Convention of not regulating a second-hand PC and existing regulations that allows illegal brokers in both countries to ship out to and in India.

After manipulating the custom with financial temptation at the hub ports of Mumbai, Chennai, Kerala and Kochi in India, PC-waste are transferred to Delhi. Importers mobilize materials and human activities by taking advantage of geographical characteristics of Delhi. The Delhi state, located inland of the country facing borders with the neighbouring states, has more availability of the physical space compared to other major ports (Officer in Toxics Link, Personal communication, 1 August 2008). Hence, a bulk of e-waste from major ports finds its way to Delhi for its treatment. Especially for the process

of segregating components and extracting metals, the big spaces for example for preparing for acid water barrel are taken up in peripheral border areas. Also there is ready market for trading recovered glass and plastic (Imrb International 2007).

Regarding the second loophole in the Basel Convention that allows for shipment of PCs if required as raw material, I could not come across any story of importing PC-waste as raw material during my field research. However, from the secondary source, this trading policy seems to be advocated by many of Asian developing countries including India, and hence I find it relevant in policy arena with relation to its effects on informal recycling activities, which I will discuss in the later chapter.

3.3 The domestic generation and flow of PC-waste in India

In India, the total absolute volume of e-waste generated has become huge with the advent of IT revolution and as EEE started to become obsolete (Widmer et al. 2005). PC sales have been accelerated for the last few years from around 1.4 million in 1999-2000 to 5.4 million in 2006-2007 (Sinha 2007). And at the time of 2007, two million PCs were ready for disposal (ibid). They are collected by either traders, retailers or recycling companies and enter in either reuse or recycling stream (Imrb International 2007). While the process in the reuse stream includes collecting, refurbishing PC-waste and reselling as a second-hand product, the one in the recycling stream are comprised of collecting, dismantling and segregating PC-waste, and extracting and smelting raw materials to be manufactured for another product. The decision on what kinds of PC-waste enters which stream is made based on the quality of PC-waste and the existing economic value of outputs traded in reuse and recycling market, which I explain more detail in the later chapter. In the rest of this research paper, I refer PC-waste as what is taken up for the recycling market.

3.4 The flow of PC-waste into informal and formal recycling chain

As explained above, PC-waste in India is sourced in both domestic consumers and importers. After disposed by them, PC-waste enters the recycling market operated in either the informal or formal sector. Each sector has its own channel to secure PC-waste as valuable raw materials, dynamically involving differentiated interests of actors who dispose and have access to PC-waste.

In this section, I first define the concept of informal and formal sector in India briefly, employing the various definitions from scholars and adding the key difference between them that I have explored during the field research. Then I discuss the PC-waste flow into each sector, paying attention to the factors that affect whether PC-waste goes into informal or formal sector.

3.4.1 The definition of informal and formal sector

Different concepts are used for distinguishing between terms of informal/formal and unorganized/organized sectors by different governmental sources in India. In this research paper, I use the term of informal/formal with

concepts employed by scholars such as Narayana and Thomas. Informal sector is a part of unorganized sector and comprises enterprises that a) engage in "the production and/or distribution of some goods and/or services meant for the purpose of sale," b) operate under ownership category of proprietary or partnership (e.g. sharing the profit of a business), c) adopt employment size of less than ten workers and casual employment (i.e. not the contract base) and d) are not under any obligation to maintain regular account on their activities (Narayana 2006). Further, in terms of economic activities of the definition a) above, it is characterized as what is called "the irregular sector", whereby "while goods and services that form the output are perfectly legal, the production and/or distribution of these goods and services involves some illegality" such as tax evasion (Thomas 1992). Consequently the formal sector is regarded as not having any of above-mentioned characteristics of informal sector.

In addition to the borrowed definitions of informal sector, I have investigated the key difference in the recycling activities between them through findings on interviews One major difference is whether environmental sound management (ESM) is implemented or not. While actors in the informal sector make profits using rudimentary methods of recycling, actors in the formal sector intend to expand the profit-oriented business based on environmental sound norms, including the clean technology for dismantling and smelting and nanotechnology for plastic processing. As government or non-governmental organization do not generally object but rather provide the economical and political supports for the ESM, ESM seems to create potential options for the formal sector to secure PC-waste from the informal sector via politically supported routes. I will discuss more on this in next section.

3.4.2 The flow of PC-waste into informal recycling chain

Currently 95% of the total e-waste that enters into the recycling market is handled by informal recyclers. More than 60% out of this e-waste is PC-waste[9] . Then how does this high ratio of PC-waste enter informal recycling chain? What would be factors that affect PC-waste stream into informal but not formal sector?

PC-waste entering the informal market is sourced from both domestic consumers and importers. Among domestic consumers, the large quantity of PC-waste is disposed by large offices including corporate and government sector. Hence I explain on how PC-waste flow from large offices into the hand of collectors who belong to the informal sector. The key channel between these actors is auction. The auction is a common method at every commercial area among large companies and government who want to dispose large quantity of obsolete products in India (Agarwal et al. 2003). They announce it through public notices such as newspaper and e-waste specialized journals and hold it in through tender and online. At the time of auction, these large generators do not care how and where PC-waste is treated after being auctioned but only concern the highest bidding, i.e. economic gains from PC-waste. Responding to the monetary interests of large generators, big traders greedy for the large amount of PC-waste participate in tenders at the drop of a

hat, spending significantly large amount of money[10]. Hence big traders with financial stability seem to play a significant role in securing the large quantity of PC-waste for the informal recycling activities held in the downward chain.

Also in the next stage of the recycling chain whereby PC-waste is passed on to small traders, there are another important determinants that affects the flow of PC-waste into the downward recycling market, the relatively high value put on reusable PC. Small traders seem to intend to pay more attention to repairable PC-waste among collected ones and sell it off to the reuse market due to the high economic value of refurbished and reused PC compared to output, or raw materials, recovered from recycling process. As a result, only 20% out of PC collected by small traders is placed at tender as a non-repairable scrap. This implies that the majority of PC-waste that finds its way into the recycling stream is the oldest and completely non-function model. Therefore in this stage of the informal recycling chain, small traders make a decision on what to enter the further recycling process based on their economical interests pulled by the external market of second-hand PCs.

Apart from domestic consumers, big traders also purchase the high volume of e-waste including PC-waste from importers through well-connected networks with them. The channel between big traders and importers are very important for the downward recycling activities because PC-waste imported is mainly non-function and hence become source of recycling. It is reported that two third of e-waste imported from U.S.A. including computer was purely non-working (ibid). Especially donation-purposed PC-waste can be nine years used before donated due to the Indian trade policy that allows for importing up to 10 years used ones.

3.4.3 The flow of PC-waste into formal recycling chain

Meanwhile, the formal recyclers face more difficulty in having access to PC-waste than informal recyclers. Only 5% of the total e-waste recycled in India is handled by four formal recycling companies who have recently emerged in the recycling market. What seems to be the biggest hurdle for them to tackle is that the majority of the large companies seek for best monetary offers while disposing PC-waste (Imrb International 2007), as is the social practice to put the value on obsolete materials. However they have been intended to squeeze out PC-waste that is meant to go into the informal recycling chain, armed with financial back-up by foreign companies that are interested in operating ESM.

As recognized by the Ministry of Environment and Forest in India, increasing e-waste generation and the lack of environmental sound recycling facilities have attracted a number of foreign companies (2008). Indeed, all the four formal recyclers in India are joint venture with foreign enterprises and encouraged to invest for environmental sound operation including recycling facilities and clean technology with the financial support from them. In order to reach out to PC-waste and open up new business chance in line with ESM, the huge investment has needed to be made for bringing in large corporate. Most of the formal recyclers have tied up with them, offering the value added services such as data-elimination and immediate pick-up as a logistics solution. They also have raised the customers' awareness of its hazardous characteristic

of e-waste and the better disposal options for ESM. As shown in the study, the awareness creation of ESM can be effective since quite a lot of organizations became to agree to take additional financial pains to make sure of disposal in an environmental friendly manner after exposure of environmental health problems (Imrb International 2007). The reason why formal recyclers intend to make efforts to tie up with corporate rather than purchasing directly at auctions is, ironically, due to pursuing this ESM. If formal recycling companies comply with ESM, they must export dismantled components to foreign companies for metal recovery, which bears significantly huge amount of costs. Hence, mentioned by one formal recycler, purchasing through auctions does not make sense as a business model. This is partially the reason why he targets as tie-up partner only multinational companies (MNCs). It is more potential to trade PC-waste with free of charge with MNCs, because their headquarters outside India are pressurized about the environmentally friendly disposal of IT products (ibid).

Apart from large corporate, some of formal recyclers are now under the negotiation with informal recyclers in specific stages of the chain on benefit sharing from PC components collected by them. The same formal recycler repeated that this scheme would create the 'win-win' effect on both of the informal and formal sides. The expected scenario is that the informal traders would gain more economic profits from formal recyclers than dismantlers or smelters in the downward chain that they now sell PC component. This is believed to be attributed to two factors. The formal recyclers could gain higher value from PC components due to access to the refinery company in Belgium that recover the high yield of metals efficiently using advanced smelting technology. Also they can sell metals recovered at the increasing international market price. For the side of the formal recycler, this partnership would also create more profits by reducing the outsourced refinery service costs through economy of scales of collected PC components. This informal-formal partnership has actually been advocated and prepared by the environmental NGOs, and hence there could be dynamic shift in PC-waste flow from the informal sector into the formal sector.

