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A MULTINATIONAL PERSPECTIVE TO MANAGING END-OF-LIFE ELECTRONICS

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Abstract

This thesis focuses on how multinational electronics manufacturers manage used products in the EU, USA, Japan and China. Managing used or end-of-life products has interesting environmental and commercial implications. Recovering end-of-life products can reduce the environmental effects of disposal, raw material extraction, transport, and production. Whereas the commercial effects include image benefits and savings on raw material costs. Manufacturer involvement in end-of-life management is especially topical in the electronics industry, which is the focus of this thesis. Electronics products, such as TVs and computers, have been targeted with extended producer responsibility (EPR) legislation in different countries across the world. EPR is an environmental policy approach that forces manufacturers to take physical and/or financial responsibility for end-of-life products.

The main objective of this dissertation was to increase understanding of how multinational manufacturers manage end-of-life products in the EU, in the USA, and in China and Japan, and the regional and company-specific factors explain their levels of involvement.

This study consisted of an inductive 16-case multiple case study. The products and companies included in the study were as follows:

- Refrigerators (Bosch und Siemens Hausgeräte, Electrolux, Whirlpool)
- TVs (Samsung, Philips, Hitachi)
- PCs (Hewlett Packard, NEC, Fujitsu Limited and Fujitsu-Siemens Computers and an anonymous company, Alpha Computers)
- Mobile phones (Nokia, Motorola, Samsung)
- Telecommunication network equipment (Nokia, Motorola, Huawei).

A manufacturer's level of involvement in end-of-life management can be characterized in terms of the level of organizational capabilities. These capabilities range from none to running a treatment facility and recovering value from own branded products. Levels in between can be characterized by outsourcing end-of-life management to industry-wide

schemes, managing contracts for treating mixed waste independently or through a more limited scheme and by having individual programs that recover value from own products.

Based on the study a company-specific prerequisite for the highest level of involvement, i.e. investments in tangible assets is the location of other functions, like R&D in the region. Whether manufacturers then actually invest in these assets depends on whether specific assets are needed to treat the companies' products and whether there is a regional recycling infrastructure. If no specific assets are needed and third party players offer the services, manufacturers are unlikely to invest in recovery facilities.

As for the second highest level of involvement, individual recovery, a prerequisite is that the company serves the B2B market. A proposition that needs further testing is whether this depends on the capabilities that the company has developed for B2B products and how it makes use of these for B2C products. A regional prerequisite is access to waste. The likelihood of being involved on this level is increased when the target market of the product in question is B2B customers and when the wear-out life of the products is short. Furthermore the possibility to benefit from these types of activities in complying with EPR legislation increases the probability of adopting them. As for the lower levels of involvement, if there is no legislation high consumer environmental awareness in the country of origin is a prerequisite.

Keywords: End-of-life management, product recovery, reverse logistics, Waste Electrical and Electronic Equipment (WEEE) Directive, electronics, extended producer responsibility (EPR), multinational

Tiivistelmä (Abstract in Finnish)

Tämän väitöskirjan päätavoite on lisätä ymmärrystä monikansallisten yritysten osallistumisesta käytettyjen tuotteiden hallintaan EU:ssa, USA:ssa, Kiinassa ja Japanissa. Käytettyjen tuotteiden hallinnalla on merkittäviä ympäristöllisiä ja kaupallisia seurauksia. Käyttämällä tuotteita uudelleen tai hyödyntämällä niistä osia valmistajat pystyvät säästämään raaka-aine kustannuksia ja vähentämään tuotteiden ympäristövaikutuksia. Elektroniikkatuotteisiin, kuten televisioihin ja tietokoneisiin, sovelletaan tuottajavastuulainsäädäntöä useissa maissa. Tuottajavastuulainsäädäntö laajentaa valmistajien vastuuta sisällyttäen siihen käytettyjen tuotteiden uudellenkäytön ja hävittämisen.

Tutkimus käsitti 16 tapaustutkimusta monikansallisista yrityksistä keskittyen viiteen tuotteeseen: televisiot, tietokoneet, matkapuhelimet, telekommunikaatioverkot ja jääkaapit. Tutkimuksessa tarkasteltiin kuinka tuottajavastuulainsäädäntö vaikuttaa yritysten osallistumiseen sekä tunnistettiin alueellisia ja yrityksestä riippuvia tekijöitä jotka selittävät osallistumisen eri tasoja.

Valmistajien osallistuminen käytettyjen tuotteiden hallintaan luokiteltiin kehitettyjen valmiuksien mukaan. Toimintatapoja lajiteltiin sen mukaan miten itsenäisesti yritykset toimivat ja hyödyntävätkö ne omia käytettyjä tuotteitaan. Valmistajien osallistuminen käytettyjen tuotteiden hallintaan vaihtelee osallistumattomuudesta omien kierrätyslaitosten hallinnointiin.

Tämän tutkimuksen perusteella yrityksestä riippuva tekijä, joka on edellytys omiin uudelleenkäyttölaitoksiin investoimiseen, on tutkimus- ja kehitysvalmiuksien sijoittaminen kyseiseen alueeseen. Valmistajien investoiminen uudelleenkäyttövalmiuksiin riippuu tarvittavien valmiuksien yritys-spesifisyydestä ja alueellisesta kierrätysinfrastruktuurista. Jos yritys-spesifisiä valmiuksia ei tarvita ja kolmannet osapuolet tarjoavat käytettyjen tuotteiden hallintapalveluita on epätodennaköista että valmistajat investoivat omiin uudelleenkäyttövalmiuksiin. Valmistajat osallistuvat omien käytettyjen tuotteidensa hallintaan todennäkoisemmin kun kyseessä on B2B tuote tai tuote jonka käyttöaika on lyhyt. Propositio joka vaatii lisätutkimusta on B2B tuotteita varten kehitettyjen valmiuksien rooli käytettyjen B2C tuotteiden hallinnassa. Alueellinen edellytys on valmistajan mahdollisuus kerätä omia käytettyjä tuotteitaan. Tuottajavastuu-

lainsäädäntö voi myös edesauttaa kyseisten toimintamallien omaksumista tarjoamalla mahdollisuuksia hyötyä niistä taloudellisesti.

Avainsanat: Tuote-elinkaaren lopun hallinta, paluulogistiikka, Waste Electrical and Electronic Equipment (WEEE) Direktiivi, sähkö- ja elektroniikkatuotteet, tuottajavastuulainsäädäntö, monikansalliset yritykset

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Helsinki, May 22nd 2007

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1. Introduction

This dissertation focuses on the involvement of manufacturers in managing end-of-life[1] electronics in four regions of the world: EU, USA, Japan, and China. Managing the end-of-life phase of electronics products is highly interesting from a societal perspective. Electronics products have direct impacts on the environment through their production, use, and end-of-life phases. Recovering end-of-life products reduces the environmental effects of disposal, and lessens the impacts of raw material extraction, transport, and production (Williams, 2003). Recovering electronics can result in considerable savings in raw materials. Matthews and Matthews (2003) estimate, based on life cycle analysis (LCA), that producing one desktop computer requires at least 240 kg of fossil fuels and 1500 kg of water. Electronics also include considerable amounts of valuable materials that can be reclaimed to reduce the use of virgin materials. Given shortages of raw materials this offers interesting reclamation possibilities. Information communications technology equipment contains copper, palladium, and gold. In fact, obsolete computers are literally a "gold mine". One metric ton of electronic scrap from used computers contains more gold than can be extracted from a 17-ton gold ore (USGS, 2001).

Diverting electronics products from landfills is important, because they contain substances like lead, mercury, and cadmium, which may have detrimental consequences to human health if not handled appropriately (Williams, 2003). Growing volumes and rapid rates of obsolescence of these products only serves to exacerbate the problem. PCs alone contribute 300 million pounds of lead to the waste stream each year (Burr, 2006). Finally, landfill space is fast becoming obsolete around the world. The Japanese Ministry of Economy and Trade estimated in 2003 that there was 13.1 years of landfill left for general waste in Japan (METI, 2003). Although electronics waste (e-waste) represents a small percentage of the municipal waste stream (typically 1-5% depending on region), it is growing at the fastest pace. It is estimated that 154 million PCs were landfilled in the

[1] The term "end-of-life products" refers to products that the original user has finished using. Some authors use the term "end-of-use products".

USA by 2005; an amount which represents about three million tons in weight and one football field area piled 3 km high in volume (Matthews and Matthews, 2003).

The perspective of this dissertation is manufacturer involvement in end-of-life management, which has become a hot topic in the electronics industry. The role of manufacturers has been cited as a key issue for future research in green supply chain management in a recent review of literature (Srivastava, 2007). Manufacturers are involved in taking back end-of-life products mostly because of legislation but also because of financial reasons (Carter and Ellram, 1998). The main reason for the surge in interest is the introduction of Extended Producer Responsibility (EPR) Legislation. EPR makes producers responsible for the post-consumer phase of their products' lives (OECD, 2001). Manufacturers have not traditionally been very active in end-of-life management (Lund, 1998), but EPR can force companies to organize and finance the take-back of end-of-life products. Compliance with extended producer responsibility legislation is expensive for manufacturers and thus merits proper attention. Compliance costs to the EU WEEE Directive alone were estimated at 1-2% of a manufacturer's revenues based on visible fees (Mayers, 2002). Costs of employee resources, development costs of software, and legal advice, are considerable due to the high level of complexity involved with understanding and anticipating requirements in the 25 EU member states. However, some manufacturers had programs in place to take back their end-of-life products before EPR legislation came into force, signaling that economic reasons motivate take-back too. Managing end-of-life products effectively can result in many benefits, such as improved customer image, input data for development initiatives, material savings, and a reliable supply of spare parts (Stock et al., 2002). Profitable end-of-life management programs within companies such as Xerox (Kerr and Ryan, 2001) highlight the importance and rewards to manufacturers for managing end-of-life products effectively.

1.1. Research Questions

The main objective of this dissertation is to increase understanding of the factors that explain levels of multinational manufacturer involvement in managing end-of-life products in the EU, in the USA, in China and in Japan. Previous literature on *manufacturer in-*

volvement in end-of-life management is scarce. End-of-life management as a topic is linked to research streams in the fields of industrial ecology and supply chain management.

End-of-life management has its roots in industrial ecology, which studies interactions between industry and the environment (Garner and Keolian, 1995).Literature in industrial ecology journals has dealt with the environmental impacts of end-of-life management as well as examining the impacts of extended producer responsibility (EPR) legislation. Lifset (1993) and Lindhqvist (2000) provide extensive discussions of EPR as a policy measure and Mayers (2001) examines its environmental impacts with respect to the UK electronics industry. Tojo (2004) studied the impacts of EPR legislation on product design in Japan and Sweden. None of these studies examine how extended producer responsibility impacts manufacturer involvement in end-of-life management, which is the contribution of this thesis to this stream of literature.

EPR has become an increasingly popular instrument for policymakers. Electronics products have been targeted with extended producer responsibility legislation on almost every continent since Japan and Switzerland introduced their legislations in 1998. Although called extended producer responsibility, the approaches taken in the various regions differ greatly. The demands put on manufacturers by legislation, and even the products targeted, vary by country. Regional/country-level differences such as cultural factors complicate developing global strategies for multinationals (Laserre, 2003). For companies that sell their products globally, developing a strategy to deal with end-of-life products that complies with regional legislations is a considerable challenge. Yet overall the impact of national characteristics on firms' environmental practices has been insufficiently studied (Starik and Marcus, 2000). Moreover a recent review of literature in this area revealed that discussion of other regional factors that may affect manufacturer involvement in end-of-life management is non-existent (Meade et al. 2007). To explore these issues, this thesis takes a multiregional perspective to end-of-life management and asks the following research questions:

1. **How does extended producer responsibility legislation impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?**
    a. **What other regional factors impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?**

Within supply chain management, end-of-life management is positioned in green supply chain management. Srivastava (2007) defines green supply chain management as "Integrating environmental thinking into supply chain management including sourcing and selection, manufacturing processes, delivery of the final product to consumers as well as end-of-life management of the product after its useful life". Within this area, a lot of work has recently been published about technical issues related to "taking products back" or "reverse logistics". Fleischmann (2001) provides an overview of analytical models in this area, whereas Flapper et al (2005) and De Brito et al (2003) review case studies related to different types of returns. Apart from legislation, manufacturer involvement in end-of-life management is driven by profitability and ethical concerns (Carter and Ellram, 1998; De Brito, 2004; Meade et al. 2007).

Previous literature in this stream of literature identifies product characteristics (De Brito, 2004; Lund, 1998; Rose et al., 2002), markets for recovered products (Thierry et al., 1995; Guide and Van Wassenhove, 2003; Geyer and Jackson, 2004), characteristics of returns flows (Guide and Van Wassenhove, 2001; Ferrer and Whybark, 2003) and consumer behavior (Mayers, 2001; Geyer and Jackson, 2004) as factors that determine the profitability of product recovery. These factors are all the same for companies within a given industry, yet there are differences in how much manufacturers are involved within industries. Previous literature does not offer much insight into strategic issues on a company level (Guide and Van Wassenhove, 2003; Meade et al. 2007), such as why one manufacturer chooses to invest into facilities for end-of-life management whereas another manufacturer, making the same product, develops minimal organizational resources to deal with it. Empirical evidence pertaining to factors underlying manufacturer involvement in end-of-life management is scarce. This thesis contributes to this stream of litera-

ture with empirical evidence and by identifying factors that explain differences between manufacturers' end-of-life management involvement within a given industry. The following research question addresses this gap:

2. **What company-specific factors impact levels of involvement of multinational manufacturers in end-of-life management?**

1.2. Scope

The scope of the study is limited in many ways: industry, type of return, perspective, type of company, and geography.

This thesis focuses on the electronics industry. Focusing on an industry helps to control extraneous variation and define the limits of generalization (Eisenhardt, 1989). The reason for focusing on electronics was that the industry is going through interesting changes in end-of-life management due to the implementation of extended producer responsibility legislation. Because of the existence of such legislation, electronics companies have been confronted with the issue of end-of-life management and have had to formulate a strategy. Furthermore, electronics are interesting because they contain hazardous substances and have durable components, which in theory have multiple options at a product's end-of-life stage.

The focus of this thesis is on end-of-life products. End-of-life products are products that the original end-user has finished using. End-of-life products include products that have more than material value and those that do not (Rose et al., 2002; Toffel 2004). Some authors refer to end-of-life products as products with no other residual value than material value (e.g., Fleischmann 2001; Flapper et al., 2005). Additionally, this thesis focuses on products that the end-user discards because he or she has finished using them- not products that are sent back to manufacturers for other reasons, such as repair under warranty. Different types of returns are argued to differ in their management (Guide and Van Wassenhove, 2001; Fleischmann, 2001). This thesis focuses on end-of-life products instead of

other types of returns as they are the most topical at the moment and are responsible for the increasing academic interest in reverse flows in general (Fleischmann, 2001).

The underlying aim in considering the end-of-life phase of a product's life is to reduce impacts on the natural environment. The ultimate goal is sustainable development "meeting the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). The perspective of this thesis is on manufacturer involvement in managing end-of-life products. This study focuses on the manufacturer's perspective and does not look at the problem from an overall environmental or societal perspective. The strategic perspective to end-of-life management has received very limited attention (Guide and Van Wassenhove, 2003) especially the role of manufacturers which is expected to grow (Srivastava, 2007).

The scope of this study is limited to multinational companies with sales of at least one out of the five products in China, Japan, the USA, and the EU. Multinational companies are defined as companies with headquarters in one country and operations in other countries (Rugman, 2005). Multinational companies include companies with varying levels of sales from different regions. Rugman (2005) groups companies into four groups: home region-oriented (over 50% sales in own region), bi-regional (over 20% of sales in two regions), host region-oriented (over 50% of sales in another region), and global (over 20% of sales in each of the regions). Studying multinationals facilitates identifying regional factors as the same company is looked at in all of the regions. Furthermore it is often argued that large companies are better for studying environmental phenomena than small or medium sized companies as they are more aware of regulations (Revell and Blackburn, 2007).

Moreover, the focus of this study is geographically on the EU, the USA, Japan, and China. The EU and Japan are often considered forerunners of extended producer responsibility legislation and are examined in this study for that reason. The USA and China are both in the process of drafting legislation. They provide an interesting setting for examining manufacturer involvement before legislation is passed and especially to examine other regional factors. The USA, EU and Asia are also considered to be the key regions of the world from an economic perspective (Laserre, 2003).

1.3. Key Concepts

As end-of-life management is an underdeveloped field research-wise, terminology is often disputed. This section provides a brief discussion on four key concepts: end-of-life products, manufacturer involvement in end-of-life management, regional factors and extended producer responsibility legislation.

1.3.1. End-of-Life Products

A product comes to the end-of-life phase when it no longer satisfies the needs of the end user. Some authors (e.g. Fleischmann, 2001) make a distinction between end-of-use and end-of-life products. According to their definition, end-of-life products are a subcategory of end-of-use products. End-of-use products have value, whereas end-of-life products have no value besides their material value. For the purposes of this thesis, end-of-life products are defined as products that may or may not have value in them. This definition is in line with e.g., Toffel (2004), Rose et al., (2002), and Kopicki et al., (1993).

1.3.2. Manufacturer Involvement in End-of-Life Management

Product recovery refers to the broad set of activities designed to recover value from a product at the end of its useful life (Srivastava, 2007). It includes activities such as recycling and remanufacturing. End-of-life management networks are typically categorized by the levels of product recovery that are practised (Fleischmann, 2001), the level of collaboration between companies and the level of outsourcing (Toffel, 2003). On the one hand manufacturers can have their own recycling facilities, entailing high levels of involvement, and on the other hand they can participate in industry-wide initiatives entailing lower levels of involvement. Section 2.1 gives an overview of end-of-life management focusing on manufacturer involvement.

1.3.3. Regional Factors

The Cambridge Advanced Learners' dictionary defines "regional factor" as a fact or situation which influences the result of something relating to or coming from a particular part of a country or the world (Cambridge, 2007). In this thesis the concept "regional factor" is used to discuss facts related to a country or in the case of the EU a part of the world that impact manufacturer involvement in end-of-life management. Extended Producer Responsibility is an example of such a factor. According to Laserre (2003) general regional/local factors pushing towards localization are cultural factors such as tastes and behavior; commercial factors such as distribution networks, technical factors such as standards and language; and legal factors.

The term "regional factors" has been used quite loosely in previous studies to denote various facts about the region/country that are claimed to explain the phenomenon under study. Okamuro and Kobayashi (2003) identify demand, cost, human resource, financial, industry agglomeration and industrial structure, and other factors as regional factors in their study of start-up ratios in Japan. Newell and Muro (2006) discuss content and scope of regulation, political environment, economic environment and level of civil society engagement as national factors that explain corporate social and environmental responsibility in Argentina. In this case, a regional factor can be a fact about the country such as legislation or environmental awareness. As the nature of this study is inductive (see section 1.5) regional factors are not prespecified apart from legislation. Legislation is treated as its own research question due to its apparent force to influence manufacturer involvement in end-of-life management.

Used in a similar way is the term *characteristics*, which has been used by (Starik and Marcus, 2000; Christmann, 2004) or *determinants* (Christmann 2004). It should be noted that economics literature has a different use for the term "regional factor". It uses the word "factor" to refer to factors of production i.e. land, labor and capital. It uses the term "regional factor" in combination with markets and price.

1.3.4. Extended Producer Responsibility

Extended producer responsibility (EPR) has become a key element of public environmental policy in several countries around the world. EPR as a term was first used in Sweden in 1990. EPR is an environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of the product's life (OECD, 2001). EPR policy comprises two interrelated features (OECD, 2001):

- Shifting responsibility (physically or economically, fully or partially) upstream toward the producer and away from municipalities
- Providing incentives to producers to incorporate environmental considerations in the design of their products.

The underlying logic behind policy measures is to correct market failures. Market failures occur when the price of the goods fails to include all the costs incurred to produce the good. Within the context of EPR, examples of these factors include costs of resource depletion and environmental externalities of resource extraction (Lifset, 1993; Walls, 2003). Extended producer responsibility policies represent a new type of policy approach, which is non-prescriptive and goal-oriented, as opposed to the more prevalent command and control approaches (Tojo, 2004). EPR programs have the following aims (Lifset, 1993):

- Achieving high levels of reuse, recycling, and related forms of recovery
- Promoting behavioral changes in materials use and product design decisions by producers
- Leveraging producers' expertise in areas such as marketing and distribution

There is some debate related to the policy instruments actually included under the concept of extended producer responsibility. At the very least, the concept includes measures that make companies responsible for the take-back of the products. Some authors (e.g., Lindhqvist 2000 and Tojo 2004) include landfill bans and material restrictions as instruments covered by the concept. In this thesis extended producer responsibility refers to take-back measures. Take-back measures are considered to be the heart of EPR policies (Gertsakis et al., 2002).

The five models for extended producer responsibility are liability, ownership, economic responsibility, physical responsibility, and informative responsibility (Lindhqvist, 1992). Liability refers to the responsibility for proven environmental damages caused by the product. Another form of EPR is when the producer retains the ownership of his products throughout their life cycle (e.g., leasing). Economic or financial responsibility means that the producer will cover all or part of the expenses of end-of-life management. Physical responsibility is used to characterize systems where the manufacturer is involved in the physical management of the products and their effects. Finally, informative responsibility signifies requiring manufacturers to supply information on the environmental properties of their products.