Chapter 4
Economic benefit and environmental health cost in the informal recycling chain

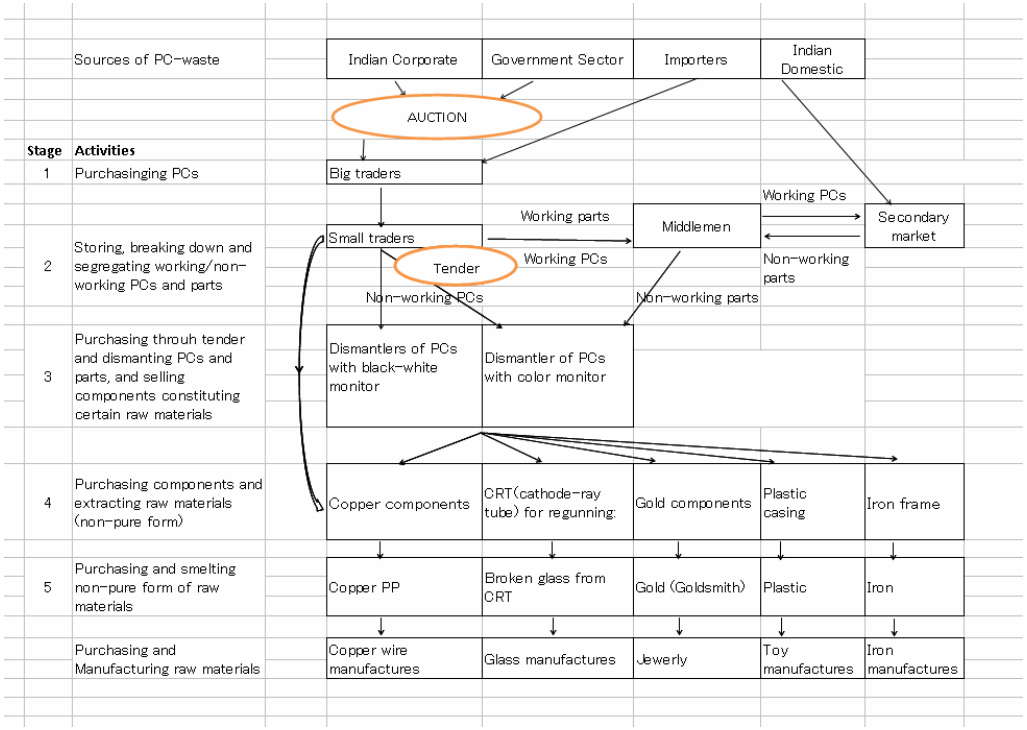
The PC-waste recycling activities in the informal chain are conducted by socially and economically differentiated people in different areas in Delhi. Some gain huge economic benefits and others suffer from serious environmental health costs. In this chapter, I first characterize the informal recycling chain, paying attention to activities in five stages, spatial organization and its social structure. Then I examine how economic benefits and environmental health costs are generated and structured, referring to the characteristics of the chain.

4.1 Characteristics of the informal recycling chain

4.1.1 Activities in five stages of the chain

The informal recycling chain is comprised of two main parts: the trading part at the top and the recycling part at the bottom. The entire chain can be divided into five stages of activities, as shown in the Figure 1. In the first stage, big traders purchase bulk PC-waste through domestic auctions and from importers, and then re-sell the PC-waste to small traders. In the second stage, small traders purchase PC-waste from big traders, store the waste, break down PC-waste and segregate it into working and non-working PCs and parts. The small traders then resell them through tender. The working PCs are sold to middlemen who resell them to the secondary market and the non-working PCs are sold to dismantlers. In the third stage, dismantlers purchase non-working PCs, mainly PCs with colour or black and white monitors, from small traders through tender or from middlemen or household waste scrap collectors called Kawadibara, and dismantle them. Then they sell dismantled components to extractors. In the fourth stage, extractors purchase scrap components constituting specific raw materials (e.g. silver and plastic) and extract these materials but not in a pure form. In the final stage, smelters recover specific raw materials.

Figure 1
Activities of the five stages in the informal recycling chain in Delhi



Source: Author's creation based on Agarwal 2003

4.1.2 Spatial organization of the chain

Big traders may just attend auctions and/or arrange the transaction of imported PC-waste in their office, and hence they do not need much physical space. Meanwhile, small traders must be equipped with big property to store a bulk of PC-waste. The site owned by a small trader that I visited is located in the urban slum very close to the central station of New Delhi. Inside the facility, not only PC-waste but also other e-waste (e.g. obsolete TVs) are piled up, around which small brick-made shelters for living are built against the fence and domesticated animals (e.g. goats) walk.

In comparison to the small traders, most of other recycling activities in the production part of the chain are carried out in smaller spaces. Some business people own their land and others illegally operate in public places. The more limited the space that actors have, the more limited their access to PC-waste with high value. For example, dismantlers who have small spaces cannot physically dismantle PC-waste with a colour monitor that contains larger quantity of high value materials such as copper and silver (Agarwal et al. 2003). Hence their potential revenue is reduced.

Most of activities in the recycling part of the chain are conducted in poor urban slums or peripheries of the urban city, New Delhi. There has been significant shift of recycling unites away from the Delhi city to its relatively poor northern periphery in order to avoid governmental scrutiny (Toxics Link, Personal Communication, 1 August 2008). For example, in one residential area in New Delhi, the establishments that had been involved in extracting and recovery activities were ordered to move out of the area and settled down in the border area with the neighboring state whereby they have established new social relations with authorities in order to maintain their activities (GTZ, Personal Communication, 25 July 2008). The residential area, instead, has remained the home only of non-industrial relatively 'clean' business such as refurbishing of functioning PCs. Besides, the recovery and smelting businesses intend to operate their activities in peripheral border areas with more spaces available because they need wider spaces to recover and smelt raw materials from PC-waste.

4.1.3 Social structure of the chain

The informal recycling chain is embedded with unique social structure with high ratio of Muslim population involved. The chain has been established behind the former Hindu caste system that had historically assigned the low caste Hindi the task of waste treatment as a social stigma. According to experts, the majority of scrap-related traders and recyclers are Muslim persons, except poor low caste Hindi scavengers who still take the social role of collecting any kinds of waste from households and small businesses (Toxics Link, Personal Communication, 15 September 2008 and Chintan, Personal Communication, 1 August 2008). Starting from big traders, the deeply connected Muslim community penetrates along the chain of recycling activities. The recycling part of the chain is mainly dominated by poor Muslim migrants.

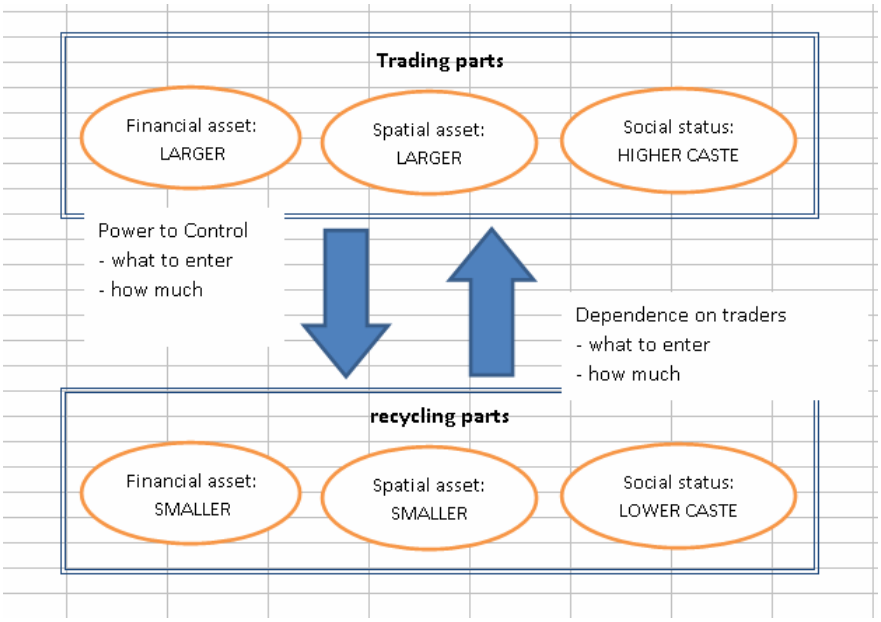
The dismantler that I interviewed has settled down his business in Shastri Park, located ouside of the center of New Delhi. Together with Seelampur, dismantlers in these two areas often buy components from Turkman gate (Imrb International 2007). The majority of e-waste recycling business in these three areas is carried out by Muslim persons (ibid). According to AIKMM, a membership-based waste recycling organization comprised of collectors and recyclers of all kinds of waste, 70% of their members in Delhi are Muslim, the majority of whom originate from the rural areas in Bangladesh or the eastern part of India where the poverty is pervasive and there are not many options for income sources (Personal Communication, 30 July 2008). And the number of Muslim migrant workers is expected to increase in the Delhi state since the Muslim population grows at a rate of 70% annually in the Assam state, which faces the border with Bangladesh. For those who have just migrated without any financial, physical and social assets, handling waste is the first income source to access in India.