Legislation can simultaneously impose multiple responsibilities on producers. Most extended producer responsibility legislations in the electronics industry impose a combination of financial, physical, and informative responsibility. Financial and physical responsibility will be discussed in the remainder of this thesis.

With regard to financial responsibility, an interesting question is how costs are passed on to consumers. Whether consumers or producers pay for the products has been found to be a key explanatory factor of motivations to make improvements (Tojo, 2004). One way of passing them on, is having consumers pay when they dispose of the product i.e. a *back-end fee*. The producer can also opt to finance the costs by fees collected as a part of the price of a new product, i.e. *front-end fee*. These fees can be visible to the consumer or they can be internalized in the price. Another interesting question stems from considering what the producers are actually responsible for financing. Producers may be responsible for financing and/or organizing (physical responsibility) collection, treatment, disposal, or any combination of these activities. In some cases they are financially responsible for setting up a collection and treatment infrastructure (i.e., recycling facilities or designated points were consumers can leave their products).

The degree of collaboration between companies in complying with the legislation is another important factor of differentiation in EPR policies. Producers can be *individually or collectively responsible* for end-of-life products. Individual producer responsibility means

that manufacturers are responsible for the end-of-life management of their own products, as opposed to collective producer responsibility, where producers share this responsibility with other producers of the same product group regardless of brand (Tojo, 2004). Individual and collective producer responsibility can refer to either or both physical and financial responsibility. Individual financial responsibility entails producers having responsibility for financing the treatment of their own products, while collective financial responsibility means that producers are responsible for financing a share of the industry's end-of-life products. What collective financial responsibility means in practice is that if a PC manufacturer has a 20% market share in a given country, that manufacturer pays for the collection and treatment of 20% of information technology waste collected at municipal waste points in that country. Individual physical responsibility means that a producer is responsible for treating his own products. Tojo (2004) identifies two characteristics of physical individual producer responsibility. Distinction of products is made at a minimum by brand and producers have control over the fate of their products with some degree of involvement in the downstream operation.

1.4. Methodological Positioning

Supply chain management and industrial ecology both utilize a variety of research approaches. Research strategies previously used in green supply chain management range from mathematical modeling and simulation to case studies (Srivastava, 2007). Qualitative case studies have become a more and more popular research strategy in business logistics literature (Spens and Kovacs, 2006; Frankel et al 2005). Qualitative case studies are a common a research strategy in industrial ecology (e.g. Zhu et al., 2007), especially in studies that examine the impacts of legislation i.e. evaluation studies (Tojo, 2004; Roine, 2006; Stake, 1995).

The logical reasoning process of this thesis includes both inductive and abductive elements. Inductive and abductive reasoning both start from an empirical observation. Inductive reasoning generalizes based on the empirical observations, whereas abductive reasoning searches for the most appropriate explanation for the observations (Kovacs and Spens, 2005). Both inductive and abductive reasoning are recommended for studies

where the objective is to improve understanding of an under-researched phenomenon (Dubois and Gadde, 2002). Inductive reasoning ends with the explanation whereas abductive reasoning ends with an application of the new theoretical framework (Kovacs and Spens, 2005).

The main differences between inductive and abductive research on the one hand and deductive research on the other hand are the aims and relationships to previous theory. Deductive research relies on formulating hypotheses based on previous literature and it aims at testing and evaluating theory. Both inductive and abductive reasoning aim to build or broaden theory (Arlbjørn and Halldorsson, 2002). In inductive case studies previous literature is often used to generate tentative constructs to focus data collection efforts and formulate research questions (Eisenhardt, 1989). It emphasizes keeping these constructs tentative and modifying them as empirical evidence is gathered.

The research strategy of this thesis is multiple case study. Case studies are often praised for their rich descriptive content and their novelty value (Eisenhardt and Graebner, 2007). Case studies are particularly suited to describing and providing explanation (Voss et al. 2002). Case studies allow the essential "why", "what" and "how" questions to be answered with a relatively full understanding of the nature and complexity of the problem (Meredith, 1998) whereas they are less useful for "how much" and "how many" questions (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Yin, 2003). Inductive case studies are recommended when the existent theory and empirical evidence does not cover an important phenomenon (Eisenhardt and Graebner, 2007), when the investigator has little control over the events, and when the focus is on a contemporary phenomenon within some real-life context (Yin, 2003). One of the main advantages of case study research is that it increases the chance of being able to determine the link between cause and effect (Voss et al., 2002; Eisenhardt, 1989). Further case studies are a recommended approach in situations where many of the variables related to the phenomenon are still unknown (Meredith and Roth, 1998).

This strategy was selected for this study for a number of reasons. In this study, the research questions are a combination of "what" and "how" questions and the study aims to

provide description and also to some extent explanation. Neither existent theory nor empirical evidence cover factors underlying manufacturer involvement in end-of-life management, which is the focus area of the research. The issue is highly important as extended producer responsibility legislation is being implemented across the world.

Alternatives to the selected research strategy would include applying a more deductive approach. The hypothetical-deductive approach requires specification of main variables and the statement of specific hypotheses before data collection begins. This would have been challenging in this study as there is no previous research on regional and company-specific factors that impact manufacturer involvement in end-of-life management. Moreover a criticism directed towards hypothetical-deductive approaches is its inability to capture phenomena that do not fall under these predetermined variables and hypotheses (Patton, 1987). As this study is directed towards identifying factors, using predetermined variables would risk limiting the findings. Instead of hypotheses, the issues, questions and search for general patterns guide inductive analysis (Patton, 1987). Finally quantitative approaches are restricted in understanding why and how a specific outcome occurs. As the focus of this study was on the "how" question, the qualitative approach was deemed more appropriate.

1.5. Structure of the Dissertation

The structure of this dissertation follows the research approach discussed in Section 1.4. The inductive case study research process involves going back and forth between theory and data collection and analysis. This differs to a deductive process where hypotheses are formulated in advance. This iterative nature makes reporting challenging in these types of studies compared to hypothetical deductive studies which are the basis of the classic structure of scientific reporting i.e. introduction, literature review, methods, empirical analyses, results (Suddaby, 2006).

This dissertation comprises eight chapters and they are related to the theoretical and empirical domains as shown in Figure 1.

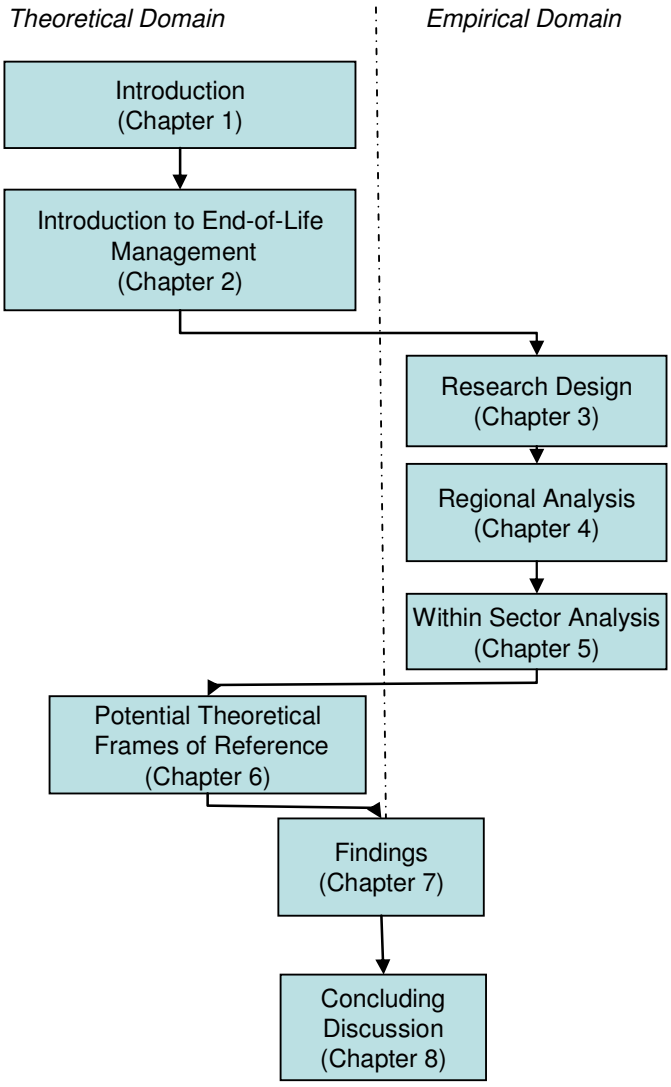

Figure 1 Structure of the Dissertation

Chapter 1 introduces the topic and the research questions. It also positions the thesis methodologically. Chapter 2 outlines previous knowledge on end-of-life management and summarizes it related to the gaps in previous literature addressed by this study. This introduction is followed by the research design chapter which explains how data was collected and analyzed. Chapters 4 and 5 present the analyses of the cases. Chapter 4 focuses on the first research question and it discusses the categorization of manufacturer involvement in end-of-life management, which was developed iteratively with the analysis. It groups the cases by level of regional involvement, and identifies factors that cross in-

dustry sectors, and explain involvement in the four regions. Chapter 5 focuses on the second research question. It groups the cases by product, searches for factors that explain the differences between companies producing the same product. The case descriptions have been organized based on industry sub-sector and are displayed in Appendices 4-7.

Chapters 6 and 7 represent the "theory matching" part of this study. Chapter 6 introduces the theories that are matched to the findings in Chapter 7. Chapter 7 also links the emergent factors with literature discussed in Chapter 2 as well as literature from other fields that emerged during the analysis. Chapter 7 answers the research questions of the study. Chapter 8 highlights the theoretical contributions related to the two fields of research, discusses limitations and suggests areas for further research.

2. Introduction to End-of-Life Management

The purpose of this chapter is to develop an understanding of manufacturer involvement in end-of-life management based on previous literature in supply chain management and industrial ecology. The separation of previous research into these two fields is not clear cut as many studies refer to both fields. The first section outlines end-of-life management from the perspective of supply chain management and discusses the factors that determine profitability of product recovery. Section 2.2 relates the research topic to previous research in the field of industrial ecology and provides an overview of existing extended producer responsibility legislation. Finally Section 2.3 summarizes the chapter and the gaps in research that this thesis addresses.

2.1. Overview of Supply Chain Management Literature

According to the council of supply chain management professionals (CSCMP) supply chain management encompasses "the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third party service providers, and customers. In essence, supply chain management integrates supply and demand management within and across companies." (CSCMP, 2007). Green supply chain management introduces the notion of environmental values into supply chain management including green design and green operations (Srivastava, 2007).

2.1.1. End-of-Life Management

Traditionally, the focus of a supply chain is on distributing products to end users. The supply chain begins with the extraction of raw material and ends with consumption. Green SCM integrates the flow of used products into this picture, expanding the supply chain to include "backwards" flows of products. Figure 2 displays a simplified diagram of flows of end-of-life products in the supply chain.

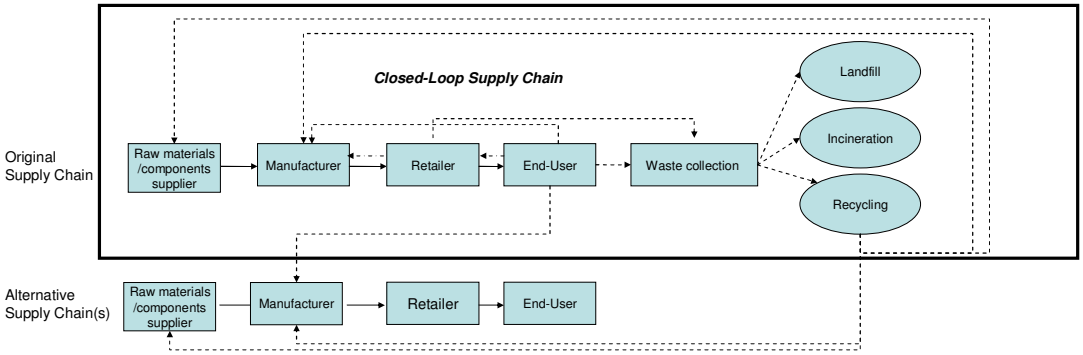

Figure 2 Flows of End-of-Life Products (Adapted from Fleischmann, 2001)

As can be seen in Figure 2, the end user of the product can send the product to waste collection, directly back into the original supply chain, or directly into an alternative supply chain. Managing this "backwards" flow of products from the end user is also referred to as *reverse logistics*. While the broad definitions of reverse logistics include any kinds of product returns (De Brito, 2004; Fleischmann, 2001; Dowlatshahi, 2000), other definitions narrow the scope of the concept down to those activities that ensure sustainable, or environmentally friendly, recovery of used products and materials (Jahre, 1995; Kopicki et al., 1993; Carter and Ellram, 1998).

Waste collectors can be municipalities, third parties, or logistics service providers. Depending on their location in the world, end users may have to pay to dispose of the product. From waste collection the product will be sent to a landfill, an incinerator, or a recycling facility. Incineration means that energy is recovered from the product, whereas recycling refers to recovering material value from the product (Carter and Ellram, 1998). From the recycling facilities the recovered materials may end-up back in the original supply chain of the product or an alternative supply chain. Recycling facilities may in some cases be owned by manufacturers, as is frequently the case in Japan (Lifset and Lindhqvist, 2003). Interestingly a lot of the electronics waste that is collected for recycling in the EU and especially the USA ends up in China, where it is manually recycled. According to a report by Greenpeace the amounts that are sent to China substantial, up to 60% of what is collected for recycling (Puckett and Byster, 2002).

In previous literature approaches to end-of-life management are typically characterized by levels of product recovery (Thierry et al, 1995; Geyer and Jackson, 2004) or through

the contracts between players involved in managing the products (Toffel, 2003; Spicer and Johnson, 2004). Additionally collaboration amongst competitors can be distinguished from systems operated by sole companies.

Levels of Product Recovery

The term *product recovery* is used when products are diverted from landfills and it can be considered to be a generic term that includes a variety of activities designed to recover value from a product (Srivastava, 2007). Product recovery alternatives can be divided into direct recovery and process recovery alternatives (De Brito, 2004). Direct recovery includes options such as reuse, resale, and redistribution. For example, a broker that buys a used product from a company and resells it "as is" would be practicing direct recovery. Thierry et al (1995) distinguish between five process recovery options: repair, refurbishing, remanufacturing, cannibalization, and recycling. They propose that the process recovery options differ in the degree of upgrading. Repair involves the least and remanufacturing the most. In repair, the objective is to restore the product to working order. Broken parts are replaced or fixed. With refurbishment, the objective is to bring products to a specified quality; used products are disassembled into modules and all critical modules are inspected, fixed, and replaced. Remanufacturing refers to transforming used products to "as new" quality. Used products are completely disassembled and all modules and parts are extensively tested. Within the repair, refurbishing, and remanufacturing recovery options, a large part of the product is reused. Repair, refurbishing, and remanufacturing are also referred to as *extending the product life* and are thus are often not considered to be end-of-life management options. They are, however, closely related to end-of-life management, as a company may seek to extend the product's life to decrease the amounts of its products that are disposed of, thereby decreasing end-of-life management costs.

Cannibalization and recycling are recovery options for end-of-life products. The purpose of cannibalization is to recover a limited set of parts and components. Cannibalization involves selective disassembly of used products and inspection of potentially reusable parts (Thierry et al., 1995). The final process recovery option is recycling. When products are recycled, only their material value is recovered. As opposed to the other recovery options, the identity and functionality of the products is lost in recycling.

Original and Alternative Supply Chains

The original supply chain refers to the actors that made the product and sold it to the end user (Fleischmann, 2001). In some cases retailers take products back, with the aim of boosting the sales of new products (Rogers and Tibben-Lembke, 1998). Returns such as this are typical in the large consumer products industries; i.e. large household appliances and furniture (Herold and Kovács, 2005). Retailers may also be mandated by extended producer responsibility legislation to collect end-of-life products (see Section 1.2.). Some manufacturers have programs in place where they buy end-of-life products that meet certain quality criteria back from business customers and consumers. In the USA, several computer manufactures offer to pick up used computers for a fee.

When the manufacturers are involved in taking their own waste products back and reintegrating the materials or products that they reclaim, the process is called a *closed-loop supply chain* (Kopicki et al., 1993). The same materials that first went to the market come back forming a loop. De Brito and Dekker (2002) further divide closed-loop supply chains into physical and functional closed-loops. In physical closed-loops, the recovered materials are used by the same end user and in functional closed-loops they are used for the same functionality. The term "closed-loop supply chain" has also been used to denote the holistic view on supply chains that combines both forward and reverse flows (Guide and Van Wassenhove, 2003). Closed-loop supply chains can take many forms with the manufacturer taking physical responsibility of the products as well as manufacturers outsourcing the actual physical activities to a third party service provider (Spicer and Johnson, 2004). In the extreme case, manufacturers can be vertically integrated into product recovery entailing that they have their own product recovery facilities.

Alternative supply chains include players other than the original supply chain that make use of the end-of-life products. The alternative supply chain can consist of a wide variety of actors that use used products as primary or secondary inputs (Fleischmann, 2001). The "producer" in the alternative supply chain can be a broker or a third-party refurbisher or remanufacturer. A US-based company called Recellular, for example, offers to buy used handsets of a certain category from operators and large companies (Recellular, 2006).

When the materials flow through an alternative supply chain they form an open loop supply chain. Open loop supply chains are far more common than closed-loop supply chains on all levels of product recovery.

The most common type of alternative supply chain is one where the municipality collects waste and some fractions are recycled by independent third parties. These third parties do not have anything to do with a particular manufacturer. A version of this is "pooled take-back". Pooled take back is when a consortium of manufacturers outsources the treatment to of their end-of-life products to a producer responsibility organization (e.g. Spicer and Johnson, 2004; Toffel, 2003). This type of arrangement is common under extended producer responsibility legislation (Toffel, 2003; Spicer and Johnson, 2004). An advantage of pooled take-back is that products do not have to travel long distances for treatment and, unlike in manufacturer run closed-loop supply chains, treating end-of-life products is the core competence of the service provider. Pooled take-back systems are often criticized for creating monopolies and lacking efficiency created by a system with competition (ERP, 2006; Toffel, 2003). Pooled take back systems also do not provide feed back loops to manufacturers. Prices are typically uniform for all producers of a given product, reducing incentives for improving design (Spicer and Johnson, 2004).

2.1.2. Profitability of Product Recovery

There are three general criteria for profitability in product recovery, which are product characteristics, manageability of returns flows and markets for recovered products, and components and materials (Ferrer and Whybark, 2003). These factors play a crucial role in determining the economic feasibility of higher levels of product recovery, such as remanufacturing and refurbishment for any player including third parties and manufacturers.

Product characteristics and product design play a crucial role in determining the profitability of end-of-life management and the possibilities for different recovery options (Thierry et al., 1995; Ferrer and Whybark, 2003; Guide and Van Wassenhove, 2003; Lund, 1998). Product characteristics that play a major role in determining recovery options include composition, deterioration, and use pattern (de Brito, 2004). Rose et al

(2002) studied the end-of-life management of various electronics products. They tested ten product characteristics as predictors of a company's level of product recovery (ranging from recycling to remanufacturing) and identified a product's wear-out life, technology cycle, level of integration, number of parts, design cycle, and reason for redesign as among the most critical characteristics. The most critical issue according to them is the ratio between wear-out life and technology cycle. Wear-out life refers to the length of time the product lasts physically, whereas technology cycle refers to the duration of time it takes for the product to become economically obsolete.

The existence of a *market for recovered products, components, or materials* is a determinant of the profitability of product recovery (Thierry et al., 1995; Guide and Van Wassenhove, 2003; Geyer and Jackson, 2004). Recovering products in the absence of a market for them, or at least the materials included in them, hardly makes good business sense. The potential market for the products, components or materials can be internal or external to the company. The products or components that have been recovered through direct or process recovery can be resold in the original market or another market (Thierry et al., 1995). The recovered products can also be sold in markets which are less technologically advanced. Cross-border sales may be the result of differences in diffusion of technology, technological change, or differences in relative wealth (Ferrer and Whybark, 2003).

Among other factors, product characteristics play a role in determining whether there is a market for the product. Lebreton (2006) argues that one of the key explanatory factors for the existence of a market for remanufactured products is the dominance of functional characteristics over psycho-sociological characteristics. When the core function of the product does not leave room for competitive differentiation, it is sought through highlighting subjective factors. Lebreton (2006) uses tires as an example. Marketing campaigns for truck tires highlight functional properties of the products, which results in a market for remanufactured truck tires. In contrast, there is no market for remanufactured car tires, which are sold based on psycho-sociological characteristics such as security and design.

Profitability of managing returns is highly dependent of generating a *steady flow of returned products* and achieving sufficient economies of scale (Ferrer and Whybark, 2003; Stock, 1998). The quality and predictability of the return flows is especially important in higher levels of product recovery, i.e. remanufacturing (Guide and Van Wassenhove, 2001). Furthermore the stability and quality of the flows depends on whether products are acquired from the waste stream or by actively buying them from end users (Guide and van Wassenhove, 2001). Waste streams typically contain products of mixed quality and brand. Companies can get more stable quality by purchasing their own used products from customers or brokers. Linked to the steadiness of returns flow is whether the company has access to end-of-life products. Limited access to products can create an inefficiency which dominates the economic performance of value recovery (Geyer and Jackson, 2004).

2.2. Overview of Industrial Ecology Literature

Industrial ecology focuses on the potential of industry in reducing environmental burdens throughout the product life cycle. It examines local, regional and global materials and energy uses and flows in products, processes, industrial sectors and economies. Moreover industrial ecology is interested in government programs and policies that facilitate environmentally sound practices relevant to industrial ecology (Journal of Industrial Ecology, 2007).

Extended producer responsibility is the most relevant type of legislation for manufacturer involvement in end-of-life management as it forces producers to be involved in the end-of-life management stage of their products (Kopicki et al., 1993). Extended producer responsibility or “take-back” legislation is a key driver of end-of-life management and more especially manufacturer involvement in it. This section provides an overview of existing extended producer responsibility legislation in the areas focused on in this study and then discusses previous work on the impacts of extended producer responsibility legislation.

2.2.1. Overview of Existing Extended Producer Responsibility Legislation

The objective of this section is to provide a general understanding of extended producer responsibility legislation in the EU, USA, Japan, and China with respect to electronics products. The following issues will be focused on in this comparison:

- Overview
- Product coverage
- Individual or collective producer responsibility
- Allocation of physical and financial responsibility.

The information in this section pertaining to legislation in the EU, Japan, and China was mostly gathered from reports by Perchards, a UK-based company. Information on US legislation was gathered from industry associations and relevant legislative texts.

2.2.1.1. The EU

Overview

Environmental policy in the EU is divided between EU and member state institutions. EU member states are obliged to pass national laws that at least fulfill the minimum requirements of EU Directives. However, if they desire, member states are allowed to adopt more stringent regulations.

Extended Producer Responsibility (EPR) has a long history in northern European countries. The Netherlands (1999), Belgium (2002), and Sweden (2002) had already adopted producer responsibility legislation for Waste Electrical and Electronic Equipment (WEEE) before EU-level intervention. The EU WEEE Directive was adopted in 2003, with its primary goal "the prevention of waste electrical and electronic equipment and in addition the promotion of reuse, recycling and other forms of recovery of such waste so as to reduce the disposal of e-waste." (EU, 2003). Although the official deadline for having systems operational was August 2005, at the time of writing many member states had not yet published clear guidelines of their requirements for the treatment of WEEE.

Product Coverage

The EU has the most comprehensive legislation where product coverage is concerned. The WEEE Directive covers virtually all electrical and electronic equipment used by consumers or equipment intended for professional use that may end up in the municipal waste stream. The WEEE Directive covers the following 10 product categories:

- Large household appliances
- Small household appliances
- IT & telecommunications equipment
- Consumer equipment
- Lighting equipment
- Electrical and electronic tools
- Toys leisure and sports equipment
- Medical devices
- Monitoring and control instruments
- Automatic dispensers

Out of the 10 product categories included in the WEEE Directive, TVs, PCs and monitors are targeted by some take-back legislation in all regions included in this study. However, product coverage is not a simple issue, even within the EU. There are 10 product groups that are covered by the WEEE Directive, but a lot specifications on inclusion of parts of equipment that are sold separately, such as USB drives, are missing on the EU level. Most member states have not gone to that depth on a regulatory level either. Not knowing whether a product is included in a specific member state or not is a big problem. Products that are included in the legislation need to be labeled and reported. Another challenge caused by the large and somewhat undefined product scope is the distinction between B2B and B2C equipment. The regulations in most EU member states are different for B2B and B2C equipment. However, many products originally sold for professional use, such as IT equipment, may end up in the municipal waste stream.

Collective or Individual Producer Responsibility

According to the EU WEEE Directive, producers are collectively responsible for historical waste[2] (i.e., waste generated before the Directive came into force). According to the WEEE Directive, the producers are individually responsible for future waste[3]. The intent behind this policy was to make manufacturers responsible for their own products, thereby encouraging design for environment. The member states did not all transpose this idea into their respective legislations. In the current WEEE laws within the EU member states, producers are responsible for the financing of a mixed share of e-waste, not their own branded products. In fact, only Sweden, Luxemburg, Italy, and Poland have fully transposed the requirements for future waste into their legislation (Mayers, 2005).

Division of Physical and Financial Responsibility

In the EU physical and financial responsibilities for waste collection and treatment are divided between consumers, municipalities, retailers, and producers. The requirements on consumers are limited. The Directive explicitly states that "disposal must be free and convenient for consumers" (EU, 2003). Funds are collected from consumers in the form of front-end fees. According to the WEEE Directive, consumers pay a fee upon the purchase of new equipment that may be visible until 2013 for cooling appliances and until 2011 for all other equipment. After this date the costs must be internalized in the product price. However, many different versions of this directive exist in member state legislations.

The most common division of physical responsibility in the EU involves municipalities and retailers, on a 1:1 basis,[4] financing and organizing waste collection from households to local collection points that they maintain, with producers assuming financial and physical responsibility from that point forward. However, some EU countries have imposed more stringent requirements. For example, in Hungary, Austria, Spain, France and the Netherlands producers are required to fund the local collection activities performed by municipalities. Where there is no collection infrastructure in place, responsibility for developing this collection infrastructure sometimes falls on producers. This is the case in

[2] Historical waste is waste from products put on market before Aug. 13th, 2005

[3] Future waste is waste from products that are put on market after Aug. 13th 2005

[4] 1:1 basis means that the retailer has to take-back an old appliance when he sells a new one

some new EU member states such as Latvia and Slovenia. Producers of B2B goods are, according to the Directive, allowed to make other agreements with their customers as well.

To fulfill their responsibilities, producers must belong to a compliance scheme. This typically takes the form of a producer responsibility organization (PRO) where producers establish an organization together to handle their physical responsibilities collectively. Most EU countries[5] have one PRO or national collective take-back system per product category. Other countries[6] have however opted for multiple competing compliance schemes (these include).

The question of multiple or single national compliance schemes remains complicated and continues to be debated in the EU. According to proponents of national collective take-back systems, the economies of scale are better and there is less administrative work when there is just one system. The proponents of multiple systems will argue that the presence of a monopoly raises costs, which can be reduced by having competing compliance schemes.

Finally, producers can usually also opt to take care of these responsibilities by themselves and set up their own collection system. Although this option is allowed in practically all the EU countries, there are significant financial implications. For example in 21 member states, individual compliers need to provide financial guarantees for the treatment of their products in case of bankruptcy whereas compliers that use national collective take back systems do not. Sweden, Italy, Germany and France are the exceptions.

The discussion so far has been about responsibilities imposed on *producers*. However, who the producer is, is in many cases not a clear issue. The producer can be the manufacturer or an importer. The allocation depends on who "puts the product on the market." "Putting on the market" is defined in different terms in the EU countries. The market can

[5] Belgium, Cyprus, Czech Republic, Denmark, Finland, Greece, Latvia, Lithuania, Netherlands, and Sweden

[6] Austria, France, Germany, Hungary, Italy, Ireland, Portugal, Poland, Slovakia, and Slovenia

be the EU or the member state, or even a county in a member state. This leads to many complications in a relatively small geographical area with distribution channels that routinely cross member state borders. Small retailers may in some cases be deemed producers under the local transpositions of the WEEE Directive.

2.2.1.2. The USA

Background

The USA also has environmental policy decision making on two levels: the federal level and the state level. In many cases, environmental policies are first adopted at the state level and then passed on to the federal level (Vogel et al., 2006).

The USA does not currently have extended producer responsibility legislation on a federal level. Several proposals for federal tax benefits to companies operating their own recycling programs have however been suggested (NERC and CSG/ERC, 2005a). In the USA, four states (California, Maine, Maryland and Washington) have passed legislation that requires some level of involvement from producers and 14 other states have some similar legislation pending ((NERC and CSG/ERC, 2005b; Product Stewardship Institute, 2006). California passed its bill first in 2003, whereas Maine passed it in 2004, Maryland passed it in 2005 and Washington in 2006. The Washington program is the only one that has not been implemented yet. It is scheduled to be ready by January 2009.

Product Coverage

The initiatives in Maine and California and most of the others are targeted at TVs and monitors containing displays over four inches measured diagonally. The laws do not apply to large industrial appliances, automobiles or other household appliances with displays. The Maryland bill applies to all personal computers and laptops whereas the Washington bill has the broadest product coverage, applying to PCs, laptops and TVs. However, some states that have not yet passed legislation for extended producer responsibility (e.g., Vermont, Rhode Island and New Jersey) have proposed as wide a scope as in the WEEE Directive. The bill in California applies to all types of users, the Maine bill applies to households and the Washington bill applies to households, charities and small businesses.

Collective or Individual Producer Responsibility

None of the US legislations propose individual physical producer responsibility. Although in Maryland producers that have their own recovery systems do not have to take part in the collective system. In Maryland producers however pay a fee, which is fixed and not dependent on their product volumes. In Maine and Washington producers are individually responsible financially. They are responsible for the costs of collecting and treating their own products (NERC and CSG/ERC, 2005c; Product Stewardship Institute, 2006). Whether these costs differ by brand is unclear. In California producers do not have financial or physical responsibility so the question is not relevant.

Division of Physical and Financial Responsibility

Out of the extended producer responsibility legislations reviewed for this study, the US legislations require the least from producers.

In Maine and Maryland local authorities have physical responsibility for collection and treatment. In Maine, municipalities collect the goods from consumers and take them to consolidators, who treat them. Consolidators are required to count the products by manufacturer. The producers have to finance the costs incurred by the consolidators for their own products as well as a prorata share of orphan products (NERC and CSG/ERC, 2005c). In Maryland, counties are responsible for collecting and recycling the products and producers are responsible for financing these operations. Producers will, however, be exempt from this responsibility if they have their own recovery operations for their own branded products. Producers are not allowed to show visible fees in the prices of new products.

In Washington producers have to organize collection, transportation and treatment from charities, schools, consumers, local businesses. They can do so by participating in the standard collection scheme or by setting up their own schemes. Costs are allocated to manufacturers based on statistical sampling of brands found in waste stream once a year. The Washington system is not based on fees; disposal must be free for consumers and costs must be internalized in product prices.

The California bill does not give producers any physical or financial responsibility for the end-of-life products. Rather, it requires producers to give information about their products. In California the costs of collection and treatment are directly covered with funds collected from consumers. The consumers pay front-end fees and retailers are responsible for collecting them and transferring them to a centrally managed fund. Certified recyclers are allowed to claim money from this fund based on claims of materials collected. A producer can be a certified recycler.

2.2.1.3. Japan

Overview

Legislation regarding environmental preservation has been made since the 1960s in Japan. Japan adopted the polluter pays principle in the 1970s making polluting enterprises financially responsible for the damage they inflicted to society (Karan, 2005). Japan suffers from low landfill capacity, thus diverting materials from the waste streams has been a priority. Regulations promoting recycling have been in place in Japan since the early 1990s. The national government sets laws but much of the implementation of policies is at the prefectural or municipal level (Karan, 2005).

Extended producer responsibility legislation in Japan is based on two laws, the Home Appliance Recycling Law (HARL), passed in 1998, and the Law for the Promotion of Effective Utilization of Resources (LPEUR), adopted in 2000. HARL was put into practice in 2001 and LPEUR in 2003 (Perchards, 2006).

Product Scope

HARL mandates the collection and recycling of air conditioners, TVs, refrigerators, and washing machines. Although LPEUR subjects 37 product categories to design for environment measures, it only introduced measures for voluntary take-back for batteries and PCs (Perchards, 2006). The original law imposed measures for voluntary take-back of B2B PCs, but the revised law, which became effective in October 2003, extended these measures to PCs for home use.

Individual or Collective Producer Responsibility

The principle behind both the HARL and the LPEUR is physical and financial individual producer responsibility.

Division of Physical and Financial Responsibility

Under HARL, responsibilities are divided between consumers, retailers, and producers. Consumers are responsible for bringing the products to collection points maintained by retailers or producers and covering the costs of collection and treatment. A clear difference to the EU Directive is that consumers must pay back-end fees (upon disposal) for collection and treatment. Producers are free to set their own level of fees, but they ended up with the same fee. Retailers are responsible for collecting used home appliances on a 1:1 basis.

The producers of home appliances are responsible for the collection and treatment of their own branded waste. There are two consortia, Group A and B, and producers may choose which consortium they belong to. Retailers sort waste by brand into two streams, according to which consortium the producer belongs to. Importers may also transfer their obligation to the Association of Home Appliance Producers (AEHA). Group A consisted of 21 producers, Group B included 23 producers and AEHA included 35 producers in 2005 (Perchards, 2006). Each consortium has set up a network of 190 collection centers in Japan. As for treatment, most recovery facilities are collectively owned by producers belonging to the same consortium. Larger producers typically have their own treatment facility. Producers are responsible for keeping track of the amounts of their own products that are treated on a yearly basis.

Under LPEUR responsibilities are divided between consumers, post offices, and producers. If the PC was bought before the law was put in effect, the consumer pays a fee upon disposal; however, if the PC was bought after the law was enacted, disposal is free of charge. Producers are not permitted to show the costs of treatment and collection in the prices of new PCs. Consumers have to pay a back-end fee when the producer cannot be identified or has gone bankrupt. Producers must offer to take-back PCs and monitors

from business customers; however, the business customers are responsible for the costs. Post offices are used as collection points for the used PCs.

From the post offices the PCs are sent to the producer's own or contracted treatment facilities. The Japanese Electronics and Information Technology Association (JEITA) set up the PC3R promotion centre to ensure take-back of orphan products and products from producers that fall below the minimum limits for size.

2.2.1.4. China

Background

China began work on its own extended producer responsibility law for WEEE in 2002. *Regulatory Approaches on End-of-life Household Electronic Equipment* is a joint initiative between three ministries (Perchards, 2005). The directive was supposed to be promulgated mid 2003, but it was delayed due to disagreements between environmental protection agencies and industry.

Product Scope

The Chinese EPR draft applies to PCs, TVs, mobile phones, DVD players, refrigerators, and air-conditioners (He et al., 2006). The scope is thus a bit broader than similar legislation enacted in Japan, but it is not as encompassing as the EU legislation.

Individual or Collective Producer Responsibility

At the time of this writing, the details about individual or collective producer responsibility were largely unknown.

Division of Physical and Financial Responsibilities

The Chinese drafts do not offer comprehensive details of the requirements on producers. Retailers will be required to collect WEEE and municipalities are encouraged to help, but the main responsibility for local collection, both financially and physically, is on producers. Draft guidelines state that the national authorities will set up a fund to finance the activities, but no details are known at the time of writing about the financial mechanisms. Producers may carry out recycling themselves or entrust this task to a third party. Special

attention is given to reused products, which need to be tested and certified by a licensed treatment company (Perchards, 2005).

2.2.2. Overview of Literature on Extended Producer Responsibility Legislation

Legislative mandate is widely recognized as a driver for environmental activities. Countless studies have reached this conclusion based on empirical research (Delmas, 2002; Post and Altman, 1994). Legislation is the most often cited reason for company involvement in end-of-life management (Carter and Ellram, 1998; Stock 1992; Kopicki et al., 1993). Moreover, even the threat of future legislation can motivate companies to take action (Cairncross, 1992; Tojo, 2004; Guide and Van Wassenhove, 2003). By taking action before being faced with a legislative requirement, companies can seek to prevent possible legislation from even being passed (Kopicki et al., 1993).

As discussed in section 1.3, extended producer responsibility (EPR) legislation aims at increasing reuse, recycling, and providing incentives for manufacturers to improve their products. Underlying EPR is a move towards a society where product flows are cyclical rather than linear and concepts such as selling services are more commonplace (Krusweska, 2006). Although the original aim of EPR is to provide incentives for producers to reduce the environmental impacts of their products (Lindhqvist, 1992), in practice, the aims of governments have been more along the lines of increasing the recycling of end-of-life products (Tojo, 2004).

Many academics have supported the assumptions of extended producer responsibility and argued that it provides economic and political incentives for waste recovery and ecodesign (Lifset, 1993; Lindhqvist, 2000; Tojo, 2004). However, empirical studies examining how EPR works in practice, and what impact it has on manufacturers, have been relatively rare.

As one of the main theoretical objectives of EPR policy is to motivate improved environmental design, most studies have focused on this perspective and have been conducted from a life cycle analysis or evaluation perspective. Moreover EPR aims at reducing the

amounts of waste by extending product lives and promoting selling function rather than products (Krusweska, 2006). The perspective of this study is manufacturer involvement in end-of-life management and how legislation impacts this. To recover value from their products effectively producers must design them to facilitate the recovery process (Thierry et al., 1995; Henrickson et al., 2003).

Mayers (2001) examines the effectiveness of the WEEE Directive in achieving environmental results for household appliances and printers. One of the findings of his studies is that it will not provide effective financial incentives for producers to design more environmentally benign products. Factors that impact this are that electronics products remain in use for several years. As the future cost savings of designing environmentally friendly products are discounted, incentives will be reduced. Due to the price discounting (Mayers, 2002) proposes that costs will be reduced by 20%-50% for small products with four-year life spans, to 50%-80% for products with life spans of about nine years. As another disincentive for producers, Mayers (2001) found that there was no relationship between environmental impacts of the products and the treatment costs charged to producers. Under the proposed WEEE Directive, producers will not have the exclusive right to any environmental benefits "designed-in" to their products (Mayers, 2001). Roine (2006) studied the impacts that extended producer responsibility has had in the plastics industry in Norway and came to the conclusion that the main impacts were on waste management practices and not design changes, as originally intended.

In contrast, Tojo (2004) found that EPR legislation has already fulfilled its promises and promoted upstream design changes. Tojo (2004) studied 21 companies in the electronics and automobile industries in Sweden and Japan. According to her study, although manufacturers were worried that their products would not be distinguished or differentiated from others, the anticipation of the WEEE Directive had effectively motivated design changes (Tojo, 2004).

The question as to whether individual producer responsibility (IPR) is needed to promote design changes has been widely discussed and debated. Most academics will agree that IPR provides design incentives at least in theory (Tojo, 2004; Lindhqvist and Lifset,

2003); however, there are many arguments against IPR and especially the practical feasibility of the concept. Walls (2003) discusses illegal disposal and poorly functioning recycling markets as challenges that undermine the design incentives from EPR programs. Sorting products and allocating costs according to recyclability is difficult for recyclers. Veerman (2004) suggests that individual responsibility would result in duplicated infrastructure and increased transport. He also argues that the low level of differences in the environmental qualities of the products makes it unlikely that the differences in price are significant enough to send price signals to producers. Tojo (2004) points out that many of these arguments are a result of a general misunderstanding of the concept. Some assume that individual producer responsibility means individual *physical* responsibility whereas others use the term to refer to individual *financial* responsibility.

Apart from legislation, some studies have identified consumer behavior as one of the key factor related to the costs of recovering used products (Mayers, 2001; Williams, 2003). The studies arrive at the conclusion that consumers do not bring products back because they perceive there to be value in them. In less developed countries i.e. Mexico, products get reused until they have no value in them (Corral-Verdugo, 1996). However, in more developed countries consumers tend to store products after they have finished using them. In an empirical study on consumer disposal behavior in the UK, Mayers (2001) found this to be the case with printers and household appliances. Williams (2003) found that PC owners store their used products for five years on average before bringing them to recycling.

2.3. Summary of Background

The purpose of this chapter was to provide a background understanding of end-of-life management. It is divided into two sections according to the field of the research. Section 2.1 discussed literature in supply chain management whereas Section 2.2. discussed literature in industrial ecology.

Section 2.1.1 discussed the flows of end-of-life products identifying levels of product recovery as well as discussing closed and open-loop supply chains. In closed-loop supply chains the manufacturer has some contact with its own branded end-of-life products ei-

ther through recovering them in-house or with the help of a third party. Open loop supply chains range from arrangements where the manufacturer is in no way involved (third party remanufacturing) to arrangements where they are involved through a consortium that uses a producer responsibility organization to take care of end-of-life products. In these consortia manufacturers have no contact with their own branded products. In short manufacturer involvement in end-of-life management can be characterized in terms of product recovery levels, outsourcing and collaboration. Section 2.1.2 examines key factors that determine profitability of product recovery from any player's perspective. These factors include product characteristics, manageability of returns flows, and markets for recovered products. The factors discussed in previous literature are all industry dependent and therefore more or less the same for all players in a given industry. *Previous literature does not provide explanation as to why manufacturers within a given industry opt for different kinds of contracts and different levels of recovery. This is a gap that this study aims at contributing to. Furthermore previous literature does not discuss why the same manufacturer would have different levels of involvement in different regions. This study aims to identify factors and understand how these factors impact manufacturer involvement in end-of-life management.*

One regional factor, namely extended producer responsibility (EPR) legislation, is widely recognized as a driver for end-of-life management. It is also makes the subject highly topical as EPR legislation has been passed in the past few years. Section 2.2 gives an overview of existing legislation and the discussion in industrial ecology on the impacts of extended producer responsibility legislation. The EU and Japan have passed EPR legislation, whereas China and some States in the USA have draft legislation. The legislation differs by product scope and by responsibilities placed on the manufacturers for their products. Currently only Japan makes manufacturers responsible for their own branded products. The impacts of this legislation have been studied to a very limited extent owing to the fact that it is such a new phenomenon and most of the impacts remain to be seen. Previous studies in industrial ecology have focused on changes in product design and environmental impacts of EPR legislation in Sweden, the UK, Switzerland, the Netherlands and Japan. *In contrast, this study focuses on the impacts of EPR on manufacturer involvement. Moreover previous literature does not discuss other regional factors that ex-*

plain manufacturer involvement. In some countries manufacturers are involved in end-of-life management even if there is no legislative mandate whereas in others they are not. This thesis aims to identify regional factors that explain manufacturer involvement.