The high involvement of Muslim persons in the chain, however, is not explained only by the fact that many recent immigrants are Muslim. It is also an indirect consequence of Hindi social practice. There are different views on waste handling between Hindu and Muslim. In the Hindi society, it is considered unrespectable. Household waste handling had been distributed to the low caste, and it is still practiced by them in some parts of India even after the practice of the caste system was outlawed in 1950. They continue to carry over the social stigma that the Hindi society placed on the waste-related job. Because of this social stigma, Hindu persons dealing with waste-related jobs are intended to quit the job as soon as they find another option for income source (Toxics Link, Personal Communication, 15 September 2008). On the other hand, in the Muslim community it is acceptable to have a job that deals with scraps. The waste-related jobs assigned to the low case Hindu in the past and culturally symbolized as 'social stigma' has been replaced by the Muslim who does not share the same cultural view.

Further, apart from the external factor of cultural difference, this Muslim-dominated recycling chain seems to have been sustained under the internal hierarchical network comprised of economically and socially differentiated persons. Due to the difference in financial and social status between trading and recycling parts, a structure of dependency of recyclers on traders have been established, as shown in the figure 2 below. Traders at the top are equipped with large financial and spatial assets and recyclers at the bottom have much more limited assets. Also in terms of social class, the majority of waste collectors and recyclers in the downstream chain are low caste people in both Hindu and Muslim community (Chintan, Personal Communication, 1 August 2008). Interestingly, moreover, these differentiated actors are linked through the 'feudal relations' that has been formed for the long period. (GTZ, Persona Communication, 27 October 2008). The relation between a trader and recyclers was expressed as the 'feudal relation' by one expert who has worked on e-waste issues in Delhi for the long period. According to him, traders at the top each have approximately 20 recyclers attached to them and they practice the 'feudal relations' for example through barter exchange. Thus it is assumed that the informal recycling chain is structured under the feudal system whereby

economically and socially lower class of people depends on the higher class to access their raw material, which in this case is e-waste. This is partially the reason why the Muslim-dominated recycling chain can remain closed from other Hindu competitors. This hierarchical feudal relation further demonstrate traders' control of the flow of PC-waste into the recycling part, affecting economic benefits and environmental health of differentiated groups of people, which I explain in the next section.

Figure 2
Structure of dependency of recyclers on traders in the Muslim-dominated recycling chain



Source: Author's creation

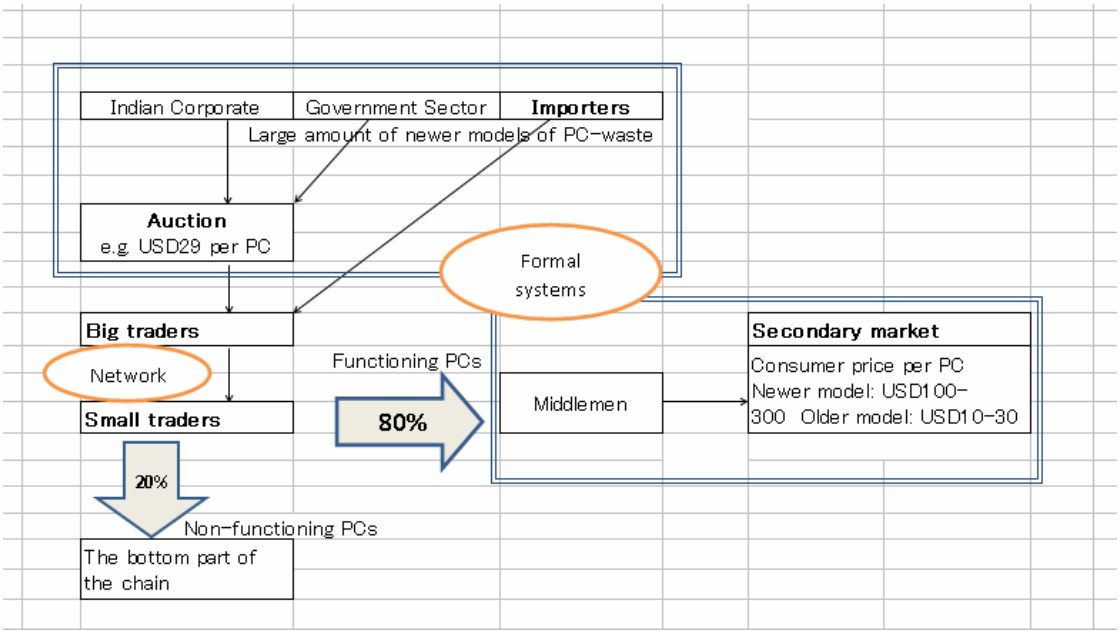
4.2 Economic benefits across the informal recycling chain

4.2.1 The upper part of the chain: traders

The economic profits generated in the trading part of the chain are mainly attributed to initial financial and spatial assets, the linkage with formal systems (auction, importing business and the secondary market) and the network among Muslim actors. In the first and second stage, big and small traders are highly motivated to trade the large volume of the functioning newer models of PC-waste for their economic gains. This is well-explained through comparing the price per pc purchased and sold by them. As shown in the Figure 3 below, big traders normally purchase PC-waste either at auctions or from importers. I calculated the price per PC sold at one of the auctions held in June 2002 for the purpose of comparison, which was USD29[11]. Then small traders are assumed to purchase PC-waste from big traders at the price higher than

USD29 per pc and re-sell 80% of PC-waste, which are functioning ones, to the middlemen at the much higher price than the purchasing price. Even though I could not collect data on the average price per PC that is transitioned between big traders and small traders or between small traders and middlemen, it can be assumed that big and small traders can gain huge profits from this transaction because 80% of PC-waste sold by them is the functional newer model of PC-waste that has greater demand and the resulting higher value at the secondary market due to the potential of being refurbished. The refurbished PCs have the far greater value as a second-hand commodity than non-functioning PC-waste as a raw material (Streicher-Porte et al. 2005). For example, the consumer price of refurbished newer models of second-hand PCs ranged from USD100 to USD300 at the secondary market in 2002[12].

Figure 3
Economic benefits in the upper part of the chain: traders



Source: Author's creation based on Agarwal 2003 and IMRB International 2007

The huge economic gain is made possible for big traders because of their huge financial assets to purchase the large amount of PC-waste and the access to formal systems of auction and importing business whereby the large volume of newer models of PC-waste are traded. Indian corporate and the governmental sector that organize auction and oversea customers that trade with Indian importers have the purchasing power of newer models of new PCs. Hence, as long as big traders have access to the formal systems, their economic profits are generated.

Also, for small traders, it is possible to make economic benefits from trading with functioning newer models of PC-waste because of their original financial and spatial assets, the connection with big traders and the linkage with second-hand PCs market. Small traders with more spaces and working capitals

are able to purchase and store the large amount of PC-waste and also segregate them into functioning PC-waste, from which they can increase their profits. However, the connections to big traders are also important because these connections help them secure the incoming flow of large amount of PC-waste and determine what type of PC-waste (e.g. functional ones) they have access to. Moreover, the linkage with the secondary market is essential because the secondary market shares nearly half of PC sales in India (Basu 2008).

And the stability of economic profits of big and the small traders seem to result from interdependent structure of both informal and formal sectors. Without financial and spatial assets of informal big and small traders, the formal systems of auction, importing business and the secondary market would not be operated. These systems are driven by profit oriented actors such as large corporate and importers. They want to sell the large volume of e-waste as high price as possible. Hence they depend on the purchasing power of financially rich traders. Also, their financial and spatial capacity is important for the secondary market because they can specifically trade the functioning PC-waste that is refurbishable and hence sellable with high value at the market. At the same time, incoming PC-waste from the formal sector such as domestic generator, importers and outflow of PC-waste into the secondary market lead big and small traders to the financial stability. Apart from the linkage with external formal systems, the big and small traders themselves seem to be deeply connected through the feudal structure of Muslim populations. According to the expert, traders would not seem to allow outsiders, or non-Muslim persons, to join the scrap trading business. The trading part in upstream chain is getting visible, and hence it has become an attractive job among Hindi traders too. However it is difficult for them to access it because big Muslim traders sell PC-waste only to small Muslim traders (Toxcis Link, Personal communication, 15 September 2008). In some cases, Muslim traders jointly bid for a huge bulk auctioned and later divide it among them (Sinha 2008). Consequently they can sustain profits by keeping competitors outside the chain.

4.2.2 The bottom part of the chain: dismantlers and extractors

The economic profits generated at the bottom part of the chain are associated with reducing the cost outside legal spheres, the collective feudal network with persons in the upward and downward chain and the opportunistic behaviour of individual owners. From personal communication (Dismantler, 31 July 2008) and observation, owners in the dismantling stage seem to gain profit at the expense of payment of safe equipment to workers and utility (e.g. water and electricity) and externality on the surrounding environment for example of throwing away plastic residuals in the street. Further, most of them do not pay any tax to the government. It can be attributed to informality of their business that is operated under no obligation to make regular account to authorities.

Owners in the extracting stage make profit through the same practice of cost reduction as dismantlers do. However, extractors seem to generate far-reaching externality on local residents and natural resources across a wide area in Delhi. The costs for externality from their metal recovery activities include

illegal locating in the public spaces in Delhi and/or peripheral communities in the border areas whereby they physically pollute air and groundwater through the extracting process. But they do not pay the social and environmental costs on the surrounding community caused by their illegal operation. Moreover, if it is the case of family-owned business, they cut the opportunity cost for family labour. For example, as indicated by one extractor, his children need to work for the whole day. At the same time he added that he let his son to go to the school but not his daughter.

In addition to the cost reduction, the Muslim owners at the bottom chain seem to secure the profit through keeping the interdependent relations with persons at the immediate upstream and downstream stage of the chain, which is formed through the network culturally constructed by the Muslim community. As long as it is kept, it is not difficult to buy and sell PC-waste since there is the stable demand for scrap as raw materials from smelters partially pulled by the increasing domestic demand for recycled raw materials (Kannan 2008,Reuters 2008). Furthermore, as explained in the former section, the recycling chain of e-waste is structured under hierarchical feudal network. One Muslim dismantler and one Muslim extractor repeated that what promotes their business is "the network with single persons who keeps contact with me." (Dismantler and Extractor, Personal Communications, 31 July and 3 August 2008). Hence this tied feudal based Muslim network may provide financial security with these economically and socially lower classes of Muslim waste recyclers, the minority of the minority in the Indian society.

Apart from the collective feudal system, it can be argued that, within the social feudal network, the interests in transaction of profitable components (e.g. PC-waste with colour monitor and PCB)[13] also encourage recyclers to behave opportunistic individually in order to secure his or her own economic gain, providing a bribe to a certain person. A good example of this is illustrated from the case of the 'tender', the official scheme of transaction between small traders in upper chain and dismantlers and extractors at the bottom. In fact, a bribe is often provided from dismantlers and extractors to small traders at the site of the tender in most cases (AIKMM, Personal Communication, 30 July 2008). Due to the financial and spatial limitations, dismantlers and extractors must choose most profitable components among the ones that fit their limits. But, since the flow of PC-waste, including the profitable parts, are controlled by small traders, they are insecure about when and how much of PC-waste they can purchase. This uncertainty leads them to be not rational but opportunistic actor, intending to connect themselves with a specific person who provides them with the profitable ones, because the expected utility of the transaction with the bribe seems to be greater than the expected utility without the bribe.

4.3 Environmental health costs across the chain

Environmental health costs are attributed to carrying out certain processes of recycling computer containing huge quantity of hazardous substances. They are most likely concentrated at the bottom part of the chain, and their recycling practices are rudimentary.

In the dismantling stage, workers including children often need to work without sufficient ventilation in the sheds or using protective equipments like masks, keeping themselves in contact with toxic materials in the gadget. The long exposure to them is eventually expected to induce chronic diseases (Basu 2008). When dismantlers segregate the materials by hammering, they also face the high level of noise, which slowly impairs their hearing (Sinha 2008). Also small pieces of plastic residuals are thrown away into the street.

In the extracting stages, workers are involved in acid bath, treating caustic soda by hands and open burning for the recovery of copper. They are highly vulnerable to the acid fumes and toxic gases, which endangers their health (Agarwal et al. 2003,Basu 2008). This extracting process causes environmental health effects on not only workers but also the residents in surrounding areas. The Energy and Resources Institute (TERI) implemented a survey on the extracting process and its environmental health impacts in the Mandoli village[14] (TERI 2006 cited in Basu 2008) They found that the acid water containing metal precipitates is damped on the land after the metal recovery due to the lack of proper drainage, and that residual heavy metals concentrated in the surface soil eventually contaminate the groundwater while being leached. The concentration of all the metals in the soil is much higher in the industrial site than in other sites in the village. Also the groundwater, which is the only source of drinking water for the villagers, is highly polluted. Hence the local residents, who have been living in this area much before the recycling industries were formed, have been facing scarcity of fresh drinking water with more and more industries thriving in the area (Basu 2008). Further, they suffer from irritation and breathing problems as the air contains acid fumes and toxic gases, which are emitted in incinerating toxic materials. The concentration of dioxin and furan in the air was reported to be four to six times compared to the standard of the World Health Organization (WHO) (Basu 2007 cited in Basu 2008). Hence over the past one year, approximately 200 families have been obliged to leave the place, becoming ecological refugees (Basu 2008).

Since the Mandoli area is officially notified in the Master Plan for Delhi in 2007 as an industrial area whereby industrial activities are allowed to be conducted[15], more recycling industry is expected to be concentrated in the future. Then this place might get caught in a vicious cycle of environmental health hazard as the more local residents migrate out of the place wanting for good quality of water, the more spaces become available for metal recovery activities and the worse the quality of water gets. This vicious cycle could further induce intergenerational effect of its environmental health problems on both inside and outside community, employing the assumption of community-environment relationship argued by Leach et al.(1999) that the environment is non equilibrium in space and time and it could result in contingent change caused by historical process involving dynamic interactions among differentiated actors in the community.

Economic benefits and environmental health costs are structured differently between the trading and recycling parts. Depending on their financial and spatial assets and social class, traders and recyclers gain economic benefits using different schemes. On the other hand, environmental health costs are mainly burdened on workers and local residents in and around the

recycling units, affected through exposure to toxic materials emitted during the recycling process.

Chapter 5
Analysis from environmental justice perspectives

In this chapter, I analyze these benefits and costs distributed to certain actors from the environmental justice framework that challenges injustice from distributional and procedural aspects. I first examine how economic benefits and environmental health costs are unequally distributed among the economically and socially differentiated actors indicated in the last chapter, focusing on what kind of power relations affect the inequitable distribution. In so doing, I classify actors into four groups in which benefits and costs are unfairly generated and distributed: the inside recycling unit relating to owners and workers, the community constituting of the informal recycling industry and local residents, the whole informal chain in India divided by trading and recycling parts and the global market of PCs incorporating globalized companies and the Indian recycling industry. Next I shift my analysis to another dimension of the environmental justice framework, namely procedural justice. I explore how equally or unequally the decision-making processes, especially in the policy arena, have been implemented between people/community with different level of social and political status and how it results in preventing or ignoring the disproportionate distribution of economic benefits and environmental health costs.

5.1 Distributional injustice

5.1.1 Distributional injustice between owners and workers in the recycling unit

The owners mainly gain profit at the expense of payment for protecting workers from occupational health hazards. In fact, most of owners engaged in dismantling process in Shastri Park were during my interview sitting outside the recycling units, hence not exposing themselves to toxic materials. This uneven distribution of benefits and costs seems to be attributed to the power relation generated from economic and social differences between them. This can be interpreted as a capitalist structure whereby owners with financial capital have control over the economically poor workers. Owners have access to the urban poor in Delhi who are ceaselessly incoming from other states in India. These migrants seek for income sources regardless of their health condition. Hence it is easy for owners to wield one-sided bargaining power to implement casual employment (e.g. not keeping a contract of their engagement period) while workers unhelpfully bear the risk of their own health in favor of the employment and economic security, being unable or unwilling to express their difficulties from health problems. Besides, among the migrant workers, some have the illegal status by crossing over the border with Bangladesh through providing a bribe to the migration officers and/or staying in some

areas in Delhi not granted to them. Under non-legal recognition, workers are unable or unwilling to raise their voices in fear of their life.

Also, migrant workers from outside Delhi may also have social disadvantage of not belonging to the feudal network that has been historically constructed in Delhi. They neither share the sense of the place nor have connections to start their own business with. This could prevent them from being economically and socially empowered, which might otherwise encourage them to raise their voice toward owners. Due to the economic, legal and social insecurity, most of workers are dependent on owners and hence immobile from the recycling units.

5.1.2 Distributional injustice between the informal recycling industry and local residents in the community

At a bigger scale than the inside recycling unit, the relation between the recycling industry and local residents in the community as a whole reveals distributional injustice that is associated with the spatial and political mobilization initiated by the recycling industry. I indicate this point by employing as an example the Mandoli village.

As described in the former chapter, huge environmental costs have been imposed on the local residents in the Mandoli village, possibly also inducing intergenerational effects of its environmental health problems on both inside and outside community.

On the other hand, economic benefits are provided to the actors who share economic interests including the recycling industry. According to an expert, in some cases, the recycling industry could thrive through influencing the decision-making process of regulatory authorities including local polices, municipality and Delhi government to keep them unnoticed (GTZ, Personal Communication, 27 October 2008). In other cases, landowners protect the recycling industry as patronage, building walls around the facilities they rent in order to make it physically invisible (GTZ, Personal Communication, 25 July 2008). All the connections with influential authorities and landowners are assumed to be made possible, for example, by the recycling industry providing them with bribes and/or the economic security from locating the industry. For municipality and landowners, it is economically appreciated if one recycling industry can settle down in their peripheral areas.