3. Research Design

The purpose of this chapter is to explain how the empirical study of the thesis was conducted. This chapter consists of five sections. Section 3.1 introduces the research approach. Section 3.2 discusses the design of the multiple case study. Sections 3.3 and 3.4 explain how the data was collected and analyzed. Section 3.5 concludes the chapter by discussing the steps taken to improve validity and reliability.

3.1. Research Approach

The research approach of this thesis includes inductive and abductive elements and it applies a case study research strategy (see Section 1.4 for discussion on selection of research approach and strategy). Figure 3 depicts the research process of this study.

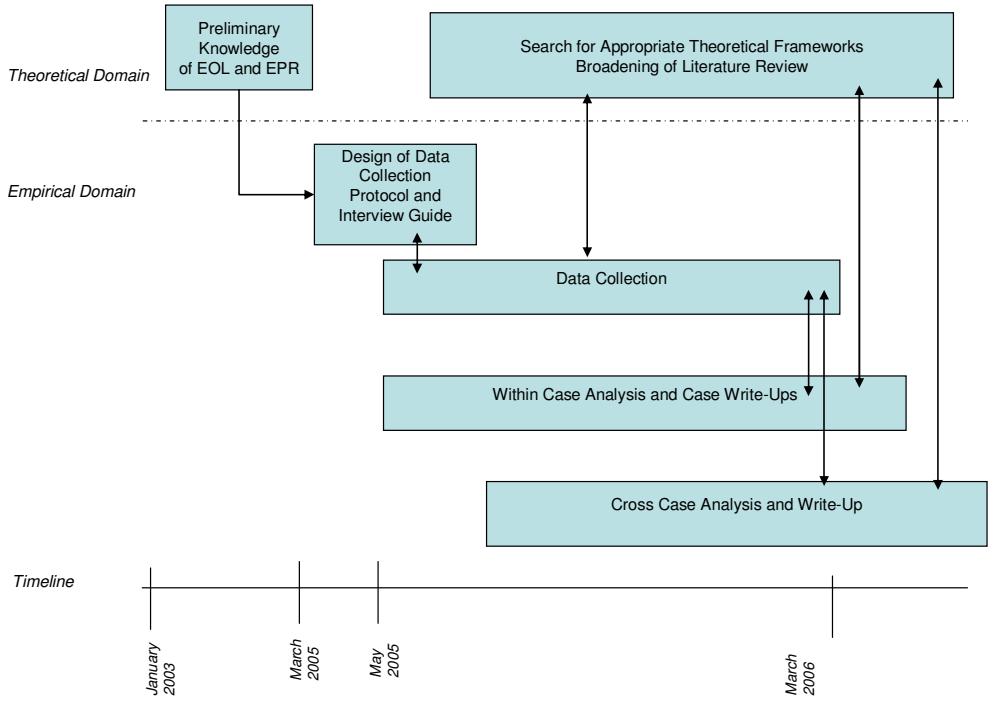

Figure 3 Research Process

The starting point of the study was an interest in the differences between manufacturer take-back programs this was followed by developing a preliminary knowledge of end-of-life management. As suggested by Eisenhardt (1989) in her guideline for inductive case studies, this study used previous literature to focus the data collection efforts. The previ-

ous literature that was used for designing the study is discussed in Chapter 2. Based on this previous knowledge a preliminary interview guide was designed and refined through the first interviews. As the study progressed, explanatory factors started to emerge and more literature was reviewed following a pattern of going back and forth between the empirical part and the theoretical part (Eisenhardt, 1989). This exchange between the empirical and theoretical domain can be referred to as "systematic combining" and it serves to deepen the understanding of both theory and empirical phenomena (Dubois and Gadde, 2002). As mentioned before this study has inductive and abductive elements. Abductive reasoning implies starting by identifying a particular phenomenon and then finding the best explanation for it (Niiniluoto, 1983). Within the context of this thesis it means that existing theories were introduced in search for factors that explain manufacturer involvement. As discussed in Section 1.5 the structure of this thesis reflects this research process. Chapter 2 introduced the pre-understanding of the topic and Chapter 6 discusses theories that are matched to the empirical findings in Chapter 7.

3.2. Sampling and Multiple Case Study Design

This study employs the multiple case study as a research strategy. Yin (2003) defines a case study as an empirical enquiry that investigates a contemporary phenomenon within its real-life context. Multiple case studies are recommended for theory building research (Eisenhardt, 1989) and they are used to increase the validity of the findings (Meredith, 1998). The depth of a case study is however always compromised in multiple case studies and some researchers have criticized multiple case studies for attempting statistical generalization (Dubois and Gadde, 2002). Multiple case studies however aim at theoretical generalization as opposed to statistical generalization which is the aim of e.g. surveys (Eisenhardt, 1989). The selection of the case is dependent on contribution to theory development within the set of cases (Eisenhardt and Graebner, 2007).To achieve theoretical generalization in multiple case studies, cases are chosen for replication, extension of theory, contrary replication and elimination of alternative explanations (Yin, 2003).

The design of this study follows replication logic and seeks out to eliminate alternative explanations. As discussed in Chapter 2, most previous literature examines recovery as a

product or industry-level issue as opposed to a company-specific issue. To examine company-specific factors as opposed to industry level factors (alternative explanation), this study sought to examine multiple companies that produce the same product. A sample of four to twelve cases has been recommended for theory-building multiple case studies (Eisenhardt, 1989). Three or four companies were interviewed for each product, leading to a total of 13 companies and 16 cases (three companies—Samsung, Nokia, and Motorola--were used for two products). A case in this study can be defined as a business unit within a company consisting of international branches.

As previous literature focuses on product characteristics to explain end-of-life management practices, they are used to design the study. This study focuses on five products from the electronics sector, representing four industry sub-sectors, which are PCs (information technology), TVs (consumer electronics), refrigerators (white goods) and handsets and network equipment (telecommunications). The main aim in selecting the products for this study was to identify and evaluate products that would be representative of electronics products and represent different lengths of technology cycles and wear-out life. To include products that would be managed differently, examples were selected for this study that had different regional legislative requirements. These products are listed in Table 1 below. Initially, the intent was to study consumer products. However, the first few interviews suggested that companies managed business-to-business (B2B) products differently. To explore this finding, a fifth product, telecommunications network equipment, was added and questions concerning how companies manage their B2B products were included in the interview protocol.

Table 1 Case Products

Product	Wear-Out Life (years)	Technology Life Cycle (years)	EPR legislation Japan	EPR legislation US	EPR legislation China	EPR legislation EU
Telecommunications (Mobile phone)	3	1			Drafted	Yes
Information technology (Desktop PC)	5	2	Yes	Some states	Drafted	Yes
Consumer electronics (TV)	>10	3	Yes	Some states	Drafted	Yes
White goods (Household refrigerator)	>10	>10	Yes		Drafted	Yes
Telecommunications (Network equipment)	>10	3				Yes

Besides examining company-specific factors, this study sought to identify and understand regional factors. All of the selected companies had to fulfill the criteria of selling at least one of the products (mobile phone, TV, Network equipment, Refrigerators, PCs) in the EU, USA, Japan and China. Examining how the same company operates in the different regions was used as a way to probe regional differences.

The approach was to seek major players in the industry with special attention to major players in each of the geographical areas examined. Country or region of origin was another determinant in being included in the study. The intent was to have representative companies from each region (the EU, USA, Japan, and China) preferably for each product. However, this was not feasible in all cases, due to practical reasons (e.g., there are no North American manufacturers that sell TVs globally) and accessibility reasons. The benefit of studying major players for environmental issues as opposed to small and medium sized companies is that they tend to have well formulated environmental strategies (Revell and Blackburn, 2007).

It should be noted that the selection of particular companies was partly opportunistic within the sampling framework. Companies were selected that the researcher had some access to within theoretical categories. While performing the research, the author organized a conference series attended by top companies in the industry. This helped identify and get contacts with companies that fulfilled the criteria. This search was supplemented

by online databases, Datamonitor and Thomson One Banker Online. Three companies that were contacted declined to participate in the study (Matsushita, Sony, and Cisco).

As having sales in the EU, USA, Japan and China was a prerequisite for being included in the study, all of the case companies are large multinationals. The annual sales of the companies range from 6.8 billion USD to 81 Billion USD in 2005. Rugman (2005) groups companies into four groups: home region oriented (over 50% sales in own region), bi-regional (over 20% of sales in two regions), host region oriented (over 50% of sales in another region), and global (over 20% of sales in each of the regions). Most of the cases included in this study fall into the bi-regional or home region-oriented categories. Table 2 groups the cases according to their geographical distribution of sales.

Table 2 Comparison of Case Companies

	company name	HQ location	Sectors
Global	Samsung	Korea	Multiple
	Philips	EU	Multiple
Bi-regional	Electrolux	EU	Home Appliances
	Hewlett Packard	USA	Information Technology
	Huawei	China	Telecommunications
	Motorola	USA	Multiple
	Nokia	EU	Telecommunications
	Whirlpool	USA	Home Appliances
Host region based	Alpha Computers	Taiwan	Information Technology
Home region based	Fujitsu	Japan	Information Technology
	NEC	Japan	Multiple
	Bosch und Siemens	EU	Home Appliances
	Hitachi	Japan	Multiple

Although all companies were selected for a specific product, Table 2 shows that there is quite a lot of variation in the level of concentration among the companies. Hitachi, Philips, and Samsung are good examples of companies that operate in a broad scale of industry sectors, whereas Whirlpool, Nokia, and Huawei are focused on a specific sector.

3.3. Data Collection

Case studies typically use multiple sources of data (Yin, 2003). The data collection methods of this thesis are qualitative. This is recommended for descriptive research aimed at understanding phenomena (Ellram, 1996). The main data source of this study is inter-

views, which was complemented by information from company publications as well as third party sources. The reader should note that as the research process was inductive, the data protocol evolved along the way and the interview questions were not formulated to test predetermined factors. Linking this back to the research questions of the study, regional factors were probed by asking the interviewees to describe their end-of-life management operations and then by asking them to explain why things were done in a certain way. Similarly company-specific factors were examined by getting companies to discuss their operations and describing why they do what they do. Followed up by why not something else. The factors identified by the interviewees were then compared with third party sources (documents from environmental agencies) and company documents such as environmental reports. In a few cases there were discrepancies, which were resolved by email.

Initial topics were used to focus the data collection process such as background information on the company, background environmental information and the companies' involvement in end-of-life management activities in terms of level of recovery, collaboration and development of in-house activities. The data sources, and which topics they were used for, are summarized in Table 3.

Table 3 Linking Datasources to Topics

Topic	Global Interview	Regional Interview	Company reports	Third party sources
Company Background Information • Global distribution of sales •Global distribution of employees •Product Assortment •Manufacturing capabilities •Location of Headquarters			x	x
Company Environmental Background Information •Globalization of environmental standards •Environmental management system •Length of measurements of environmental impacts •Third Party Acknowledgements	x		x	x
Involvement in End-of-Life Management •History of involvement in end-of-life management •Organizational capabilities dedicated to end-of-life management in regions •Investments into end-of-life management •Regional end-of-life management operations for selected product and other products including levels of product recovery and outsourcing •Reasons for differences •Impacts of extended producer responsibility on operations •Challenges and opportunities	x	x	x	x

Each of these areas was deepened as the interviews progressed and understanding increased. Most of the cases were worked on in parallel, but some issues needed to be readdressed by the first few interviewees. This was done bv email.

Interviews

Semi-structured, open-ended interviews were used as the primary data collection method. A total of 34 interviews were conducted between May 2005 and May 2006. Three pilot interviews were conducted between May 2005 and September 2005. These interviews were used to test and revise the protocol. Most of the interviews took place between November 2005 and February 2006. The interviews lasted between 30 and 90 minutes, depending on the availability of the interviewee. Six interviews were conducted in person, twenty-six by phone, and two by email. The interviewees were environmental or quality managers with responsibility for end-of-life management practices. In two cases the interviewees were governmental affairs managers (Whirlpool and NEC). Two to four managers were interviewed in each company. Interviewing multiple companies was necessary

to identify company-specific factors whereas interviewing personnel from multiple regions was important for identifying regional factors. The depth of a case is always limited in a multiple case study. However given the research questions, this strategy was deemed to be more appropriate than reducing the number of cases.

The focus on a particular division in the company also limited the content scope of questions. For eight of the cases, the interviewees for the global-level interviews were managers with global responsibility for end-of-life management. In the other cases, there was no globally responsible person, or that person was unavailable for an interview. In three cases, the regional-level manager in the region of headquarters answered the global-level questions. In one case, a senior advisor from the region of headquarters answered the questions. In these four cases, the respondent was, however, considered to have sufficient global-level experience. There were also three cases (Hitachi, Huawei, and Philips) that had only one interviewee. The list of interviewees, including job title and date of interview, is provided in Appendix 1.

A general framework of questions was sent to the interviewees beforehand and covered in more detail during the interviews. One of the benefits of the semi-structured interview format is it allows diversion from the actual questions to explore new insights (Eisenhardt, 1989). One researcher conducted all but one interview. The interviews were conducted with a common protocol, which included global and regional level questions (see Appendix 3). Four academics reviewed the protocol, which was subsequently tested and revised in the first three interviews with managers. Further, the protocol was revised as the interviews progressed to refocus questions around arising issues. Some questions were also dropped because they were not yielding interesting information. In some cases, managers had to be contacted again due to these changes in original interview questions.

Other Sources

One disadvantage of collecting data through interviews is that they are subject to bias, poor recall and poor or inaccurate articulation (Yin, 2003). Company publications (annual and environmental reports) were used to collect background information about the companies. Third party sources were consulted to verify and deepen environmental in-

formation provided by companies. Third party sources included reports from Datamonitor, Euromonitor, Greenpeace, and the Dow Jones Sustainability Index. As there were some problems with getting enough interviewees in Japan (US and European companies did not have managers there), reports by other researchers were used to complement the information collected. This second hand information consisted of reports on Japan from the UK Department of Trade and Industry (DTI, 2005) and the doctoral thesis of Naoko Tojo (Tojo, 2004). A DTI group visited recycling factories of Hitachi and some of the other Japanese companies to gather best practices for the UK. Tojo (2004) interviewed Japanese electronics companies to find out about their design for environment practices in order to assess the impacts of extended producer responsibility legislation.

In addition to the primary data collection, the author participated in numerous conferences during 2002-2006 and conducted two studies in Finland about end-of-life management in 2004. The findings of these studies are reported in Herold (2004), Herold and Kämäräinen (2004) and Herold and Kovács (2005). In 2005 and 2006, the author was also in charge of a seminar series, called the INSEAD WEEE Directive Series. The series brought together around 80 industry experts, academics, and governmental representatives to discuss the implementation issues of the WEEE Directive. The author organized four conferences. Organizing the series brought invaluable contacts and perspective into the study. The author also had the opportunity to visit a recycling plant in Belgium to gain further insight into recycling white goods and consumer electronics.

3.4. Analysis

The first step in the analysis was focusing and simplifying the data in the transcriptions and interview notes and combining it with data from other sources to develop preliminary case study write-ups. In these preliminary case write-ups, the data around each of the research constructs was reported, including quotes from the transcriptions. Everything that was deemed worthy of further analysis was included.

The write-ups also served as a check for comparability of the data across cases. The interview guide evolved over time and some of the companies that were interviewed early

in the process had to be contacted again with additional questions. In some cases (Huawei, Nokia, Electrolux) interviewees were contacted again. Each case was analyzed for answers to the research questions, interesting findings, and emerging patterns. After this analysis, case study reports were sent to interviewees for an accuracy check. Some changes were made based on their comments. All of the reports were sent to the interviewees during March-April 2006. Sending the reports at the same time for all cases was a way to check that the cases would be comparable, even though there was a time lag between the actual interviews. The results of these write-ups are detailed in the cases provided in Appendices 4-7.

The data from all the cases was filled in to a meta-matrix (Miles and Huberman, 1994), which included all the case data in a condensed format. Analysis within the meta-matrix was facilitated through the use of the MS Access database program. This database was used for the cross-case analysis. To enable data analysis in the matrix, the cases were clustered by various criteria (e.g., by end-of-life management operations, country of origin, industry sector) to search for differences and similarities. The patterns that had arisen from the within case analysis were also tested to see whether they were supported by the other cases.

The results of these analyses are reported in Chapters 4 and 5 in this dissertation. Chapter 4 analyses regional-level operations and Chapter 5 presents the within-sector analysis. Chapter 4 is more focused on the first research question, whereas Chapter 5 focuses on the second research question of this study. After testing the explanations internally, they were tested for external consistency. Chapters 4 and 5 compare the overall findings of the study with findings from other studies. Finally, Chapter 7 draws together the findings from the analysis and compares them to both literature used as a basis for the study and literature collected as the study proceeded.

3.5. Validity and Reliability

Four tests have generally been used to establish the quality of empirical social research: construct validity, internal validity, external validity, and reliability (Yin, 2003). Table 4 summarizes the measures taken to increase the quality of the study.

Table 4 Quality Measures

Test for quality	Measures taken in this study
Construct validity	Multiple sources of evidence Interviewees reviewed case reports External reviewers for protocol
Internal validity	Comparison with conflicting literature Comparison with similar literature Pattern matching across cases Comparison with external cases
External validity	Multiple case study design
Reliability	Data collected into a case study database Interviews were recorded and transcribed

Construct validity refers to establishing correct operational measures for the concepts being studied. In case studies, construct validity can be increased by using multiple sources of evidence, establishing a chain of evidence, and having key informants review the draft case study report (Yin, 2003). In this study at least three sources of evidence were used in all cases, as shown in Table 3. Moreover, multiple informants were used for each case study. The case study reports were also reviewed by the key informants. As a result of this review process, changes were made and the reports were sent to the informants for re-review and approval. To verify the logic of arguments, i.e., the chain of evidence, an external reviewer was also used to read the case study write ups, analyses, and results.

Internal validity refers to establishing a causal relationship showing that certain conditions lead to other conditions as distinguished from spurious relationships. The investigator should do pattern-matching, explanation building, use logic models, and address rival explanations (Yin, 2003). Explanation building and comparing against both internal and external data was used as a key technique to increase internal validity.

External validity refers to establishing the domain to which a study's findings can be generalized (Yin, 2003). To increase external validity this study had a multiple case study

design. This study is focused on the electronics industry and within it globally operating companies producing consumer products. The findings can be generalized to that domain.

As a fourth test, reliability refers to demonstrating that the operations of the study can be repeated with the same results. The issues here are documentation and measures taken to reduce researcher bias. The main ways to increase reliability in case studies is to use a case study protocol and to develop a case study database (Yin, 2003). A case study protocol was developed. The material for each case in the database consists of:

- Interview protocol
- Recordings of interviews
- Transcriptions of interviews
- Published company reports (environmental report, annual report)
- Case study write ups
- Email exchange with interviewees.

The interview protocol was reviewed by three academics that have published extensively in the area and three managers involved in end-of-life management. The interview protocol was revised extensively.

As a further step to increase objectivity, the interviews were recorded and transcribed when possible. Out of 34 interviews, 29 were recorded and transcribed. Five interviews were not recorded due to technical difficulties. In three cases, no digital recorder was available. In two cases, the interviewees responded in writing because they did not feel confident in speaking English. These interviews naturally weaken the reliability of the data collection.

Social desirability refers to respondents' tendency to give statements on the basis of the perceived acceptance of their actions. Social desirability biases are important to take into account when designing any study on corporate responsibility (Leggett et al. 2003; Park and Stoel, 2005). Social desirability bias can be reduced through the use of indirect questions during data collection (Fisher, 1993) and by triangulating interview data with different data sources (Leggett et al. 2003). In this study the same questions were asked of

more than one respondent in the cases and the data was triangulated with company reports and data from third party sources.

Cultural differences are a known source of communication challenges. In this case, the interviewees represented 12 nationalities. In all but two cases, the interviewer and the interviewee came from a different culture. Gesteland (2002) distinguishes between a number of characteristics that divide people from different nationalities according to how they practice business. Communication is the most relevant aspect of data collection as derived through the interview process. Gesteland distinguishes between cultures that use indirect as opposed to direct language. According to him, this difference is the greatest cause of misunderstandings between relationship-oriented and deal-oriented people. Deal-focused people use direct language. To them the most important thing is to be clearly understood. They say what they mean and mean what they say. Table 5 below summarizes the nationalities of the interviewees and their classification of deal vs. relationship-focus, based on Gesteland (2002).

Table 5 Cultural Bias

	Nationality	Cases
Deal focused	Germany	Fujitsu-Siemens, NEC
	Sweden	Electrolux, Alpha Computers
	USA	Whirlpool, Hewlett Packard, Motorola, Nokia
	the Netherlands	Philips
	UK	Nokia, Motorola, Samsung
	Finland	Nokia, (Interviewer)
Moderately deal focused	Italy	Whirlpool
	Belgium	Whirlpool, BSH
Relationship-focused	China	Huawei, BSH, Nokia
	Japan	Fujitsu, NEC, Hitachi
	Singapore	Motorola
	Korea	Samsung
	Taiwan	Alpha Computers

With the exception of one interview (performed by a Japanese person), all interviews were conducted by a Finn. Finns are known to be very direct and deal-oriented. In relationship-focused cultures people give top priority to maintaining harmony. People tend to use vague and indirect language. The challenges resulting from this centered on correctly interpreting what these people actually said. A way of dealing with this was having each respondent review the reports written based on their interviews.