In the case of the Mandoli village, located in the northern periphery of the urban city, New Delhi, economic benefits and environmental health costs are unevenly distributed through the unequal power structure whereby the recycling industry takes advantage of the spatial characteristics of Mandoli, what is called by Blowers and Leroy, 'peripheral communities'. Due to being geographical remoteness and relative inaccessibility, a coalition of economic interests of capital and labour reinforces the hazardous activities of the unwanted industry and hence results in environmental degradation. (Blowers and Leroy 1994 cited in Blowers 2003) They argue that in those 'peripheral communities', the dependence on a dominant industry leads them to be "monocultural, subject to economic risk as well as relatively powerless, their fortunes controlled by external influences" (ibid). I could not visit the Mandoli

village during my field research, hence I cannot describe to what extent it is isolated geographically and economically so as to depend on the recycling industry. However, as Basu (2008) demonstrates, many of the local residents face health problems but are unable and unwilling to raise their voices toward the recycling industry as most of them are employed within the recycling industry. Instead, about 200 families have left their places in the village for the year (ibid). Hence it is argued that the dependence of the community residents or workers on the owners leads to the bigger scale of the dependence of the community as a whole on the dominant recycling industry.

Apart from economic interests of capital and labour, the case of the Mandoli village reveals the far stronger economic coalition that is backed up with authorities and landowners. Creating the connection with influential authorities who have the decision-making power, the recycling industry seems to be able to sustain their hazardous activities. In other words, the polluting recycling industry with capital politically approaches local authorities in the community who have the political power to influence the decision-making within the community, being aware of their community and local residents/employees' economical disadvantages. The recycling industry seems to practice their capitalized power in that it relocates itself in the peripheral areas and configure it into less conflict and unorganized community, which is indicated as capital inequality by Ruiters (2002).

5.1.3 Distributional injustice between traders and recyclers in the informal recycling chain

The uneven distribution between owners and workers and between the recycling industry and local residents at the recycling part of the chain needs to be looked at from a bigger scale, namely the chain as a whole. How is it related to the trading part under what kind of power relations?

As demonstrated in the former chapter, the big and small traders gain huge economic benefits by purchasing and selling large quantities of functioning PC-waste without getting involved in the potentially hazardous and labour intensive recycling activities. Meanwhile, recyclers at the bottom part of the chain gain fewer benefits, suffering from environmental health problems caused by their recycling activities. They do not have any power to change the recycling process or hazardous components inside determined at the pre-consumer process by software and hardware companies, just accepting the limited financial and spatial options and also their socially low status.

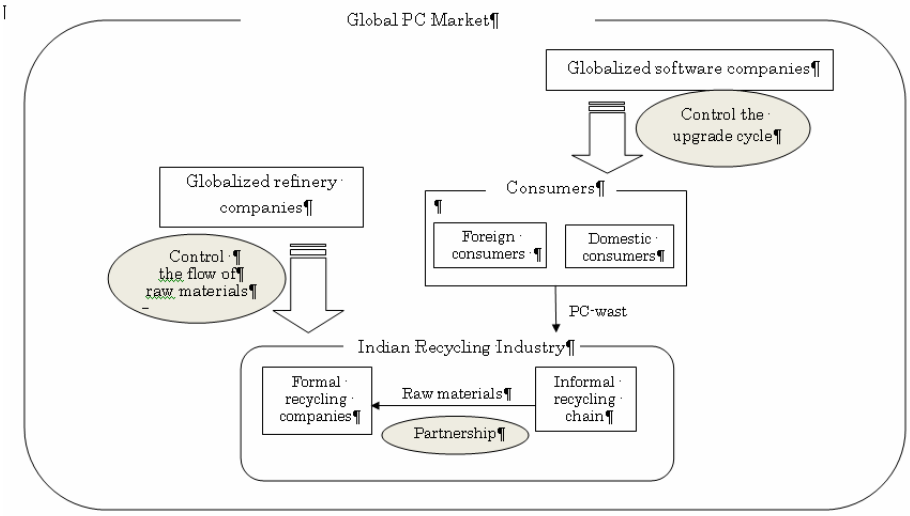
This disproportionate distribution of benefits and costs is attributed to the power relation created by the combination of economic differences and the historically established feudal relation. It seems to be easy for the high capital traders to build social relations with recycling owners because economic difference makes them dependent on traders, which is the same structure as seen in the cases between owners and workers and between recycling industry and peripheral community. Indeed, this dependency brings the extra profit to traders outside the official transaction. As explained in the former chapter, recycling owners provide them with a bribe in order to have the economic security under their command on the flow of PC-waste. This bribe, or the

profit, is continuously distributed to traders. However, the economic difference does not motivate recyclers to organize social movements with other owners against uneven distribution of benefits and costs because traders and recyclers share the identity of handling e-waste as a Muslim person, hence not imposing social stigma on each other that the Hindu society would otherwise put on, and also that they have the common norms practiced for long period in the feudal relation. No Muslim recycling owners at the bottom are willing and able to change the structure of traders determining how much of scrap can be passed on to them for example through social movements. Rather, they highly depend on the hierarchy embedded with financial and spatial differences and the social network. In other words, traders can keep the competitive market undermined with use of their socio-economic power to control the whole chain. Hence the areas dealing with hazardous process become less intensified without the symptom of any class conflict. Indeed, in Shastri Park, full of dismantling business, there has never been any social movement or labour union creation (Dismantler, Personal Communication, 31 July 2008), which have documented in other parts of the world (Agbola and Alabi 2003,Anand 2004).

5.1.4 Distributional injustice between the Indian recycling industry and the global companies in the global computer market

The informal recycling sector in India with the socially and economically differentiated actors involved appears to generate and structure the disproportionate distribution of benefits and costs locally. In fact, the informal recycling sector, together with the formal recycling companies, is incorporated into the global PC market, as shown in the Figure 4.

Figure 4 Incorporation of the Indian recycling industry into the global PC market



Source: Author's creation

Under the global PC market, the economic benefits are unevenly distributed to the globalized companies that enable themselves to control the flow of PC and PC-waste with the huge financial capital. For example, software companies such as Microsoft Corporation continue to make profits by innovating new software technologies and encouraging consumers to purchase new PCs that are compatible with these new technologies. In other words, they gain huge economic benefits by controlling the upgrade cycle of PCs as long as there remains the high-consuming corporate and individuals in the world. In addition, software companies sustain economic gains at the expense of social and environmental costs generated during the PC-waste management including the recycling process in India, which is indirectly caused by their upgrade of software technologies and the resulting increase in the volume of PC-waste. Most of the environmental legislations in developed countries, where many of the headquarters of multinational software companies are located, do not put the financial responsibility of e-waste management on them but on hardware producers. Hence, economic profits are continuously being distributed to the globally-diffused software companies.

Also, at the end of the life cycle of PCs, the globalized refinery companies such as Umicore in Belgium gain the huge economic profits from the energy-efficient and environmentally sound clean technology for recovery of precious metals that are contained inside PCs. Umicore charges Rs 1,000,000 (USD25,000)[16] for one container of e-waste as a service charge (Imrb International 2007). However, the formal recycling companies that trade e-waste collected in India with Umicore do not seem to have any bargaining power to compete with the price of the service charge, because there is no such clean technology for refinery or the standards of measuring the value of e-waste in India, which Umicore states 'important criterion' for price deciding (Personal Communication,3 September 2008), and hence the formal recyclers seem to have to follow what Umicore determines.

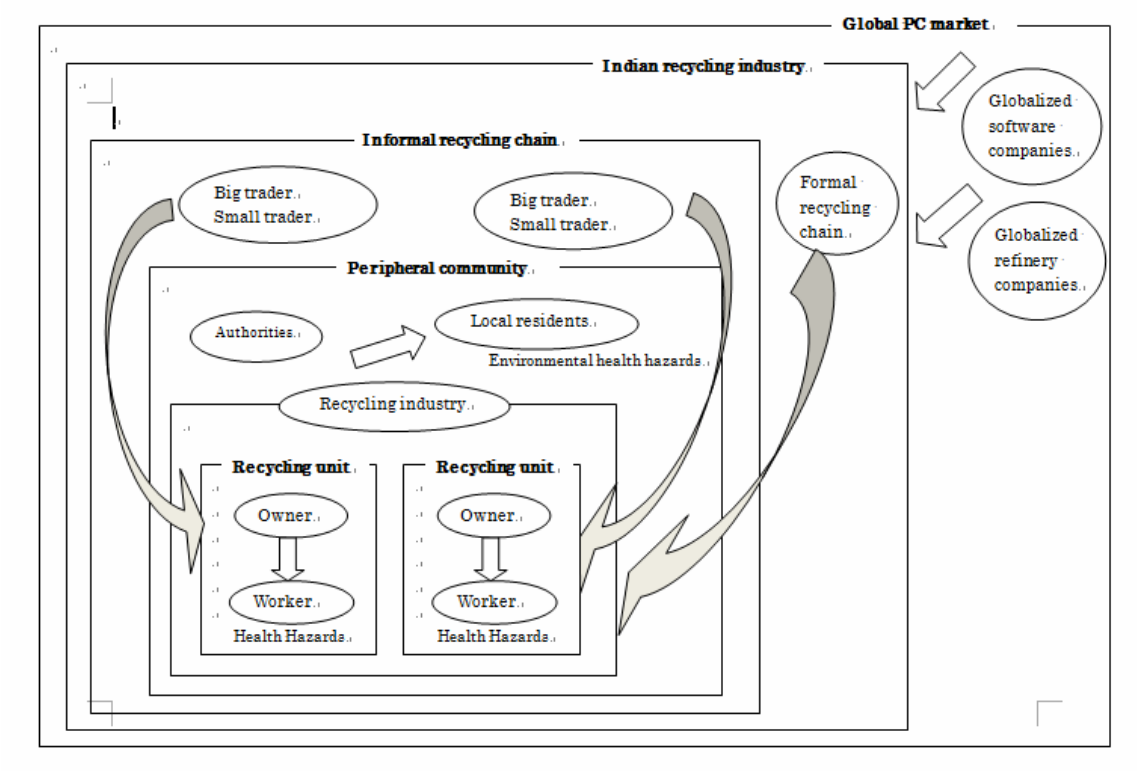
On the other hand, environmental health costs are concentrated in Indian recycling industry, especially informal recycling workers and local residents in the surrounding community, as explained in the former section. This uneven distribution of benefits and costs in the global PC market is attributed to the power relation whereby global corporate with the economic clout such as software and refinery companies control the material flow (e.g. PC and PC-waste as a raw material) while the Indian recycling industry with less economic power need to depend on global corporate for their economic gains. For example they are concerned over what type of PC-waste they can access to, whether they are the newer models of PC-waste or the ones with less toxic substances.