4. Regional Analysis

The objective of this chapter is to examine levels of manufacturer involvement in the different regions, identify factors that explain them and discuss how regional factors explain manufacturer involvement. This chapter addresses the first research question of the study:

1. How does extended producer responsibility legislation impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?
    - What other regional factors impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?

This chapter begins with a categorization for examining manufacturer involvement that was developed as the study progressed. The second, third, fourth and fifth sections discuss regional involvement in the EU, USA, Japan, and China, respectively. Each section groups the companies according to the scale discussed in Section 4.1. The section then proceeds to analyze regional factors that explain the level of operations. The analysis is divided, according to the research questions, into how extended producer responsibility impacts organizational operations and what other regional factors explain the company's level of involvement. The findings of the chapter are compiled in Section 4.6. The case descriptions can be found in Appendices 4-7.

4.1. Categorization of Manufacturer Involvement in End-of-Life Management

The main objective of this dissertation is to understand the factors that explain the different levels of manufacturer involvement in end-of-life management. Although previous literature has examined end-of-life management and closed-loop supply chains, it has looked at manufacturer involvement to a very limited extent. To the knowledge of the author no previous studies have explicitly aimed to understand the differing levels of involvement of manufacturers within the same industry context.

As explained in Section 2.1 product recovery is typically approached through the levels of recovery, the actors involved and the degree of collaboration. This distinction served as a basis for developing the interview protocol and the constructs served useful when categorizing manufacturer involvement in end-of-life management. The interviews suggested that companies that manage their contracts independently or in more limited schemes need to develop capabilities to select service providers. Moreover companies that take back their own products and recover something from them need to develop capabilities to manage this process, which companies that are not involved in recovering value do not. They also have to develop ways to get their own products back and manage their own contracts. The highest level of capabilities would be in a company that manages all or most of this in-house. Based on the analysis, the level of organizational capabilities depends on:

- how independently the company manages its contracts
- whether it is involved in recovering value from its own products

The main benefit of using a capabilities-based approach is the possibilities it provides to distinguish between companies. Capabilities have been examined to understand differences between individual companies (e.g. Argyres, 1996). The remainder of this section will discuss the levels of involvement identified during the empirical study based on organizational capabilities (see Table 6). Many companies are involved on multiple levels for example a company may have its own take back operations alongside membership in national compliance schemes. The capabilities that it has depend on the highest level of involvement.

Table 6 Levels of Manufacturer Involvement in End-of-Life Management

Scale	Name	Organizational capabilities	Own/mixed waste	Description	Examples
0	**Nothing**			No end-of-life Management operations	Monitoring legislative Developments
1	**Collective contracting**	+	Mixed Waste	Few organizational capabilities	Industry-wide national collective take back systems only
2	**Individual contracting**	++	Mixed waste	Contracting capabilities, mixed waste	Limited brand take back systems
3	**Individual Recovery**	+++	Own Waste (+mixed waste)	Contracting and recovery management capabilities, own and mixed waste	Recovery programs for own products/ Recovery programs for own products alongside collective/ limited brand schemes
4	**Vertical integration**	++++	Own Waste (+mixed waste)	In-house recovery capabilities	Fully owned recovery facility/ Joint venture with treatment provider or competitor for recovery facility

Doing Nothing

The most prevalent option in many industries and regions of the world is not being involved in product recovery. The manufacturer produces a product and sells it through the distribution channel and has no involvement after the first end user has finished using the product. This does not mean that the product is not recycled; it simply means that the manufacturer is not involved. Although the manufacturer is not involved in take-back activities, it might assign someone to monitor the legal situation and report findings back to the company's headquarters.

Collective Contracting

The lowest level of manufacturer involvement entails very limited organizational capabilities. This type of involvement has been discussed in previous literature as "pooled take-back" and consortia. Manufacturers that only participate in industry-wide take-back initiatives and compliance schemes fall into this category.

This level of involvement was highly visible in the cases in the EU. Characteristically individual companies have very limited control over how the scheme is managed and

what happens to the products. The companies are not interested in higher levels of recovery and are typically involved only to comply with the legislation. The schemes that they participate in do not distinguish between different brands of products. Rather than distinguishing between product characteristics, in such schemes, manufacturers typically contribute to a share of the total costs of collection, treatment, and overhead, based on their market shares.

When there is extended producer responsibility legislation and a company adopts this level of involvement, a group of manufacturers usually sets up a producer responsibility organization (PRO) to manage contracts with collection and treatment service providers. In an extreme case, the consortium can cover a whole industry. In Belgium, for example, electronics manufacturers formed Recupel, which is a PRO that operates a country-wide collection and recycling scheme (Recupel, 2006). I

In an environment without applicable legislation, a similar level of involvement has manufacturers taking part in industry take-back events and promoting the recycling market. This level of involvement could be observed in the USA. Promoting the market in this context is geared toward raising awareness: the chief aim is to educate consumers about the need to recycle. Such initiatives can take various forms, such as organizing community collection events (Toffel, 2003). Or, companies can sponsor awareness campaigns. For example, in the USA, many TV manufacturers sponsor, the "plug-in to recycling"- campaign, a program that organizes collection events within specified cities or towns. These types of collection events typically collect all kinds of e-waste of mixed brands that are then sent to recycling centers.

Individual Contracting

The second level of manufacturer involvement is also characterized by low organizational capabilities and no tangible assets. As opposed to collective contracting, here *the company manages its end-of-life management contracts independently or with selected partners.* Outsourcing compliance independently requires a higher level of organizational capabilities, because the manufacturer has to evaluate different suppliers. As opposed to industry-wide schemes the company also has more control over what happens to the

products. Service providers collect and treat the products, but they are not treated separately by brand.

An example of this is the European Recycling Platform (ERP). ERP was established by Electrolux, Hewlett Packard, Braun and Sony to introduce competition to the recycling market (ERP, 2006). It manages collection and treatment for its members separately from national collective take-back systems. Another example would be a company that contracts with a fourth party service provider to manage its end-of-life products. In some EU countries, producers can contract their WEEE compliance needs to service providers individually. In Germany, for example, a producer can have a contract with a fourth party logistics service provider that deals with its WEEE compliance. TechProtect is an example of such a service provider. This organization coordinates other service providers to provide producers the capabilities needed to manage end-of-life products. This arrangement requires organizational capabilities in the sense that someone has to have the knowledge to manage the contracts established with the treatment providers.

Individual Recovery

The previous alternatives have all been limited to dealing with mixed waste, i.e. different companies' products. A higher level of involvement in terms of organizational capabilities would be *to treat, at least partly, the company's own products and take control over what happens to the products.* The reason for the word partly is that companies that take products back from customers typically end up taking other companies' products back too. A company with this level of involvement will have dedicated organizational capabilities, but no own recovery facilities. It will however work with service providers refurbish or remanufacture its products. As discussed before the products that the program deals with are products that the user has finished using and not for example warranty returns.

Companies that engage in this level of involvement may do so as part of their extended producer responsibility requirements or in addition to them.

Vertical Integration

At the extreme end, a company can invest in treatment facilities. In other words, the manufacturer is vertically integrated into end-of-life management. The Xerox Corporation is a famous example of vertical integration (Kerr and Ryan, 2001; Guide and Van Wassenhove, 2003). Xerox owns facilities that remanufacture its products that are returned from global leasing arrangements. Another example is Toyota which operates its own automobile shredding facility with its subsidiary Toyota Metals (Toyota, 2006). Another option is a joint venture with a service provider. Springfield Remanufacturing Corporation and John Deere have such an arrangement in the USA to remanufacture engines and engine components (John Deere, 2005). The company typically treats its own and some mixed products and has some component reuse, refurbishment or remanufacturing activities.

4.2. Manufacturer Involvement in End-of-Life Management in the EU

Manufacturer Involvement

There is a long history of voluntary end-of-life management operations in the EU. Six companies included in the study (BSH, Electrolux, Hewlett Packard, Motorola, Nokia, and Philips) had different take-back practices in place before extended producer legislation was passed. All companies in the EU have been involved in industry pilots to test different models for take-back since the mid 1990s. Some companies have also had programs where they took back their own branded, used products and refurbished them. Out of the companies included in this study Electrolux, Fujitsu-Siemens Computers, Hewlett Packard, and Motorola have had these recovery programs in the EU. Nokia has had a take-back system, without refurbishment, in place since 1999. Philips Consumer Electronics and Electrolux are no longer involved in refurbishment. Philips used to own a recycling plant that it used for learning about recycling electronics, but ultimately sold it because recycling is not their core competence. From 1999 to 2003, Electrolux took back and refurbished washing machines in Sweden.

In the EU, companies can be divided into four groups based on their current involvement in end-of-life management. Table 7 displays the cases according to their level of involvement.

Table 7 Manufacturer Involvement in EOL in the EU

EU	*Company Name*	*Product*	*HQ location*	*% Turnover EU*
Vertical Integration	Fujitsu-Siemens	PC B2B	Japan/EU	13%
Individual Recovery	Motorola	mobile phone	USA	13%
	Hewlett Packard	PC B2B	USA	39%
Individual Contracting	Electrolux	refrigerator	EU	45%
	Motorola	Network equipmer	USA	13%
	Nokia	mobile phone	EU	42%
	Nokia Networks	Network equipmer	EU	42%
	Samsung	TV	Korea	21%
	Samsung	mobile phone	Korea	21%
	Fujitsu	PC B2C	Japan	13%
	Hewlett Packard	PC B2C	USA	39%
Collective Contracting	Huawei	Network equipmer	China	NA
	Alpha Computers	PC	Taiwan	53%
	Whirlpool	refrigerator	USA	20%
	NEC	PC B2B	Japan	NA
	NEC	PC B2C	Japan	NA
	Philips	TV	EU	42%
	Hitachi	TV	Japan	5%
	Bosch und Siemens H	refrigerator	EU	85%

Scaling
4= "Vertical Integration" Strong organizational capabilities, own branded products also
3 = "Individual Recovery" Good organizational capabilities, own branded products also
2 = "Individual Contracting" Some organizational capabilities, mixed products, limited brand schemes
1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Only one company that participated in the study, Fujitsu-Siemens Computers, is *vertically integrated* into end-of-life management in the EU. Fujitsu-Siemens has a manager running the operations and a team of people working on the process part-time. Its recycling and remanufacturing operation in Germany dates from 1987 and comes from the Siemens side of the joint venture. Its reasons for choosing this strategy for its B2B products are the image considerations and the profitability of the operations. However, Fujitsu-Siemens Computers' B2C PCs are managed through national collective take-back systems.

Hewlett Packard offers asset recovery and leasing services for its B2B customers. It has been offering these services in the EU since the 1990s. Motorola is currently involved in a joint initiative with Recellular, where they collect Motorola's own branded used phones, refurbish them, and sell them in different markets. So far the volumes collected through this effort have been very low. Motorola is involved in these activities alongside its WEEE compliance, which consists of participating in national collective take-back systems in all the member states.

A large number of the cases fall into the group of individual contracting. They participate in limited brand schemes or they have their own contracts for end-of-life management. In some cases they have these alongside membership in national collective take-back systems. They only deal with mixed waste and are not involved in refurbishing and remanufacturing products.

Electrolux, Hewlett Packard, and Samsung employ a joint scheme, together with a few other companies, to comply with the WEEE Directive, which is called the European Recycling Platform (ERP). ERP operates in competition with the national compliance schemes in eight EU countries (ERP, 2006). The reasons for setting up ERP were increasing competition within the recycling industry, with the ultimate objective of decreasing costs. ERP deals with mixed waste allocated based on its members' market shares. Electrolux and HP belong to ERP because they believe in individual producer responsibility and that they can get lower prices through competing compliance schemes.

Nokia has take-back initiatives alongside its membership in national collective take-back schemes. Nokia has been collecting phones through its service network in the EU since 1999. The phones collected through the network go to third party service providers for recycling. The phones are mixed brands and Nokia is not involved in higher levels of recovery. Nokia is still looking into ways for integrating this practice with its other compliance activities.

NEC and Nokia Networks also have developed organizational capabilities in the EU to manage EOL management. They both mostly sell B2B products and interviewees from these organizations mentioned the difficulties of finding compliance schemes that would take care of their compliance requirements. Often national collective take-back systems only cater to B2C products.

Huawei and Alpha Computers have also contracted the handling of their share of mixed waste to service providers, but they have not developed organizational capabilities in the EU. Moreover, they do not use national collective take-back systems in all markets be-

cause they perceive the costs to be lower through outsourcing collection and treatment separately. They each have one person dealing with the WEEE Directive part-time, while performing other responsibilities. Both companies are new to dealing with end-of-life management and have not been involved in voluntary initiatives.

The next group of companies solely uses national collective compliance schemes to comply with the WEEE Directive. The companies belonging to it are BSH, Hitachi, Philips and Whirlpool. They have some personnel monitoring compliance requirements and participating in the schemes, but they have mostly outsourced end-of-life management.

Analysis

Grouping by organizational capabilities, most multinational companies have similar levels of involvement in end-of-life management in the EU. There is not much vertical integration into end-of-life management in the EU and companies are not very involved in taking their own products back. Fujitsu-Siemens was the only one that owned treatment facilities whereas Hewlett Packard (B2B) and Motorola have some refurbishment activities. The companies that participated in this study were not interested in investing in tangible assets in the EU.

Extended Producer Responsibility Legislation

As discussed in Section 2.3.1, the basis for the extended producer responsibility legislation in the EU is the WEEE Directive. The Directive's ambiguous wording resulted in many differences at the member state level. Where B2C products are concerned, the national transpositions of the WEEE Directive make companies responsible for a share of mixed waste proportional to their market share.

Table 8 shows the manufacturers' level of involvement before the WEEE Directive came into force in 2003, and after it was supposed to be implemented in 2005. However, to properly assess its effects would require going back further in time, as the first versions were published in 2000.

Table 8 Manufacturer Involvement in EOL before and after EPR in the EU

Case	EU before 2003	EU after 2005
Hitachi	0	1
NEC B2B		
NEC B2C		
Fujitsu (-Siemens) B2C		
Huawei		2
Whirlpool	1	1
Alpha Computers		2
Hewlett Packard B2C		
Samsung (TV)		
Samsung (handset)		
Motorola		3
Bosch und Siemens H	2	1
Motorola (net)		2
Nokia		
Nokia (net)		
Hewlett Packard B2B	3	3
Philips	4	1
Electrolux		2
Fujitsu (-Siemens) B2B		4

Scaling
4= "Vertical Integration" Strong organizational capabilities, own branded products also
3 = "Individual Recovery" Good organizational capabilities, own branded products also
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1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Table 8 shows that manufacturers are more involved in end-of-life management now than they were prior to the WEEE Directive. Most of the companies fall into the category of either not being involved at all before the Directive, or being involved in national collective take-back systems in some countries, but not having organizational capabilities dedicated to end-of-life management.

If we look at the main impacts on the companies involved, they were having a take-back system that covers the EU in place and organizational capabilities to deal with WEEE. The complexity resulting from complying with 25 different member state laws is a key factor that has led to an increase in the number of people companies have hired to manage compliance with the WEEE Directive. However, although many companies have teams of people dealing with the WEEE Directive, managerial processes such as performance measurement are still lacking. Most interviewees had no responses when they

were asked about performance measures for end-of-life management. Two companies (Whirlpool and BSH) responded that they had not set any performance measures, primarily because the national compliance schemes that they belong to take care of it.

Six out of the thirteen companies interviewed had some measurements that they collected data on. A few interviewees said that they had some measurements, but they were unaware of their contents. Only one company said that the measurements they have in place are confidential (Motorola). Organizational resources were mentioned by most as the main investment made to comply with the WEEE Directive. NEC and Samsung also reported to have invested in new information systems to manage data requirements. Fujitsu-Siemens and Motorola said that they had made necessary investments before the Directive, and Huawei and Whirlpool said that they had not made any investments.

For a few companies the key impact of the WEEE Directive was having a system to take care of B2C end-of-life products. Hitachi, Fujitsu-Siemens, and Hewlett Packard had well established systems and organizational capabilities in place for their B2B products prior to 2003, but nothing for their B2C products. Samsung, Motorola, and NEC had ad hoc solutions for their B2B products.

One of the main objectives of the WEEE Directive was to promote reuse and design for recovery in the EU. None of the companies interviewed perceived the WEEE Directive to have implications for their product design (apart from labeling). In fact, when asked about the main ways in which the WEEE Directive has impacted the supply chain, a few interviewees claimed that the WEEE Directive has nothing to do with the supply chain or product design. Moreover, in most of the companies, the interviewees in charge of end-of-life management said that they are unable to answer any questions about eco design as it is handled by a different department. Some companies described the WEEE Directive as a tax that had nothing to do with higher levels of product recovery. This is not surprising as companies are allocated costs based on their market shares and not on attributes of their products.

Why are companies not investing in their own facilities or more sophisticated capabilities like product life extension? An explanation that came from the interviews is that they are unable to benefit from improvements that they make in design for recovery and voluntary take back programs. Instead they pay for mixed waste according to their market shares. Recovering mixed waste can only result in recovering the material value of the products. If the waste stream includes only one brand of products, the material value can be higher and in some cases, components can be recovered from the products. In most EU countries, companies are not able to deduct the amounts that they collect through their own take-back systems from their WEEE compliance quotas. Germany is the only EU country that allows this directly (Perchards, 2006). Four countries allow it provided that the producer sets up a nation-wide collection infrastructure. In some countries national collective schemes allow this for selected product categories, typically information technology products (i.e. in Sweden and Switzerland).

Another related point that arose from the interviews was that member state legislations favor national collective take-back systems to individual compliance. If a company wants to contract its compliance needs to another service provider instead of the national collective take-back system it has to pay more administrative costs and it has to provide financial guarantees. Members of national collective take back systems are exempt from providing financial guarantees in most EU countries. Only France, Germany, Italy and Sweden require financial guarantees from collective compliers too (Van Rossem et al., 2006). The infeasibility of individual systems resulting from this was a frequently quoted reason for not developing any more advanced systems for dealing with end-of-life products.

The issue for most companies is not that they would want to set up their own compliance schemes, but rather that they want to benefit from their efforts in design for recovery and product life extension. This could be achieved by differentiating costs within the national collective take-back systems based on design improvements and programs that manufacturers have in place for extending their products' lives.

Other Regional Factors

Another explanation for the relatively high levels of involvement in the EU, even prior to the WEEE Directive, mentioned by the interviewees is that EU citizens hold environmental protection in high regard. According to a recent study by Eurobarometer (2005) consumers perceive environmental factors (72%) to influence the quality of life as much as social factors (72%), whereas economic factors are perceived as slightly more important (78%). EU citizens support environmental policies. According to the Eurobarometer (2005) survey, 90% believe that policy makers should take the environment into account more when developing policy in areas such as economy and employment. 72% of Europeans claim that they would be willing to sort waste. Although the general level of consumer environmental awareness is high in the EU, there are some regional differences. Apart from Italy, the majority of people in all member states indicate that they often or sometimes make efforts to protect the environment (Eurobarometer, 2005). These types of surveys provide some insight into consumer attitudes, but the risk for social desirability bias is high.

Although the manufacturers had teams of employees dealing with the WEEE Directive, not many are involved in treating their own products and or investing in tangible assets. Another explanation as to why they have not invested in tangible assets could be the existence of a recycling infrastructure. Plenty of third party recyclers take care of the products without involvement from manufacturers. Manufacturers did not see the need to invest into tangible assets, because there are third parties that take care of this independently. According to Eurostat (2005) 33% of municipal waste is recycled.

An interesting observation related to markets for recovered products were the reasons stated by the telecommunications interviewees for their lack of involvement in higher levels of recovery in the EU. Both Nokia and Motorola said that they have limited access to sufficient volumes of products. Consumers do not return cell phones to collection points; they prefer to keep them in their drawers. Moreover, they claim that third parties are able to buy the returned products from operators and refurbish them at lower costs due to lower quality requirements.

4.3. Manufacturer Involvement in End-of-Life Management in the USA

Manufacturer Involvement

Overall, few manufacturers are involved in end-of-life management in the USA. In fact, most companies are not involved in any operations and do not have any organizational capabilities there. The companies are grouped in the Table 9 according to their levels of involvement in end-of-life management operations in the USA.

Table 9 Manufacturer Involvement in EOL in the USA

EOL in the USA	*Company Name*	*Product in Focus*	*HQ location*	*% Turnover from USA*
Vertical Integration	Hewlett Packard	PC B2B & B2C	USA	40%
Individual Recovery	Motorola	mobile phone	USA	47%
Individual Contracting	Nokia Networks	Network equipment	EU	8%
	Motorola (net)	Network equipment	USA	47%
	Nokia	mobile phone	EU	8%
Collective Contracting	Philips	TV	EU	26%
	Samsung	TV	Korea	23%
No Operations	Bosch und Siemens H	refrigerator	EU	6%
	Electrolux	refrigerator	EU	40%
	Hitachi	TV	Japan	9%
	Huawei	Network equipment	China	-
	Whirlpool	refrigerator	USA	67%
	Alpha Computers	PC B2C	Taiwan	11%
	Fujitsu	PC B2B & B2C	Japan	7%
	NEC	PC B2C &B2B	Japan	-
	Samsung	mobile phone	Korea	23%

Scaling
4= "Vertical Integration" Strong organizational capabilities, own branded products also
3 = "Individual Recovery" Good organizational capabilities, own branded products also
2 = "Individual Contracting" Some organizational capabilities, mixed products, limited brand schemes
1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Three companies included in this study (Hewlett Packard, Nokia, and Motorola) have developed organizational capabilities to deal with end-of-life management in the USA, and they are actively involved in taking products back. Out of these companies, Hewlett Packard (HP) is the most heavily involved and has been involved for the longest time. HP has a recovery facility, jointly owned with a mining company and it has been involved in take-back in the USA since 1987. HP is also very involved from an organizational perspective. It has a dedicated team and a full-time manager taking care of recycling. Separate teams manage higher levels of product recovery and recycling.