The linkage with the global PC market are created by the profit-oriented actors such as big traders who import PC-waste and the formal recycling companies who export the dismantled PC components as raw materials. Both actors are financially well-off and have the bargaining power to control the flow of PC-waste inside the Indian recycling industry. However, they do not have the economic power to overturn or change the flow outside the country.

5.1.5 A chain of power relations

The disproportionate distribution caused by an unequal power relation within the above-mentioned relationships is actually the indirect outcome of a power structure on the bigger scale, as shown in the figure 5 below. Of the most affected by a chain of these power relations is the recycling workers and local residents in the peripheral communities at the bottom of the recycling. Actors with socio-economic power control the material flow, mobilizing the financial resource and political power, while workers and local residents need to depend on the hazardous and polluting activities to access their income sources. The hazards imposed on workers under unequal power relations with owners is caused by an external dependent structure of owners and traders in which owners without the bargaining power over PC-waste depend on the traders who control the flow of PC-waste. Also, environmental health damage encountered by local residents under unequal power relations with the recycling industry and authorities in the community is also shaped by the same external dependent structure whereby owners in the recycling industry who do not have the bargaining power for spatial options due to the financial limit just depend on the traders in feudal relation that provide economic security for them as long as they follow traders. Moreover, the environmental health problems encountered in the whole Indian recycling industry is formed within the global market structure of PC where the Indian recycling industry depends on global companies with the economic power to access PC-waste as raw materials.

Figure 5
A chain of power relations affecting workers and local residents in India



Source: Author's creation

5.2 Procedural injustice

Then the question that should be investigated next is how a chain of these power relations and the dependent structures has been accelerated or tackled in the policy arena. Environmental justice cannot be achieved just through revealing the uneven distribution of benefits and costs, but also through inspecting the policy implementation and the policy-making process (Anand 2004). Thus, in this section, I critically analyze how the current policies in India are created and implemented or not in order to challenge the disproportionately distribution of economic benefits and environmental health costs, focusing on the unfairness in decision-making processes.

5.2.1 Policy implementation on 'environmental sound management'

The Ministry of Environment and Forest (MoEF), Government of India, stated in the National Environmental Policy 2006 (NEP 2006) the action plan on management of industrial and municipal waste including PC-waste to "[g]ive legal recognition to, and strengthen the informal sector systems of collection and recycling of various materials" and particularly "enhance their access to institutional finance and relevant technologies." (Ministry of Environment & Forests 2006) It encourages the informal recycling sector to manage PC-waste in a safe and environmentally sound way through providing them with access to finance and technology. However, as I demonstrated in the former chapter, the action plan does not seem to be implemented or taken seriously. Rather, the recycling workers at the bottom and local residents in the acceptance community have suffered from environmental health hazards.

Instead of carrying out the action plan of NEP 2006, the MoEF seems to start shifting their attention to the financial capability of the formal recyclers in order to establish environmentally sound management of e-waste. The MoEF has proposed that environmentally sound management (ESM) of e-waste should be responsibility on the producers as an extended producer responsibility (EPR) (2008). The MoEF suggests the Indian producers of electronic product should take responsibility on establishing take-back system, recycling and final disposal of their end of life products. On one hand, it does make sense that IT producers should burden the costs of their obsolete products since they financially benefit from selling their products. But on the other hand, they are still private companies, big players in the market, and hence there is possibility for them to seek for profit-oriented solutions such as contracting the collection system out to formal recyclers. Furthermore, to add potential intervention of the market-driven solution, ESM is encouraged through the channel with foreign capital after the assessment on the existing e-waste management. One of the rationales behind the "Need for the Guidelines for Environmentally Sound Management" is the "Lack of environmentally sound recycling infrastructure" stated as follows:

"Existing environmentally sound recycling infrastructure in place is not equipped to handle the increasing amounts of e-waste. […] The potential of increased e-waste generation and lack of adequate recycling facilities have attracted the attention of a number of recyclers globally, expressing interest to start recycling facility in India."

(Ministry of Environment & Forests 2008)

From this statement, it seems that the MoEF is interested in foreign recycling companies' investment in the infrastructure.

Through the policy on leaving the establishment of ESM to private companies, the process of decision-making on how to achieve ESM also seems to be shifted outside the public policy arena. MoEF only regulates registration of companies involved and the use of environmental sound technology. As described in Chapter three, the formal recyclers have arranged the partnership with the informal sector for increasing their profits. However this partnership, expected to bring the 'win-win' effect for both formal and informal sectors, would not actually bring economic benefits to *all* informal workers and leave environmental damage in *some* part of the Delhi city. This uneven distribution is attributed to the unequal decision-making process whereby formal recyclers control what kind of PC-waste should be exchanged between them.

According to AIKMM, a waste collector and recycler organization with 17,000 members in Delhi, who arrange this partnership with formal recyclers, the informal recyclers are asked to collect and give them away brand-name PC itself but not dismantled components. This implies that the labour-intensive dismantling stage occurring in the informal sector will be cut off. Alternative employment for them is most likely to become a PC-waste collector assuming that it is an easier job to get. Due to the increasing number of workers engaged in the collecting activity, however, it becomes competitive. This competitiveness could create the possibility that some workers may be excluded out because they are economically and socially disempowered and/or because other collectors with the social network behave opportunistically by for instance providing a bribe to PC owners. Besides, even in the ideal situation whereby all collectors share the benefits from profits by selling PCs to formal recyclers, the pie that each collector receives would get reduced with the participation of a large number of collectors. Under the economic, social and political uncertainty, it is not assured that the partnership is going to make *all* informal workers economically better off than now. In other words, this partnership, a by-product of the EPR policy, is not concerned enough with the socio-economic condition of the informal sector to prevent their exclusion.

Apart from configuring economic benefits among poor workers, this partnership should be questioned regarding complete clearance of environmental health problems. Since the formal recyclers are the reliable economic source for the informal workers under this partnership, the command of what should be collected is placed on the formal recyclers. One formal recycler that I interviewed in July told me that he would definitely ask for profitable materials such as a PCB that contain precious metals (Personal Communication, 20 July 2008). At the interview conducted in July, AIKMM

also agreed that they would have to provide the formal recyclers with what the formal recyclers request since their concern is to make workers in the informal recycling chain economically empowered (Personal Communication, 30 July 2008). If this economic interest of formal recyclers was realized, it would not solve ESM that they are responsible to take, because unprofitable and unwanted components and residuals from dismantling and smelting them would remain in the informal recycling streams, not being treated safely or environmentally friendly by economically and socially powerless workers.

Thus little economic benefits of the recycling workers and environmental health costs on workers and local residents would remain under the partnership between formal and informal recyclers whether they exchange PC as a whole or profitable component. Hence, advocated by the government, the EPR would enable private companies including the formal recyclers to initiate the profit-oriented management of e-waste, which may reduce environmental health impact but does not necessarily eliminate its root causes.

5.2.2 Policy implementation on importing 'old computers'

The uneven distribution of economic benefits for the traders and environmental health costs on the recycling workers and the local residents seems to be attributed to the policy on importing old PCs, which is promoted as the governmental regional development model. Government of India allows for importing second-hand PCs, PCs less than 10 years old[17], for the reuse purpose, and also non-functioning PC-waste for the recycling purpose if considered as raw materials[18].