Motorola and Nokia have individual contracts with service providers in the USA to take care of their end-of-life products. Motorola has some dedicated organizational capabilities in the USA whereas Nokia's environmental managers manage end-of-life management as a part of their jobs. Motorola's program covers the whole country whereas Nokia has collection bins in service centers in some states. Nokia's and Motorola's programs also differ with respect to the extent of reuse. Motorola has contracts with refurbishers to refurbish and resell its products, whereas Nokia just recycles the products it collects. However, the volumes collected through these programs have been low. The secondhand market is very active in the USA. Many third party players buy used phones back from operators and refurbish them. On the network products side, Nokia has a global service package that includes take-back. Motorola also provides take-back services for network equipment when asked to do so.

Samsung and Philips have been involved in the USA Environmental Protection Agency's (EPA) "plug in to recycling programs", among other pilots. Samsung is still looking into a good way of being involved in take-back. Decisions in this area are made at corporate headquarters, but these organizations have some staff monitoring developments locally.

Out of the companies that did not have take-back systems in place, four companies had some personnel monitoring issues related to end-of-life management. Whirlpool, Electrolux and BSH have personnel that monitors legislative developments as a part of their job. The main reason for not having a system in place is that there is currently no requirement to be involved.

Analysis

Table 9 shows that very few manufacturers have developed organizational capabilities or invested in tangible assets for end-of-life management in the USA. Interestingly, even companies that had vertically integrated into product recovery in other regions (NEC, Samsung, Fujitsu-Siemens) did not have personnel that manage EOL in the USA.

Extended Producer Responsibility Legislation

One explanation for the lack of manufacturer involvement in EOL in the USA could be the lack of legislation. As discussed earlier, there is no legislation in the USA that compels manufacturers to be involved in end-of-life management. In the USA, individual states can develop their own legislation regarding waste. As discussed in more depth in Section 1.2, eleven states have drafted some kind of producer responsibility legislation and four states have passed it. Compared to Japan and the EU, these legislations put very little pressure on companies to be involved in the collection and treatment of their waste. In fact, in California the manufacturers are not involved at all. The EPR legislations target TVs and monitors with cathode ray tubes in the USA.

In the USA, as in the EU, complying with the legislation is complex, because all the states are allowed to develop their own regulations. However, many companies were skeptical of a federal level bill being passed and opted to handle EOL management from their headquarters outside the USA. So far, EPR initiatives have not been very successful in putting pressure on manufacturers in the USA. Extended producer responsibility efforts have failed in the United States, with most players pushing for policies where the burden is mostly on local authorities (Sheehan and Spiegelmann, 2005). A possible explanation could be the cultural differences between the EU and the USA. Culturally there is a difference between the USA and the European attitudes to public sector policies. In the USA, public sector interventions are less accepted (Schwartz, 1992; Lodge, 1990; Lifset, 1993). In contrast according to a recent survey (Eurobarometer, 2006), 90% of EU citizens feel that the EU should make more environmental policies.

Other Regional Factors

Another regional factor for the lack of involvement from the manufacturers' side could be that some products are recycled profitably without the manufacturers' involvement. Interviewees (e.g., Whirlpool and BSH USA) claim that white goods are recycled at a profit. Consumers do not pay fees to have their white goods collected and this treatment is not subsidized through tax funds. 3.6 million tons of white goods waste was in generated in the USA in 2005, of this amount 2.4 million tons of steel was recovered through recycling, leading to an estimated 67% recycling rate (US EPA, 2005). This can be com-

pared to the 80% recovery target by weight in the WEEE Directive for large household appliances (EU, 2003) and 50% in Japan (Perchards, 2005). According to the International Association of Electronics Recyclers the revenues of the electronics recycling industry amounted to 1.5 billion USD in 2005 (IAER, 2005). The recycling rate of municipal solid waste in the USA was almost as high as in the EU in 2005, 32.1% in the USA in 2005 (US EPA, 2005) compared to 33.9% in the EU in 2003 (Eurostat, 2005).[7] In such a case, legislators and other stakeholders may put less pressure on manufacturers to get involved.

4.4. Manufacturer Involvement in End-of-Life Management in Japan

Manufacturer Involvement

Out the regions included in this study, manufacturer investments in recovery capabilities are the highest in Japan. However, the analysis of involvement in Japan is lacking due to the limited amount of interviewees. The Non-Japanese companies did not have any managers focused on end-of-life management in Japan. Table 10 displays the level of manufacturer involvement in EOL management in Japan.

Table 10 Manufacturer Involvement in EOL in Japan

EOL in Japan	*Company Name*	*Product*	*HQ location*	*%turnover Japan*	*%turnover Asia*
Vertical integration	Hitachi	TV	Japan	73%	84%
	Fujitsu	PC B2B & B2C	Japan	70%	80%
	NEC	PC B2B & B2C	Japan	78%	NA
Individual Recovery	Hewlett Packard	PC B2B	USA	4%	15%
Individual Contracting	Nokia Networks	Network equipment	EU	NA	26%
	Motorola (net)	Network equipment	USA	7%	19%
	Nokia	mobile phone	EU	NA	26%
	Motorola	mobile phone	USA	7%	19%
	Alpha Computers	PC	Taiwan	NA	20%
	Hewlett Packard	PC B2C	USA	4%	15%
Collective Contracting	Samsung	TV	Korea	NA	54%
	Electrolux	refrigerator	EU	NA	4%
No operations	Bosch und Siemens H	refrigerator	EU	NA	5%
	Huawei	Network equipment	China	NA	60%
	Philips	TV	EU	NA	26%
	Samsung	mobile phone	Korea	NA	54%
	Whirlpool	refrigerator	USA	NA	4%

[7] It should be noted that these figures are not necessarily completely comparable as different countries include different products in municipal waste.

Scaling
4= "Vertical Integration" Strong organizational capabilities, own branded products also
3 = "Individual Recovery" Good organizational capabilities, own branded products also
2 = "Individual Contracting" Some organizational capabilities, mixed products, limited brand schemes
1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Three companies have their own recycling facilities in Japan: NEC, Fujitsu, and Hitachi. Fujitsu set up its facility and nation-wide recovery network the earliest, in 1995 and 1998 respectively. This service dealt with B2B products. Since 2003 Fujitsu has been treating B2C products as well. Hitachi's facility was set up in 1999 as a response to legislation under development. It was opened first as a testing plant for the recycling of home appliances. Hitachi belongs to Group B, which is known as the more innovative amongst the two compliance schemes. Major companies in both groups own their own recycling facilities. However, only companies belonging to Group B use them to recover materials from their own products. Moreover Group A uses existing third party recyclers to a large extent. Hitachi uses the materials recovered in its own facilities in its washing machines and refrigerators.

NEC has been offering cradle-to-cradle services for its B2B products since 1969. Apart from its activities in recycling PCs, NEC has been offering a refurbishment service to consumers. It buys used PCs that meet quality criteria back from consumers and then refurbishes these products at its own facilities. NEC claims to refurbish and resell used consumer PCs at a profit. The Japanese companies have all implemented environmental accounting and use it for performance measurement in end-of-life management.

Apart from the Japanese companies, Hewlett Packard offers recovery services for its B2B products. As in other regions of the world it takes these products back and refurbishes them when possible. Another group of companies contract their end-of-life management activities to service providers but are not involved in higher levels of recovery. For Alpha Computers and HP for B2C products this is driven by legislation. Motorola and Nokia have collection bins in their service centers in Japan. However, end-of-life management of handsets is mostly taken care of by operators there. Finally, Samsung and Electrolux belong to Group A, but have not developed organizational capabilities or invested in tangible assets in Japan.

Analysis

Out of the regions analyzed, end-of-life management is the most sophisticated in Japan. Three companies have their own recovery facilities where they recover materials for use in new products. Fujitsu, NEC and Hewlett Packard are involved in higher levels of recovery for their used products.

Extended Producer Responsibility Legislation

Japan was one of the first countries in the world to pass extended producer responsibility legislation for electronics products. Environmental regulations are strict, well enforced, and based on strong monitoring capabilities in Japan (OECD, 2002). This naturally offers some explanation for the level of sophistication in Japan. The Japanese legislation does not force companies to have their own recycling plants, but major manufacturers made an agreement with the government to invest in facilities. One difference in comparison to the EU is that in Japan products are sorted by brand. When products are sorted by brand companies can learn from their used products and in some cases recover components from them. This was cited as a key issue in the interviews of this study, and those in Tojo (2004) and DTI (2005). Another issue is that reuse is counted towards the recovery targets. Individual manufacturers can benefit from their refurbishment programs.

Interestingly, it is only the Japanese companies that are so heavily involved. Most, other companies have outsourced their activities almost completely. A reason given by an interviewee from Samsung was that the Japanese legislation requires very limited involvement from them. Costs are covered directly by consumers. Japanese EPR legislation differs largely from that in the EU (e.g., consumers have to pay back-end fees (fees upon disposal) for TVs, refrigerators, air conditioners, and washing machines). In Europe, costs are currently covered by front-end fees. For PCs, the manufacturers have to internalize costs in Japan. However, this could also be due to the western companies interviewed generating very low percentages of their sales from Japan.

Other Regional Factors

Waste reduction and recovery activities are motivated by the lack of landfill space. The Japanese ministry of economy and trade estimated in 2003 that there is 12.1 years of

landfill space left for general waste (METI, 2003). The figures obtained by DTI (2005) suggest that the situation is even more alarming; their figures suggest that Japanese landfill space will run out in 2008.

High levels of consumer awareness may be a driving force behind the development of these capabilities. Interviewees in Europe claimed that Japanese companies have an advantage through wider public acceptance of environmental issues. In any case Japanese consumers are very aware of environmental issues (Karan, 2005; Pew Research Centre, 2006; DTI, 2005). This may provide a societal incentive for manufacturers to be involved on higher levels. According to a recent survey by the Pew Research Center, Japanese consumers are the most concerned about global warming (Pew Research Center, 2006). About 90% reported to be a fair amount or a great deal concerned about global warming compared to about 50% of consumers from the USA. The survey did not measure consumer willingness to sort waste.

4.5. Manufacturer Involvement in End-of-Life Management in China

Manufacturer Involvement

Very few out of the companies interviewed for this study were involved in end-of-life management operations in China. Table 11 below displays the levels of involvement.

Table 11 Manufacturer Involvement in EOL in China

EOL in China	*Company Name*	*Product*	*HQ location*	*%turnover China*	*%turnover Asia*
Individual Recovery	Hewlett Packard	PC B2B	USA	NA	15%
Individual Contracting	Nokia	mobile phone	EU	11%	26%
	Nokia Networks	Network equipment	EU	11%	26%
	Motorola	mobile phone	USA	9%	19%
	Motorola (net)	Network equipment	USA	9%	19%
No operations	Bosch und Siemens H	refrigerator	EU	5%	5%
	Huawei	Network equipment	China	NA	60%
	Philips	TV	EU	NA	26%
	Whirlpool	refrigerator	USA	NA	4%
	Hewlett Packard	PC B2C	USA	NA	15%
	Electrolux	refrigerator	EU	NA	4%
	Alpha Computers	PC	Taiwan	NA	20%
	Hitachi	TV	Japan	NA	84%
	Samsung	TV	Korea	NA	54%
	Fujitsu	PC B2B&B2C	Japan	NA	80%
	NEC	PC B2B&B2C	Japan	NA	NA
	Samsung (mobile phone)	mobile phone	Korea	NA	54%

Scaling
4= "Vertical Integration" Strong organizational capabilities, own branded products also
3 = "Individual Recovery" Good organizational capabilities, own branded products also
2 = "Individual Contracting" Some organizational capabilities, mixed products, limited brand schemes
1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Three of the manufacturers included in this study have been active in take-back operations in China: Nokia since 2002, Motorola since 2004, and HP since 2003, with its planet partners program. Nokia and HP have some organizational capabilities within China, whereas Motorola coordinates its efforts from Singapore. On the consumer side, Nokia and Motorola collect batteries and used handsets through their service networks. The low volumes that get collected are sent to contracted recyclers (Nokia, for example, has collected one metric ton of used handsets and batteries in China since 2002). HP offers its global B2B take-back and refurbishment services in China, but is not involved in the end-of-life management of its B2C products in the region.

In addition to the three companies with EOL management activities in China, BSH and Huawei have some personnel monitoring and taking part in the development of legislation in the area. The rest of the companies included in this study are not involved in end-of-life management in China.

Analysis

Extended Producer Responsibility Legislation

As discussed in Section 1.2, China has drafted EPR legislation for electronics, but most details are still undefined. When the interviewees were asked about the impacts of extended producer responsibility legislation on their operations, many were skeptical about the legislation being passed. Interviewees were also skeptical about the legislation applying to local companies as stringently as it does to foreign companies.

If we look at the regions included in this study, China differs from an environmental management perspective from Japan, the USA, and the EU. China has passed over 20 laws related to environmental protection in the last ten years; however, among other reasons, it has considerable troubles enforcing them due to a weak management system and low awareness on the part of operational managers (Child and Tsai, 2005). Chinese state-owned companies do not follow environmental legislation and political constituencies fail

to press for improved environmental behavior (Liu et al., 2004; Child and Tsai, 2005). Public Sector interviewees in a survey by Child and Tsai (2005) admitted to not enforcing environmental regulations on local companies, for competitiveness reasons. According to Tong et al (2005), the incentives for China to adopt EPR in e-waste management are quite different from those in developed countries. The domestic policy is more a response to perceived green trade barriers erected by EU on Chinese exports.

Other Regional Factors

The interviews also raised lack of access to waste and consumer awareness as issues that impact their levels and ways of involvement in China.

Both Motorola and Nokia stated that their programs are geared toward raising awareness and building an infrastructure, more than taking products back cost effectively. One of the issues discussed by the interviewees was the difficulty of getting products back. The average level of income is still low compared to the price of new goods. Most consumers cannot afford to buy new products. The markets for used products are very active in China. Products get passed down from relative to relative until they are no longer usable.

China does not have a functional collection and recovery infrastructure. Everything has to be built from scratch. Building a recovery infrastructure is expensive and it typically requires large-scale collaborative efforts between industry and local governments. This naturally changes the nature of end-of-life management. The situation is exacerbated by low consumer awareness about the need to separate e-waste. A considerable amount of the funding for end-of-life management goes into education about environmental issues.

Levels of environmental awareness in China are considered to be very low (UNDP, 2006). Chinese consumers ranked low in a recent study on awareness about global warming (Pew Research Center, 2006). Low consumer awareness also offers an explanation to why there are not many business to business recovery services either. Most Chinese managers have not had any education about environmental issues and do not demand them from their suppliers (Shi et al., 2003). A recent study by Huang et al (2006) however indicates that the situation is improving in the industrialized areas of China and consumers

are increasingly willing to recognize that they have a responsibility toward the environment.

Despite the skepticism for its environmental management, China has proceeded to test extended producer responsibility in two provinces. The main problems that both systems ran into were the lack of end-of-life products and negative attitudes from producers on accepting the costs of treating their end-of-life equipment. Convincing Chinese industry of the benefits of environmental activities was cited by Shi et al (2003) as one of the main challenges in China. However, Shi et al (2003) claim that the concepts of closed-loop economies are more readily accepted by industry than other environmental measures because they integrate the ideas of economic growth and environmental protection.

4.6. Key Findings from Regional Analysis

This chapter analyzed the cases according to their level of involvement in the different regions and presented a categorization for manufacturer involvement in end-of-life management. The purpose of the chapter was to use the case data to identify factors that explain companies' differing level of involvement across the regions.

It was found that companies are the most frequently involved in end-of-life management in the EU, whereas they have the most tangible assets and sophisticated organizational capabilities in Japan. Most companies have low levels of involvement in the USA and China. In the USA, when companies do have involvement, it tends to be either low-level involvement in industry events or individual product recovery programs. In China, the companies that were involved did so in collaboration with their competitors.

Extended Producer Responsibility (EPR) legislation is the first, rather obvious regional factor that affects involvement in end-of-life management. The EU and Japan have passed EPR legislation, whereas most states in the USA and China only have drafts for it. Where it exists, legislation pushes companies toward at least a minimum level of EOL involvement. The key determining issue for its impact seems to be the possibilities it provides to companies to benefit from improvements in their practices and their products.

Evidence of this could be seen in observing how companies are involved in the EU compared to how they are involved in Japan. In the EU, only one company had tangible investments. Most of the companies fell into the level of involvement categorized by their having developed organizational capabilities but no tangible assets. Most companies with extensive operations in Japan had their own treatment facilities there. The information technology companies interviewed remanufactured their own products. For household appliances, some companies claim to reintegrate materials from used products into new products.

Comparing China with the EU, Japan, and the USA also suggests other factors. Rather than competing, manufacturers seem to be collaborating in China when it comes to end-of-life management. Collecting used products is virtually impossible, because products are used until the very end of their physical lives. Consumers pass products on to their relatives once they have finished using them. The level of income is low in China compared to the price of new goods. Consumer awareness about the need to recycle electronics products is also low. Due to the lack of access to waste, companies' recovery systems are geared more toward raising awareness than collecting used products profitably.

5. Within Sector Analysis

This chapter addresses the second research question of the study:

What company-specific factors impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?

This chapter compares the cases within their industry sub-sectors. Sections 5.1 to 5.5 identify differences in how companies in a given industry sector operate, factors that explain these differences and discuss how they explain these differences. Five products were included from four industry sectors: TVs from consumer electronics, PCs (B2B and B2C) from information technology, handsets and telecommunication equipment from telecommunications and refrigerators from white goods. Section 5.6 summarizes the results of the analysis. The case descriptions can be found in Appendixes 4-7. Consumer Electronics cases are described in Appendix 4, information technology cases are provided in Appendix 5, Telecommunications cases are presented in Appendix 6, and finally white goods cases are detailed in Appendix 7.

5.1. Consumer Electronics – TV

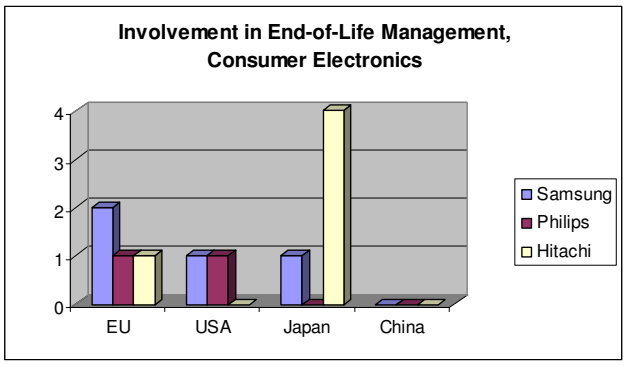
Fifteen companies have major sales in video products in the EU, USA, and Asia[8]. The consumer electronics business is characterized by a heavy presence of companies with their headquarters and manufacturing facilities in Asia-Pacific, with Japan accounting for the majority. Only five of the top twenty companies do not originate from that region. There are no manufacturers, based in the USA, that sell TVs globally (Euromonitor, 2004). The TV-producing companies interviewed from these top 20 companies include one Korean company, Samsung Electronics, one Japanese company, Hitachi, and one European company, Philips. Their turnovers range from Philips' $ 35 billion to Samsung Hitachi's $ 84 billion[9].

[8] Video products include Televisions, television combinations, video cassette recorders, DVD players, camcorders and digital cameras.

[9] Samsung's turnover is from 2004. No published figures were found for 2005.

Involvement in End-of-Life Management

Figure 4 shows the current level of involvement in product EOL management operations.



Scaling
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0= no activities

Figure 4 Involvement in End-of-Life Management, Consumer Electronics

Figure 4 shows some differences in the level of manufacturer involvement in end-of-life management of TVs, both on a global and regional level. None of the three companies interviewed is involved in take-back on a global basis for TVs[10]. All of their operations are focused on countries where companies have some legal responsibility to take care of waste. In principle, Philips has a global strategy, whereby it lobbies for collective take-back systems with visible fees in every country where legislation is being developed. For high-end LCD screens, Samsung has plans to develop global operations. Samsung and Philips have some staff in the EU, USA, and Asia, whereas Hitachi has none in the USA.

Higher Levels of Recovery

In the consumer electronics industry, end-of-life management is to a large extent focused on treating mixed waste. Of the three companies, Hitachi is the only one that treats its own products and this practice is limited to Japan. Hitachi and Philips do not see any possibilities in recovering and reusing TVs, whereas Samsung sees recovery possibilities for high-end LCD screens.

[10] Hitachi has take-back operations for its B2B products globally.

EU

There are some differences in the companies' WEEE Directive compliance operations. Philips and Hitachi have both joined national collective take-back systems in all markets, whereas Samsung has joined the ERP in markets where it operates. The European Recycling Platform is a pan European compliance scheme that was founded by Electrolux, Hewlett Packard, Sony, and Braun with the aim of bringing competition into the recycling market.