Export/import of a second-hand PC is not regulated in the Basel Convention, since a reusable product itself is not hazardous. In accordance with this international regime, second-hand PCs are allowed to be imported to and sold in India through the free market. This policy on importing old PC brings the overall price of PC down through the market mechanism. The more second-hand PCs are flowed into the secondary market, the lower the price of new PC in the primary market gets to compete with the second-hand ones. Consequently it leads to broadening an access of relatively cheaper PCs among the wider range of people with different income levels.

Also, second-hand PCs are encouraged to be imported as donation. The government of India in its 2001-02 budgets had clear stipulation for the import of old PCs as recommendation of the National Task Force on Information Technology and Software Development (Agarwal et al. 2003). Also the tax incentives for donation have been raised for both donors (e.g. zero custom duty) and receivers including educational institutions and hospitals (e.g. exemption from gift and income taxes). This donation policy assists in prevailing education for Information and Communication Technology (ICT) and increasing the quality of hospital service.

Moreover, e-waste including PC-waste is promoted to be imported to India despite of the restriction of the Basel Convention. The 'landmark' policy was formulated in the international conference with other South Asian countries in 2002. They prioritize economic development through the use of e-waste as a raw material rather than preventing the risks from e-waste (Iles

2004). They agree that it is acceptable to take environmental health hazards in the short period in order to increase the standards of living through development.

Importing 'old computers' is strongly encouraged by the government of India as a regional economic development models that encompass the increasing access to second-hand PCs among the wide range of people, offering the educational opportunity for ICT and raising the quality of health services and the standard of living. However, an important question needs to be asked: who gains the access to these benefits? It does not seem to be the economically and socially lower class of workers at the bottom of the informal recycling chain, namely the ones who recycle non-functioning PCs that have been utilized by those who have access to imported PCs. Instead, recycling workers and local residents continue to suffer from environmental health hazards in favour of little income source, since the continuous incoming old PCs, PCs less than 10years old, become non-functioning scraps sooner or later.

From the environmental justice viewpoint, this is not a fair policy: while a certain group of people including governmental officers enjoys clean environment *and* economic development, others have to share the burden of environmental health costs from recycling activities. The government of India prioritizes the policy in favour for further economic development, instead of creating the policy on redistributing the economic benefits, such as provision of the free health care, to those who suffer from the health hazards caused by recycling activities for economic development. As implied by Iles , the development model that India seek for can induce conditions conducive to people with bargaining power profiting from PC-waste recycling conducted by the working poor who are under their control and hence cannot raise their voice (2004).

5.2.3 Policy-making process for e-waste management

The lack of serious governmental concern on environmental health hazards imposed on workers and local residents at the bottom part of the informal recycling chain may be attributed to disregards of social, economic and spatial differences among the informal sector. From the experience of attending the policy-related debate, the national workshop on e-waste management[19], I analyze how the 'informal sector' is recognized in the policy arena. I was able to attend only one workshop and hence I cannot investigate in depth the dynamic interaction among actors or the politics behind the decision-making process. However, along with the findings from interviewing key NGOs involving the e-waste management in India, there are two points that I can argue: inclusion of traders and exclusion of workers and local residents in the policy process.

Firstly, the informal traders are incorporated in the e-waste collection system that is recommended by the former Director of the MoEF. They are placed as one of the key duty-takers who are expected to manage the collection centers that is going to be authorized by the government, and, more than that, suggested to be provided with an appropriate 'discount' for their collecting activities. This implies that they would gain a certain kind of economic benefits

if this recommendation was to be realized. As one officer from policy-advocating NGO was struggling to deal with big traders, expressing that "it is our challenge to cope with big traders who hide themselves normally but control the flow of e-waste.", policy-makers may also concern the presence of big traders as a key player.

The second point investigated is that the recycling workers and the local residents in the community were not identified in the workshop except an NGO that initiates some programmes with them. Instead, the participants mentioned the 'informal sector' or 'recycler' or 'dismantler', categorizing owners and workers, migrant workers, lower class of Muslim and Hindu persons all in the same status. No discussions on local residents were made. I doubt what they meant as the 'informal sector' includes the working poor inside the recycling units since this policy debate does not address the environmental health problems imposed on them or the unequal structure that forces them to face the problems.

In fact, several NGOs, some of which attended the workshop, make efforts to include the 'informal sector' into the ongoing formulation of e-waste management legislation. However, some of them seem to overlook social, economic and spatial characteristics of workers/residents and local communities. For example, two NGOs officers offensively reacted answering that it is true but 'irrelevant' for the discussion when I asked them about how the high ratio of Muslim workers in the whole informal recycling chain should be dealt with in the e-waste management. Also another officer even stated that there is no caste division in the Muslim religion. However, it should be also important for these NGOs who especially work closely with recyclers at the bottom to discuss the possibility that social, economic and spatial differences could lead them to be excluded from the access to economic benefits and/or disempowered for raising their voices, and that it could result in their earning less but bearing the burden of environmental health hazards. Not paying attention to broader issues but focusing on clean environment may keep these politically influential persons missing out the potential root causes or issues to be investigated and subsequently excluding the particular group of people out of the discussion in the policy arena. Consequently uneven distribution of economic benefits and environmental health costs between people with and without bargaining power are not challenged. Dependent on which category of 'informal recyclers' are connoted by policy-makers, the problems intended to solve vary and may not include urgent issues such as environmental health hazards of workers and local residents.

5.2.4 Linkage to ecological modernization

Reflecting upon the policies and the policy-making process discussed in the former sections, the approach toward the e-waste management in India appears to be in line with ecological modernization. The government of India promotes the market entry for establishing the environmental sound technology by employing the strategy of extended producer responsibility. This policy reduces the governmental role on environmental sound management while encouraging private companies to create the partnership with the

informal recycling sector. In this respect, the market/state nexus has been strengthened, following the ecological modernization approach.

In addition to the market/state nexus, policy-makers and some NGOs do practice ecological modernization that overlook the issues of inequality in the sense that they do not attribute the environmental health problems generated from the hazardous recycling activities in Delhi to the power structure in which the workers, the local residents and the acceptance community as a whole have to depend on the opposite to access their income sources, not being provided a safe and environmentally sound equipment or facility.

And it seems that the social consequences of this ecological modernization approach is embodied as an uneven distribution of economic benefits and environmental health costs and exclusion of people who actually suffer from these costs, namely recycling workers and local residents, out of the public policy arena.

Chapter 6 Conclusion

In this paper, I have intended to achieve three objectives of this study: 1) characterize the generation of and the flow of computer waste in and between developed and developing countries, and the flow into the formal and informal recycling chains in India, 2) investigate how economic benefits and environmental health costs are generated and structured in the informal recycling chain in Delhi, and 3) analyze how the policies and policy processes in India affect the distribution of economic benefits and environmental health costs. In this chapter, I summarize the major findings that have been demonstrated in this paper.

In both developed and developing countries, there has been a growing volume of PC-waste due to the ever shorter life of computer hardware that is caused by incompatibility of hardware with continuously upgraded software. Additionally, some amounts of PC-waste generated in developed countries are shipped into developing countries through illegal routes inside both exporting and importing countries. In the case of the Netherlands and India, illegal importing activities are operated through informal systems interwoven with formal companies. These cases uncover the crucial loopholes in the international treaty, the Basel Convention, which does not regulate the shipment of a second-hand PC. In India, after being labelled as a 'second-hand' PCs, the illegally imported non-functioning PCs flow into the informal recycling chain together with domestically generated PC-waste.

The interesting finding is that this informal recycling chain is embedded within a unique social structure, with high ratio of Muslims involved. There seem to be three main reasons for this social structure. Firstly, there have been increasing Muslim migrants from the eastern parts of India and Bangladesh where poverty is a strong motivator. They have migrated in search of an income source. Secondly the waste-related jobs assigned to the low case Hindu in the past and symbolized as 'social stigma' culturally has been replaced by the Muslim who does not share the same cultural view. Thirdly, the Muslim workers remain economically secured under the feudal system, whereby economically and socially lower class of people depends on the higher class to access their raw material, or PC-waste.

However, the dependent structure embedded with dynamic power relations among actors with economic, social and spatial differences seems to cause an uneven distribution of economic benefits and environmental health costs across the chain. I have investigated it in four different relations: the relations between owners and workers, recycling industry and local residents, traders at the top and recyclers at the bottom of the chain and the Indian recycling industry and global PC-related companies. There seem to be a power structure that each relation has in common and that affect the unequal distribution. The actors with relatively larger financial, spatial and social capital gain economic benefits through the command over limited spatial options and socio-economic disadvantages of the counterpart, and they also sustain their profits through access to and dependence on formal systems with financially

bigger-scale and/or hierarchical feudal network. Meanwhile such counterparts share the burden of the environmental health costs, being unable and unwilling to raise their voices due to disempowerment from economic, social and spatial disadvantages. An owner of the recycling unite, the recycling industry, traders and the global PC-related companies have relatively larger financial assets than the counterpart in the respective relations, namely, workers, local residents, recyclers and the Indian recycling industry. These powerful actors gain economic benefits by controlling the flow of PC and PC-waste, taking an advantage of the counterpart's socio-economic constraints and spatial disadvantages such as workers' immobility, the peripheral characteristic of acceptance communities and recyclers' limited working space and mobilizing economic and political power.

Meanwhile, the disproportionate distribution caused by an unequal power relation within each relationship is the indirect outcome of a power structure on the bigger scale that is embedded within the peripheral community, the informal recycling chain, the whole Indian recycling industry and the global PC market. The recycling workers and local residents at the bottom of the recycling chain are, however, most affected by a chain of these power relations, facing serious environmental health hazards.

Despite the uneven distribution of economic benefits and environmental health costs, the current policies and policy process in India does not seem to have tackled it effectively, considering the findings from analysis on two policies and one policy-related debate. Firstly, the extended producer responsibility for the environmental sound management has been promoted by the government of India. This 'producer'-focused policy encourages the private companies to take profit-oriented strategies and hence leads to involvement of the formal recycling companies. The formal recyclers, also being a private company, seek profit-oriented management, initiating the partnership with the informal sectors. However, while reducing environmental health impacts for some, this partnership would not actually bring economic benefits to *all* informal workers and leaves environmental damage in *some* parts of the Delhi, due to the unequal decision-making process in which the financially big-scale formal recyclers control what kind of PC-waste should be exchanged between them.

Secondly the policy of importing 'old computers' is strongly encouraged by the government as a regional economic development strategy as a way to expand the educational opportunity for ICT and raise the quality of health services. This policy is appreciated by those who have access to these benefits. Meanwhile, the recycling workers and local residents with less access to it, continue to suffer from environmental health hazards, since the imported 'old' PCs become non-functioning rubbish soon or later.

Lastly, it is less likely that environmental health hazards faced by socially and economically powerless workers and local residents or its potential root cause, inequality, have been discussed as a problem in the public policy arena. They seem to be excluded not only from the policy debate physically but also from the intent of policy-makers and some influential NGOs.

In sum, the globally growing volumes of 'old PCs' generated by technological innovation of PC has unevenly distributed economic benefit as

well as environmental health problems across the recycling chain in India. I have found that there is a chain of unequal power relations and dependent structures attributed to economic, social and spatial differences that causes affect this disproportionate distribution. However, these social issues appear to be hidden under heated discussion of the myth of 'environmentally sound' management.

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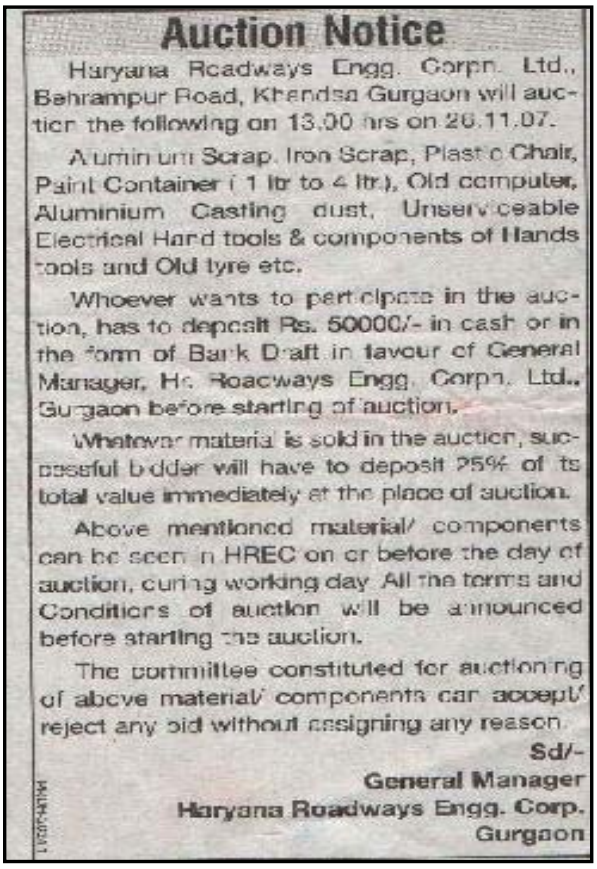
APPENDIX A
The auction notice from a company in India



Auction Notice

Haryana Roadways Engg. Corpn. Ltd., Behrampur Road, Khandsa Gurgaon will auction the following on 13.00 hrs on 26.11.07.

Aluminium Scrap, Iron Scrap, Plastic Chair, Paint Container (1 ltr to 4 ltr.), Old computer, Aluminium Casting dust, Unserviceable Electrical Hand tools & components of Hands tools and Old tyre etc.

Whoever wants to participate in the auction, has to deposit Rs. 50000/- in cash or in the form of Bank Draft in favour of General Manager, Hr. Roadways Engg. Corpn. Ltd., Gurgaon before starting of auction.

Whatever material is sold in the auction, successful bidder will have to deposit 25% of its total value immediately at the place of auction.

Above mentioned material/ components can be seen in HREC on or before the day of auction, during working day. All the terms and Conditions of auction will be announced before starting the auction.

The committee constituted for auctioning of above material/ components can accept/ reject any bid without assigning any reason.

Sd/-
General Manager
Haryana Roadways Engg. Corp.
Gurgaon

(Source: Imrb International 2007)

Notes

[1] Please find the details at http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21chapter30.htm

[2] Please see Widmer et al. 2005 for the details on which countries have reached high market saturation

[3] The percentage change of china and India between 1993 and 2000 is 1052% and 604% respectively while the world average is 181% (Empa 2008).

[4] Please visit http://jad.fujitsu.com/adver/societyeco/newspaper/series09/ for the details.

[5] It is demonstrated by ranking of PCs per 1000 inhabitant in 2002 (Widmer et al. 2005)

[6] The rest 94,000MT of e-waste is comprised with 24000MT of computers, 143MT of mobiles and 70,000MT of televisions.

[7] The number of the international waste shipments detected was 374, out of which 78 shipments were found illegal with reference to EU Regulation 259/93 and/or the Basel Convention

[8] 12 out of 105 retailers inspected in 2006 were found to provide e-waste to unregistered 'collector'

[9] In 2007, the total e-waste recycled is 19,000MT. This figure is constituted of 12,000MT of PC-waste and 2,000MT of television waste.

[10] This is because of the high costs on participating in and winning for auction. One auction notice depicted in the report made by IMRB International (2007) states that persons who want to participate in the auction has to deposit Rs. 50000 (approximately 750 euro at the time of September 2008) "in case or in the form of Bank Draft" and that "a successful bidder will have to deposit 25% of its total value immediately at the place of auction" (Annex I).

[11] Most of auctions are carried out along with other office scraps such as furniture and hand tools. Whoever wants to buy computers needs to purchase the whole lot (Imrb International 2007). And the total payment includes minimum auction price and deposit for participating. At the auction held in 2002, the price set for 29 computers, 24 printers six TV and a few other electronic goods was Rs 30,000 (Agarwal et al. 2003). The deposit was calculated as Rs 36,332, by correcting Rs 50,000, the deposit determined at another auction in November 2007 (Imrb International 2007), to the real value in the year 2002, using Consumer Price Index of Industrial workers in Delhi State of the year 2007. Then I divided the total payment of the auction Rs 86,332 by the total number of items 59, assuming that obsolete computer, printer and TV have the similar value. Each item accounts for RS 1463. Then I calculated this figure based on the average exchange rate of American Dollars to 1 Indian Rupee (1INR=0.02USD) in February 2002, which is equal to USD 29.

[12] The price of second-hand newer models is ranged from Rs5,000 to Rs15,000 at the time of the survey in February 2002 (Agarwal et al. 2003). Through calculating at the exchange rate mentioned before (1INR=0.02USD), the figures are corrected to USD100 to USD300.

[13] According to (Agarwal et al. 2003), the purchasing price of PC-waste with colour monitor ranges from Rs 500-700, equal to USD10-14 while the one with black and

white monitor ranges from Rs 100-150, equal to USD2-3 (calculated by the exchange rate of 2002, i.e. 1INR=0.02USD). Also, many interviewees mentioned that PCB contains precious metals such as copper and gold and can be sold at the high price.

[14] It is located in the border with the neighboring state, and the recycling processes such as acid bath of printed circuit board and open burning of plastic from wires are seen in the industrial site

[15] Please visit the website http://urbanindia.nic.in/moud/what'snew/mps-eng.pdf for the details

[16] This is calculated based on the exchange rate of USD to 1 INR (1INR=0.025USD) in December 2007, the time of this survey.

[17] (Agarwal et al. 2003)

[18] This is stated in the Schedule 3 of the Hazardous Wastes (Management and Handling) Rules 2003 that is covered in the Guidelines for environmentally sound management of e-waste (Ministry of Environment & Forests 2008)

[19] The National Workshop on Awareness and Consultation on 'Guidelines for Environmentally Sound Management of e-Waste' was held in New Delhi on 17th July 2008 with the following panelists: Central Pollution Control Board, Department of Information Technology at the Ministry of Communications & Information, ELCINA Electronic Industries Association of India, Government of National Capital Territory of Delhi, GTZ (international cooperation enterprise), Hewlett-Packard, International Business Machines Corporation (IBM), Manufacturers' Association for Information Technology, Ministry of Environment & Forests, Technology of Information, Forecasting and Assessment Council at the Department of Science and Technology, TES-AMM(e-waste refinery company), Toxics Link (environmental NGO)