All EOL management operations in the EU deal with mixed waste and none of the companies has operations for dealing with their own branded equipment. Samsung sees individual producer responsibility as unrealistic at the moment, because of the lack of technology. Philips Consumer Electronics feels that individual producer responsibility does not make sense for its products because of product characteristics. Philips had a recycling facility in the Netherlands, but sold it to a recycler, as recycling is not their core competence. There are many third parties specialized in recycling, they can do it much more efficiently. Philips purportedly used the facility to learn about recycling. However, the company still retains a remanufacturing facility for medical equipment. Hitachi believes in individual producer responsibility, as it has already implemented it in Japan. However it sees that it is such a small player in this market that it is not necessary for it to have any separate end-of-life management systems.

USA

None of the consumer electronics companies is systematically involved in end-of-life management in the USA and, more specifically, none of them has programs in place to deal with their own branded products. Legislation has been passed in several states for management of waste TVs, but so far, the legislations do not require much involvement from manufacturers.

Samsung and Philips Consumer Electronics reported to be involved in industry-wide collection activities and pilots. An example of such a program where manufacturers sponsor local collection events is the United States Environmental Protection Agency's programs

called “plug in to recycling.” Samsung and Philips Consumer Electronics both have some employees working on end-of-life management issues as part of what they do, whereas Hitachi coordinates EOL management in the States from its headquarters in Japan. For Samsung and Philips, most of the decision making for end-of-life management in the USA takes place at the headquarters level.

Japan, China and other Asia

As discussed in the introduction chapter, TVs are targeted with EPR legislation in several Asian countries, including Japan, Taiwan, and South Korea. There are some differences between the companies’ levels of involvement in Asia. Samsung and Hitachi have their own treatment facilities in the countries where they are based, and Philips Consumer Electronics has some employees involved in monitoring and lobbying activities as part of their jobs. Philips Consumer Electronics is, however, not involved in take-back operations in Asia. Hitachi and Samsung set up their own recycling plants as a response to the respective local legislation in Japan and South Korea. To a large extent, Hitachi’s plant treats its own branded products, whereas Samsung’s plant treats mixed e-waste. Hitachi reclaims materials from its products and uses them in new products.

Analysis

The companies have some interesting differences in the locations of their tangible assets, the geographical reach of their involvement and their attitudes towards recovery.

Investments in Recovery Capabilities

Each company is the most involved in end-of-life management in the region where it is based. Each company has (or in Philips’ case has had) a recovery facility in the region where it is based, whereas these same companies have had no such assets in other countries. The companies were also all involved in EOL management in their respective countries before extended producer responsibility legislation was passed. This suggests that companies are more active in their country of origin than elsewhere. When asked for reasons for this, the Samsung interviewee responded that they know the market best in Korea. Similarly, the Hitachi interviewee explained their decision on Japan being the only market where they are a major player. The focus of all these facilities is to learn about

recycling rather than extend product lives or generate profits from recovery. Locating these facilities close to R&D could also explain the focus. The companies locate most of their R&D functions by their head quarters. Furthermore, in all three cases the companies worked with the governments to set up the facility and collection infrastructure. The companies appear to perceive themselves to be a more integral part of society in their country of origin as opposed to another country. When asked about the reasons for setting up the facility, according to Samsung they were requested to do so as there was no existing recycling infrastructure. This was echoed in the Japanese cases.

Global Reach of End-of-Life Management Activities

Philips and Samsung are more active in the USA than Hitachi. Philips and Samsung generate considerable amounts of their sales in the USA, whereas Hitachi is more focused on the Japanese and other Asian markets. Compared to Hitachi, TVs are a major product category for both Philips and Samsung, so if any related legislation is passed in the United States it will have an impact. As discussed in Section 1.2.3, some states have proposed extended producer responsibility for the end-of-life management of TVs.

Another difference in geographical reach is that Samsung and Hitachi have activities in Asia, whereas Philips does not. Both Samsung's and Hitachi's operations in Asia are, however, limited to the countries where they are based. Neither Philips nor Samsung are as heavily involved in take-back in Japan. Looking at the geographical spread of revenues offers some explanations (see Figure 5) Philips and Samsung are global, whereas Hitachi's sales are dominated by the Japanese market (77% of its turnover)[11].

[11] Rugman, A (2005) a company is considered global when at least 20% of its sales are generated in the EU, USA and Asia.

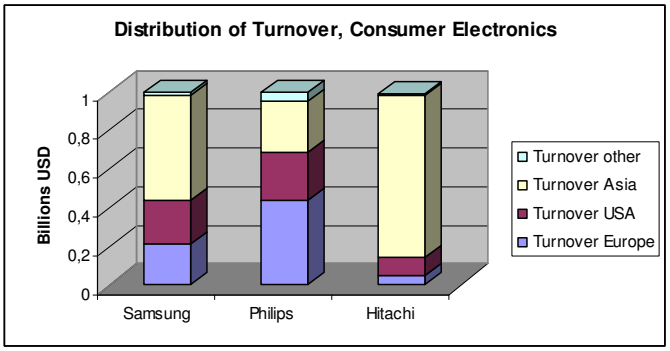

Figure 5 Distribution of Turnover, Consumer Electronics[12]

Product Recovery

What the companies appear to have in common is the low level of recovery. Interviewees stated that TVs are not treated on higher levels because they are used for such long durations of time by consumers. According to Philips, treating these products separately by brand does not make economic sense, because the differences in recovery costs of different brands are very small. The companies however differ in their responses toward individual producer responsibility and recovering TVs. Samsung sees the recovery of LCD screens as a possibility and supports IPR, whereas Philips Consumer Electronics does not.

One explanation that arose from an expert outside the study, was that Samsung has developed its LCD technology expertise in house, whereas Philips Consumer Electronics has bought into a partnership with LG to gain the expertise. Samsung is the world's largest manufacturer of LCD panels. It was one of the first companies to develop capabilities in LCD manufacturing (Euromonitor, 2004).

Differences in the companies' environmental backgrounds do not appear to offer explanation. Philips and Hitachi have a long history of being involved in environmental management. Both companies were already measuring the environmental impacts of their production processes as early as the 1970s. Philips and Hitachi are both included on a range of sustainability indexes. Philips was selected as the top player in the cyclical in-

[12] Separate figures for Japan and China unavailable for most companies

dustry in the Dow Jones Sustainability Index World two years in a row (2003-2004). All companies report to have the same environmental standards in use globally. The companies differ on their views on whether this leads to competitive differentiation. Philips and Hitachi do not see environmental performance leading to a competitive advantage currently. Philips said that environmental legislation has leveled out the playing field. It feels that enforcement of the legislation is tighter for big brand names like itself. Hitachi said that there might be some environmental differentiation in relation to low-end players, but between big companies there is none. Samsung stated that competitive differentiation from environmental activities is a strategic aim of the company and design for environment plays a key role in this.

5.2. Information Technology- PC

Four companies were included in this study: two Asian companies, NEC and Alpha Computers[13]; one European/Asian company, Fujitsu (-Siemens)[14]; and one company based in the USA, Hewlett Packard. HP holds the number two position globally for PCs. Alpha is one of the top ten companies. NEC and Fujitsu are top companies in Japan. Fujitsu-Siemens Computers, interviewed for the European perspective for Fujitsu, is a market leader in Germany.

Involvement in End-of-Life Management

The discussion on involvement in EOL management for PCs has been divided into two parts. The first part discusses the companies' involvement in end-of-life management for B2B products, whereas the second section focuses on B2C products.

Involvement in End-of-Life Management – B2B PCs

Figure 6 shows each company's level of involvement in EOL activities for B2B PCs. On a global level, there are considerable differences in what the four companies do. Hewlett Packard offers global EOL management services for its B2B computers. Alpha com-

[13] Company's name is disguised

[14] Fujitsu –Siemens, a 50-50 joint venture, was interviewed for the European part of the study.

puters, Fujitsu, and NEC are only involved in end-of-life management where legally required to be.

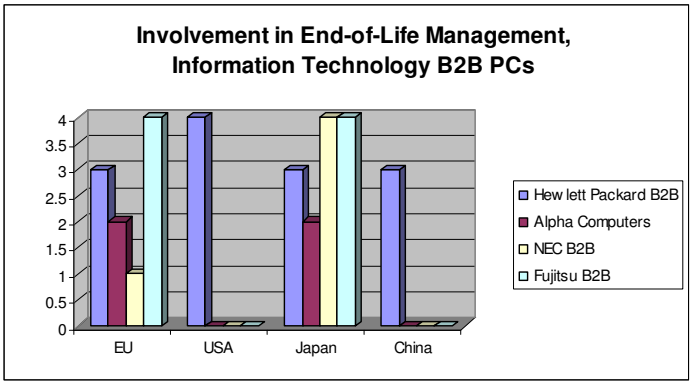

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Figure 6 Involvement in End-of-Life Management, Information Technology B2B PCs

Higher Levels of Recovery

With the exception of Alpha Computers, all of the companies have end-of-life management programs in place for their own branded products and treat them in their own facilities. All of the companies support individual producer responsibility.

EU

Fujitsu-Siemens Computers and Hewlett Packard have take-back programs in place for their own branded B2B products in the EU. Through these programs they offer value-added recovery to corporate customers. Fujitsu-Siemens has the highest level of involvement in end-of-life management in the EU. The company has had a recycling and remanufacturing facility for its B2B products since 1989 in Germany.

Unlike Fujitsu-Siemens, HP does not have tangible assets dedicated to end-of-life management in the EU. Hewlett Packard has contracted treatment of its end-of-life B2B products to service providers. It has been offering take-back and refurbishment services to its corporate customers since the 1990s. Alpha Computers tries to outsource end-of-life

management in the EU as much as possible to individually managed service providers. NEC participates in national collective compliance schemes.

USA

HP is the only company to have developed organizational capabilities to deal with end-of-life products in the USA. It has separate dedicated teams for value- added recovery and recycling. As for tangible assets, it has a joint venture with a mining company to own a recycling facility. Its recycling plant treats products from different manufacturers, but its refurbishment and remanufacturing activities are limited to its own branded products. None of the other companies have developed organizational capabilities for end-of-life management in the USA.

Japan, China and other Asia

NEC and Fujitsu are heavily involved in EOL management in Japan in terms of both organizational capabilities and tangible assets. They both have facilities that treat their branded B2B and B2C PCs. NEC remanufactures both B2B and B2C PCs that it purchases back from consumers. HP and Alpha have contracted their end-of-life management activities related to B2B and B2C PCs to service providers in Japan. They do not have tangible assets there. Furthermore, HP has organizational capabilities in Singapore, and Alpha Computers has some in Taiwan. Unlike the other three companies, HP offers end-of-life management services to its B2B customers all over Asia. NEC and Fujitsu are focused on Japan, whereas Alpha Computers is a part of the industry wide take-back initiative in Taiwan. HP is the only one of the companies that offers corporate customers end-of-life management services in China. It does not, however, have dedicated organizational capabilities there.

Involvement in End-of-Life Management – B2C Pcs

Figure 7 displays each company's level of involvement in EOL activities for B2C PCs.

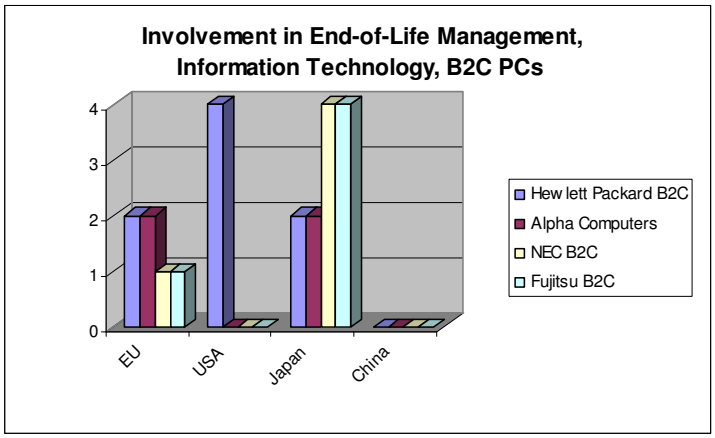

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Figure 7 Involvement in End-of-Life Management, Information Technology B2C PCs

Figures 6 and 7 suggest that the manufacturers are more involved in the end-of-life management of B2B than B2C PCs.

Higher Levels of Recovery

Apart from NEC's and Fujitsu's activities in Japan, each of the company's B2C end-of-life management efforts focus on mixed waste. One of the major differences to B2B is that B2C end-of-life management typically deals with mixed waste.

EU

None of the companies treat their own B2C PCs in the EU. They pay for a share of mixed B2C waste allocated to their compliance scheme based on their market share. None of the companies were independently involved in end-of-life management of B2C computers before the WEEE Directive was passed in 2003. However, all companies had taken part in some level of joint industry initiatives. Besides NEC, the companies use the services of Pan European service providers alongside national collective take-back systems. HP was involved in setting up a competing compliance scheme, the ERP, to comply with the WEEE Directive. NEC is only involved in national collective schemes.

USA

HP is the only company involved in end-of-life management of B2C PCs in the USA. It has a nationwide program in place where consumers can return their products to HP against a fee that is refunded if the consumer purchases something from them. HP has dedicated teams to deal with B2C end-of-life product returns in the USA and it is heavily involved in lobbying for individual producer responsibility there. HP does however not recover more than value from its B2C products.

Japan, China and other Asia

All four companies have EOL management operations in Japan for B2C PCs, as they are legally required to do so. Similarly to B2B products, NEC and Fujitsu each have plants that remanufacture and recycle their own branded B2C PCs. They purchase their old products back from consumers. NEC and Fujitsu started these operations as the EPR legislation was passed in 2003. Hewlett Packard and Alpha Computers are also involved in end-of-life management in Japan, but to a more limited extent. They do not have organizational capabilities or physical assets there. They outsource their activities to service providers.

Apart from HP's B2B programs, none of the companies reported to be involved in end-of-life management in China.

Analysis

There are big differences in an organization's regional involvement in EOL operations within the information technology sector.

End-of-Life Management for B2B and B2C Products

The information technology sector illustrates an interesting difference between a company's involvement in end-of-life management for B2B and B2C products. When the interviewees were asked about this they said that B2C products have no residing value in them. Consumers keep them longer than business users and dispose of them with municipal waste. Mixed brands end up in municipal waste and recovering value from it is im-

possible. This appears to mostly be a problem in the EU. In Japan and the USA, manufacturers are able to collect their own B2C products back.

Global Reach of End-of-Life Management Activities

HP has the most global reach, whereas the other three are only involved in regions where it is necessary. HP is also the most global of the four companies. If we look at the companies' sales distributions, we see that they generate different levels of sales in the countries. Figure 8 below shows that while HP and Alpha Computers have a relatively equal distribution of sales across the EU, the USA and Asia, NEC and Fujitsu are home-market based.

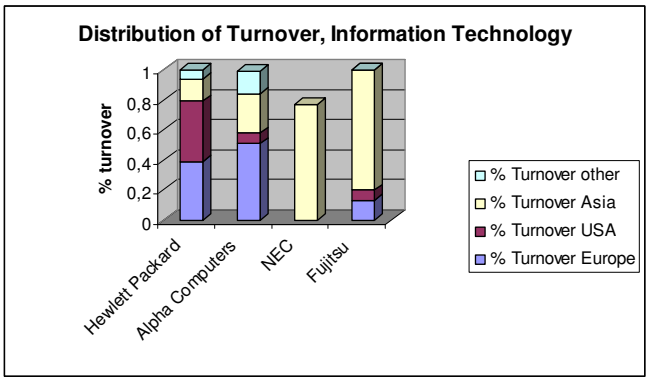


Figure 8 Distribution of Turnover, Information Technology[15]

NEC and Fujitsu, both home-market based, claimed that they are only involved in end-of-life management in the regions where they are big. Fujitsu-Siemens Computers' North American representatives said that end-of-life management is not really relevant to them as they are just a small sales organization.

Investments in Recovery Capabilities

Apart from Alpha Computers, the manufacturers echo the pattern found in the consumer electronics cases: Companies are the most involved in end-of-life management in the countries where they are from. In fact besides Alpha, all the companies have tangible assets related to EOL management in the regions where they are based. All the other com-

[15] Separate figures for Japan and China unavailable for most companies

panies are involved in some remanufacturing activities. NEC and Fujitsu have vertically integrated in Japan, Fujitsu-Siemens has a facility in Germany and HP has a joint venture in the USA. HP said that its facility is dedicated to learning about recycling; they are not actually in the business of recycling.

The four companies' product assortments also vary. Figure 9 displays the companies' product assortments according to the groups used in this study.

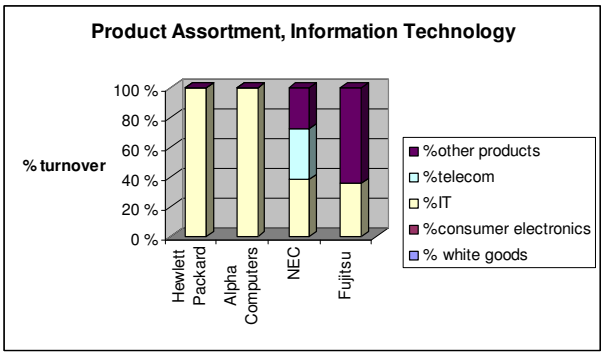


Figure 9 Product Assortment, Information Technology

HP and Alpha focus on IT products and services, whereas NEC and Fujitsu only generate 43% and 36% of their respective revenues from information technology products. Fujitsu generates a considerable percentage of its sales from consulting, software, and electronic devices. Apart from IT, NEC sells telecommunications equipment and electronic devices. Fujitsu (and Fujitsu-Siemens Computers) and NEC are very focused on B2B products. HP's products are mostly for dual use, and Alpha generates most of its sales on the B2C market. These companies all developed recovery capabilities to B2B products first and then went on to expand these to B2C products. It could be that Alpha has not developed these capabilities because it does not have a strong presence on the B2B market. Additionally, a clear difference between Alpha and the others is that Alpha does not manufacture products; it sells its own brand of products. This may explain why Alpha Computers differs from the others in the sense that it does not remanufacture products.

Another explaining factor may be the cultural environment regarding environmental aspects in Taiwan, where Alpha Computers is based. Alpha does not only differ from the others by product assortment, it also differs related to environmental background infor-

mation. Alpha Computers does not measure the environmental impacts of its production activities and it published its first environmental report in 2005. NEC, Fujitsu, and HP have long histories of involvement in environmental activities. Each of these corporations is included on the DJSI world sustainability index. Additionally, NEC and Fujitsu are also included on the FTSE Good index. HP and Fujitsu see environmental proactiveness as a source of competitive differentiation. They see their depth and length of involvement as differentiating factors. NEC was one of the first companies to consider reuse, but it feels that all the companies are more or less on the same level now, due to environmental regulations. NEC initiated eco-audits in 1973 and it published its first results in 1999. Fujitsu started measuring the environmental impacts of its activities in 1991 and it has been reporting results since 1996. Fujitsu and NEC have both implemented environmental accounting as a means to track the costs and benefits of their environmental activities. Greenpeace scored companies based on their end-of-life management and design for recovery operations in 2006. Based on their ranking, HP scores the highest (4.7) whereas Alpha Computers and Fujitsu-Siemens score considerably lower (2.3 and 3, respectively) (Greenpeace, 2006)[16].

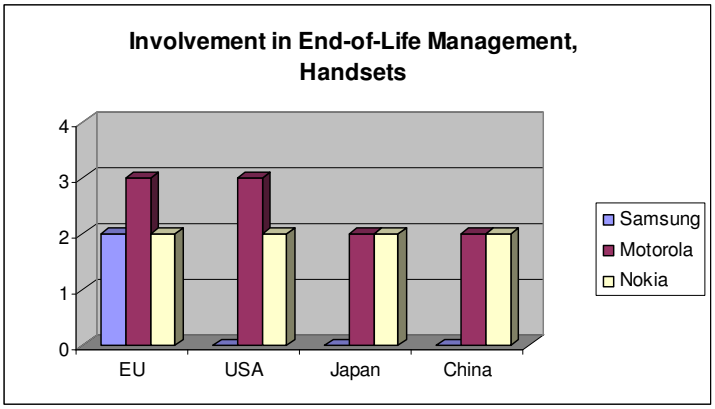
5.3. Telecommunications – Handsets

Three companies were included in the study for their EOL management operations with handsets: Nokia (EU), Motorola (USA), and Samsung Electronics (Korea). The Nokia and Motorola cases can be found in Appendix 6, whereas the Samsung case is in Appendix 4.

Involvement in End-of-Life Management

Figure 10 displays the companies' level of involvement in EOL management operations in the EU, USA, Japan, and China.

[16] NEC is not included in the Greenpeace study



Scaling
4= "Vertical Integration" Strong organizational capabilities, own branded products also
3 = "Individual Recovery" Good organizational capabilities, own branded products also
2 = "Individual Contracting" Some organizational capabilities, mixed products, limited brand schemes
1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Figure 10 Involvement in End-of-Life Management, Handsets

As can be seen in the figure above, there is a lot of manufacturer involvement in end-of-life management operations of handsets. Nokia and Motorola have take-back operations and some organizational capabilities in all over the world. Nokia was the earliest out of the three to start voluntary collection operations of its own on a global scale (since 1999 in most countries). Motorola collected goods in the States since the early 2000s and started expanding globally. Motorola launched most of its EOL operations in 2004 and 2005. Samsung set up its recycling facility in South Korea in 1998, but did not start EOL operations elsewhere until the WEEE Directive came to force.

Higher Levels of Recovery

All of the manufacturers' take-back programs accept products from all manufacturers for recycling. Motorola is the only one to collaborate with a third party to remanufacture its own branded products in the USA and in the EU. Nokia does not support reuse anywhere and Samsung does not practice it anywhere.

EU

In the EU, all three companies have similar levels of involvement. Nokia and Motorola run their own take-back systems alongside their WEEE compliance activities, in which they pay for their share of mixed waste and support the national collective take-back sys-

tems. Samsung belongs to the European Recycling Platform in the EU. Nokia collects phones for recycling through its service network, whereas Motorola has a collection program through the postal service in place in most EU countries and it collaborates with third party treatment providers to get the phones treated.

USA

In the USA, none of the companies owns recovery facilities dedicated to handset recovery. Motorola however has a facility to recover other products. Motorola and Nokia have some personnel there, whereas Samsung coordinates its efforts from headquarters, with some employees monitoring the situation. As for activities in the USA, Motorola is the only company with a countrywide collection scheme. It allows consumers to return phones of any make, free of charge, with prepaid envelopes. Motorola then collaborates with third party treatment providers to get Motorola-branded phones remanufactured. Nokia has also been involved in take-back initiatives in the USA, but its systems have been more local and geared toward raising awareness. Samsung is in the process of setting up a collection system in the USA for handsets.

Japan, China and other Asia

Samsung collects used phones through its network of service centers in South Korea, but it does not currently have take-back operations involving handsets in other Asian countries. Nokia and Motorola have some collection initiatives in place in Japan, China, Singapore, and Malaysia, among others. They have collection bins in their warranty service centers and they participate in various take-back events. Samsung has personnel dedicated to product EOL management in South Korea, whereas the other two organizations have some employees that take care of this activity as a part of their jobs. None of the companies are involved in reuse or refurbishment of the handsets in the Asia Pacific market.

Analysis

There are two interesting differences between the companies involved in end-of-life management operations in the handsets sector: global reach of the programs and their attitudes toward reuse.

Global Reach of End-of-Life Management Activities

All of the handset manufacturers are involved in end-of-life management globally. As can be seen in Figure 11, all three companies are relatively global in their sales too. Samsung is global and the other two organizations are bi-regional in their sales.

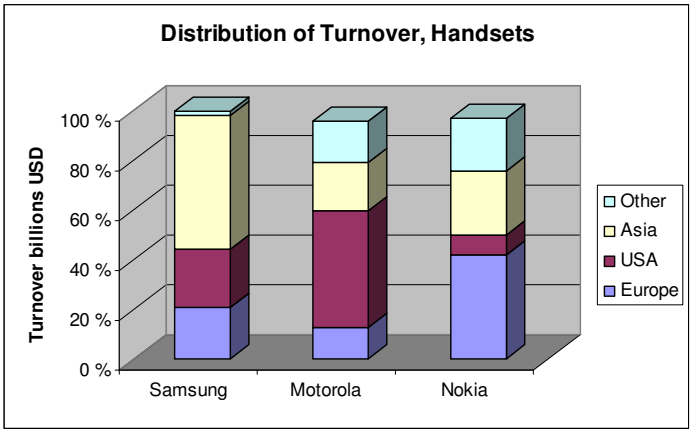


Figure 11 Distribution of Turnover, Handsets[17]

The companies are also all relatively proactive environmentally. All three companies have global environmental standards for their manufacturing activities. Motorola has some regional exceptions in material content for products that are made especially for a specific market, i.e., the United States defense industry and handsets made according to Japanese standards. Nokia and Motorola are both included on the Dow Jones Sustainability Index. Samsung started environmental measurements in 1992, whereas Nokia and Motorola started measuring their impacts in the late 1990s. All three companies see environmental issues as something that leads to a competitive differentiation. The main source of differentiation, according to Samsung and Motorola, is design for environment activities. Nokia considers reach of its environmental activities as a main source of differentiation.

Product Recovery

[17] Separate figures for Japan and China unavailable for most companies

An interesting difference between the companies is organizational attitude toward product recovery. Motorola is involved in the reuse of complete phones, whereas Samsung and Nokia are not.

This difference could also be explained through capabilities. Figure 12 compares the product assortments of the companies. Compared by product portfolio, Samsung is the most diversified and Nokia the most focused. Samsung has sales in all the product categories included in this study.[18] Telecommunication accounts for about 33 % of its sales. Samsung generates a considerable amount of its sales (31%) from electronic devices such as semi-conductors. For Motorola, the "others" category is comprised of embedded electronics solutions for the automobile and defense industries. Samsung has high sales to the B2B sector too, but in components, not products for professional use. Samsung is not currently involved in remanufacturing for any products.

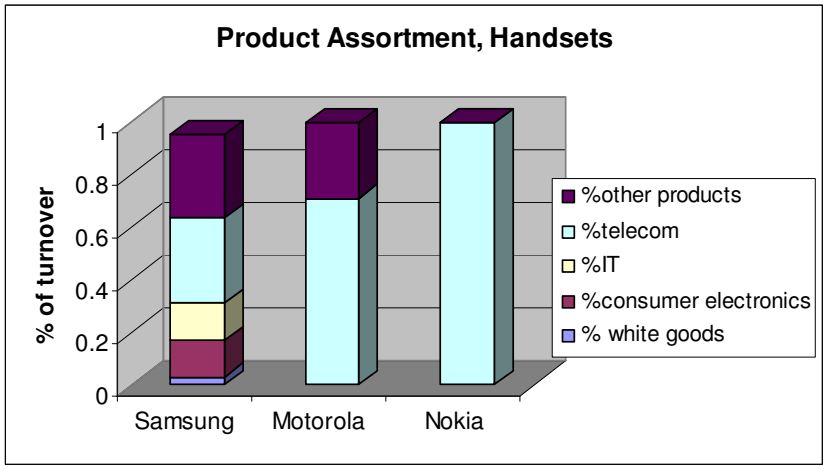


Figure 12 Product Assortment, Handsets

Out of the three companies, Motorola has the most experience in remanufacturing, generating about 30 % of its sales from professional equipment for which it has remanufacturing programs at its own facility in the USA. Having these capabilities in-house may have helped it develop these capabilities for handsets too.

[18] Consumer electronics and IT reported in the same product division as 28.9% of turnover. Here divided into two.

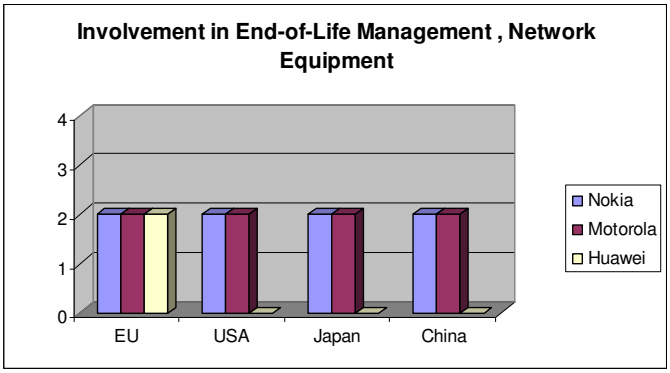
Here another possible explanation, which arose from the interviews, is different images on the consumer market. Nokia, on the other hand, stated that selling second-hand phones of inferior quality might hurt its brand image. Samsung also stated that selling the idea of offering recovered handsets to its designers was not successful. Nokia and Samsung are traditionally known as brands that produce fashionable products, whereas, until lately, Motorola has focused more on the functionalities of the products. Motorola now collaborates with the Dolce & Gabbana Fashion house and launched the "razor" phone as a fashion item.

5.4. Telecommunications – Network Equipment

The major players in the global telecommunications network business are Nokia, Motorola, Ericsson SpA, Siemens AG, and Cisco Systems (Datamonitor, 2005). These players generated 40% of the sales in 2004 (Datamonitor, 2005). A company based in three of the four regions participated in the study for network equipment: Nokia (EU), Motorola (USA), and Huawei (China). With respect to revenue, the smallest is Huawei (8.3 billion USD), the largest company is Nokia (40 billion USD), with Motorola about the same size (roughly 35 billion USD).

Involvement in End-of-Life Management

Figure 13 displays the manufacturers' level of involvement in end-of-life network equipment management across the four regions.



Scaling
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2 = "Individual Contracting" Some organizational capabilities, mixed products, limited brand schemes
1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Figure 13 Involvement in End-of-Life Management, Network Equipment

Nokia and Motorola offer take-back globally. There are some slight differences in their operations, however. Nokia offers this activity as a service package as part of their life cycle services and Motorola offers it on a more ad hoc basis outside the EU. Nokia sees this type of service offering as a potential source of competitive differentiation and its level of involvement has remained constant over the last three years, whereas Huawei and Motorola only became involved as the WEEE Directive was passed. Huawei is only involved in EOL management where it is legally required to do so. The corporation does not see end-of-life management as a source of competitive differentiation. One of the reasons for this is that its competitors are so far ahead in developing their approach to this activity.

None of the three companies has invested in tangible assets for EOL management and each has some personnel dedicated to it in their region of headquarters and the EU. Nokia is the only company that has a manager focusing on EOL management of network equipment full time. The logistics departments provide support in the other regions. Because all jobs at Motorola are organized so that a team of people is involved both on a global and local level, there is no full-time manager. The returns management department takes care of end-of-life management. Huawei has a team in China and one manager in the EU that dedicates a part of his time to EOL. The quality department at Huawei takes care of end-of-life management.

Higher Levels of Recovery

The companies all offer take-back on a 1:1 basis. They take-back old equipment if they renew it. The equipment that they take-back can thus be theirs or any other manufacturers. None of the companies currently reuse their products, but it is something that Motorola is actively working on. Currently, Motorola and Nokia review all the used products that return from the market for need in spare part stocks. According to Motorola one of the main challenges in EOL management is changing people's attitudes toward reuse.

EU

None of the companies has invested in recovery capabilities in the EU. All three companies contract their end-of-life management activities independently to service providers. Nokia has a dedicated manager focusing on EOL management full-time in the EU and it has been offering these services since 1999 as a part of a service package. Before the WEEE Directive Motorola offered end-of-life management on an ad hoc basis, but after the directive was issued the company has developed some organizational capabilities to deal with the policy in the EU. Huawei outsources its compliance needs to service providers, but it has a quality manager that dedicates time to the WEEE Directive.

USA

None of the companies has invested in tangible assets in the USA. As for organizational capabilities, Nokia and Motorola both have some employees that work on it as a part of what they do. Nokia and Motorola both offer take-back services to their network customers when they buy new equipment. Huawei is not involved in end-of-life management in the USA.

Japan, China and other Asia

None of the companies has invested in tangible assets in Japan or China. As in the USA, Nokia and Motorola offer take-back services across the region with the help of third party service providers and they have personnel that coordinate these services. Huawei has some employees working on EOL management in China, but it is not currently involved in any take-back operations.

Analysis

The main interesting difference in the end-of-life management operations in the network equipment sector is the global reach of the services. In this context, Huawei is the least involved in EOL management. Motorola takes care of it on request and Nokia has a standardized service package that is offered globally.

Geographical Reach of End-of-Life Management Activities

The explanation for the differences in global reach does not appear to lie in the global sales distributions. The companies are all relatively global companies. As can be seen in Figure 14, all three companies are very global in their sales generation although they each have a dominating region. The only turnover information for Huawei that was available was that 59% of its sales are from China.

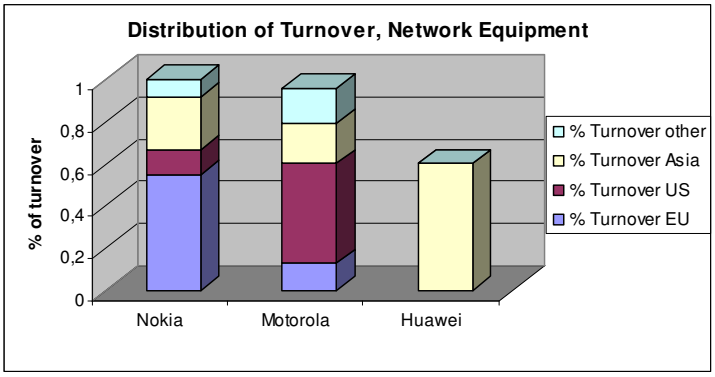


Figure 14 Distribution of Turnover, Network Equipment[19]

The exact division of Huawei's sales across regions was unavailable at the time of writing so it is difficult to compare in this respect. However, as over 40% of its sales are generated abroad, the lack of sales in the EU and USA do not account for the lack of activity.

Huawei does not only differ from Nokia and Motorola in EOL management, but also in other environmental considerations. Motorola and Nokia consider themselves to be very proactive environmentally and they both see it as a source of competitive differentiation. Motorola sees that it is leading in product assessment, whereas Nokia sees energy effi-

[19] Separate figures for Japan and China unavailable for most companies

ciency and design for environment as differentiating factors. Both companies have global environmental standards and they are listed in a number of sustainability indexes. On the other hand, Huawei does not see environmental issues as a source of competitive differentiation. It does not publish environmental reports and it has regional environmental standards. Huawei measures its environmental impacts to a limited degree. One explanation for this may be the culture related to environmental issues in their respective countries of origin. Compared to the USA and the EU, where Motorola and Nokia are based, China, where Huawei is based, is still developing in this respect (see Section 4.4.). Environmental issues do not receive a lot of attention in the company.

Investments into Recovery Capabilities

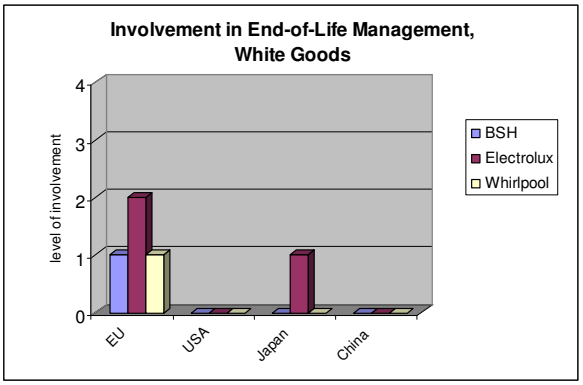
None of the companies has invested in tangible assets or recovery capabilities. One explanatory factor is the rapid technological change versus the time that the products are in use, which can be decades for many regions. An interviewee from Nokia stated that by the time the products are coming back technology has evolved many times. Overall, the Network business can be characterized by rapidly evolving technologies, frequent new product introductions, short product life cycles and evolving industry standards (Datamonitor, 2005). The main potential items for reuse would be components from old base stations that can be used as spare parts for warranty purposes. Nokia and Motorola reported to be investigating this possibility, but had challenges with various aspects of information management, quality issues, and customer acceptance of used products.

5.5. White Goods – Refrigerator

There are seven players in the kitchen appliances business with global sales. The companies from the white goods sector include two EU-based companies (Electrolux and Bosch und Siemens Hausgeräte, BSH) and one USA-based company (Whirlpool). These three companies are the largest and most global players in the large kitchen appliances business (Euromonitor, 2006).

Involvement in End-of-Life Management

Figure 15 displays each company's regional involvement in end-of-life management of white goods.



Scaling
4= "Vertical Integration" Strong organizational capabilities, own branded products also
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1 = "Collective Contracting" Industry-wide schemes only
0= no activities

Figure 15 Involvement in End-of-Life Management, White Goods

As can be seen in Figure 15, none of the companies are involved in EOL management globally; none has substantial organizational capabilities specializing in end-of-life management outside of the EU. Finally, none of the companies currently has tangible assets for end-of-life management.

Higher Levels of Recovery

Electrolux used to remanufacture washing machines at a plant in Sweden, but it is no longer working on that. The Electrolux case is interesting because it is the only one that deals with the company's own products as opposed to a share of mixed waste.

EU

Organizationally, each company's approach to end-of-life management differs. BSH and Electrolux both have groups dedicated to EOL management or WEEE Directive compliance, whereas Whirlpool has divided work on these issues across different functions and outsourced the activity to the national compliance schemes that it works with.

With a few other electronics companies, Electrolux established its own compliance scheme, the European Recycling Forum (ERP). The compliance scheme was set up with the aim of bringing competition into the arena of EOL management. With the help of the scheme, the companies hope to benefit from lower prices due to increased competition and their advances in the area of design for recycling. Electrolux is the only organization among the white goods companies included in this study that is a strong supporter of individual producer responsibility. BSH and Whirlpool have both opted for joining national collective compliance systems everywhere. BSH and Whirlpool in the EU believe that end-of-life management is something that industry as a whole should take care of together. They do not believe in individual producer responsibility because they see it as unrealistic. Waste, they claim, is anonymous and cannot be sorted by brand. Electrolux is however not advocating sorting waste by brand, rather it proposes that companies pay according to the environmental attributes of their products.

Interestingly, BSH and Electrolux have historically been involved in voluntary end-of-life management projects in the EU during the late 1990s- BSH, in Germany, and Electrolux, in a few European countries. Both had projects where they offered take-back services to retailers for a fee. In addition, Electrolux had pilot projects in Sweden and the UK, where it offered leasing services to consumers and took back used products for refurbishment and resale.

USA

In the USA, the three companies' involvement is non-existent. According to the interviewees, the recycling industry recycles white goods profitably in the USA. None of the companies has developed dedicated organizational capabilities for end-of-life management there. BSH and Electrolux have someone assigned to monitor legislative developments, whereas Whirlpool is involved in lobbying in the USA. Whirlpool USA takes a different stance toward EPR for white goods. It feels that governments should not force manufacturers to take responsibility for it. Rather, Whirlpool USA believes that market forces should be allowed to operate freely such as in the USA, where recycling white goods is a profitable business.

Japan, China and other Asia

As in the USA, each company's involvement in Asia with respect to white goods is low. BSH has a team of people working on the WEEE legislation project in China, whereas Whirlpool and Electrolux both have someone monitoring legislative developments. Electrolux is also a member of a compliance scheme in Japan, Group A. It does not, however, have any personnel dedicated to end-of-life management or recovery facilities there.

Analysis

The levels of involvement of white goods companies in end-of-life management are somewhat comparable.

Geographical Reach of End-of-Life Management Activities

The global reach of their EOL management operations is the same. The companies are only actively involved where legally necessary. Electrolux is involved in two countries. This could be explained by differences in the global sales distribution. BSH generates most of its sales from the EU, whereas the North American market dominates Whirlpool's revenues. Electrolux has two almost equally strong markets. Figure 16 below compares the distribution of turnover of the three companies included in the study for this sector.

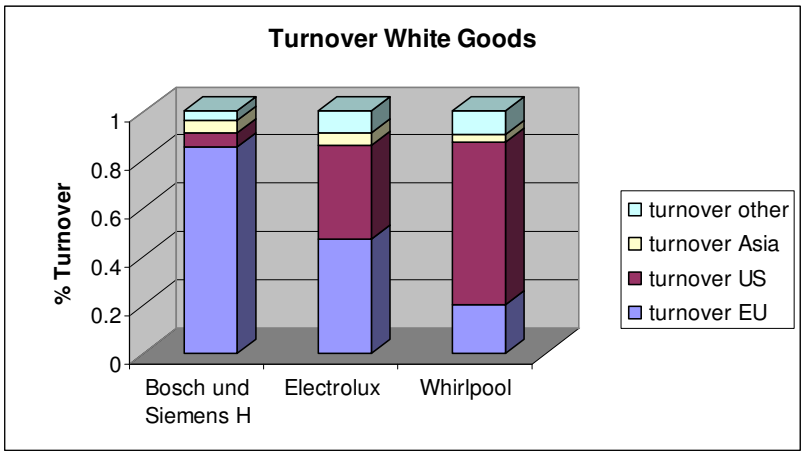

Figure 16 Distribution of Turnover, White Goods[20]

[20] Separate figures for Japan and China unavailable for most companies

In general the white goods manufacturers are not very global in their sales. All three companies have relatively low sales in Japan and China, with total sales from Asian countries ranging from 3-5 % of their total turnovers. Players that are based in the Asia Pacific countries, such as LG (South Korea) and Haier (China) dominate the market (Euromonitor, 2006). Western manufacturers do not have large market shares in Asia, but Asian companies have been entering western white goods markets in the past decade. Samsung, Matsushita Electric Industrial, Sanyo, Sharp and Haier are examples of this. Samsung and Sharp managed to get 5% market shares in the North American market in 2003 (Euromonitor, 2006).

Investments into Recovery Capabilities

Electrolux has been and continues to be slightly more involved in terms of tangible assets and its attitude toward individual producer responsibility. It has also been more active in the EU in the sense that the company was involved in setting up an independent Pan European scheme, whereas the others joined industry-wide schemes.

The three companies studied have relatively similar environmental backgrounds. They all consider themselves to be environmentally proactive companies, but they seem to agree that competitive differentiation through environmental issues is not possible in the white goods sector, predominately because the sector is mature. All of the companies started measuring production-related environmental impacts in the late 1980s or early 1990s. BSH and Electrolux have been publishing environmental reports since the mid-nineties, whereas Whirlpool does not publish them at all. Whirlpool and Electrolux are part of the Dow Jones Sustainability Index.

On the product assortment side, Electrolux clearly differs from the other two (see Figure 17). Electrolux generates 16% of its turnover from professional products, whereas the other two focus all of their efforts on the B2C sector. Whirlpool and BSH focus on the white goods market, whereas Electrolux generates 35% of its turnover from other categories. The others categories at Whirlpool and BSH are other household appliances or components of them.

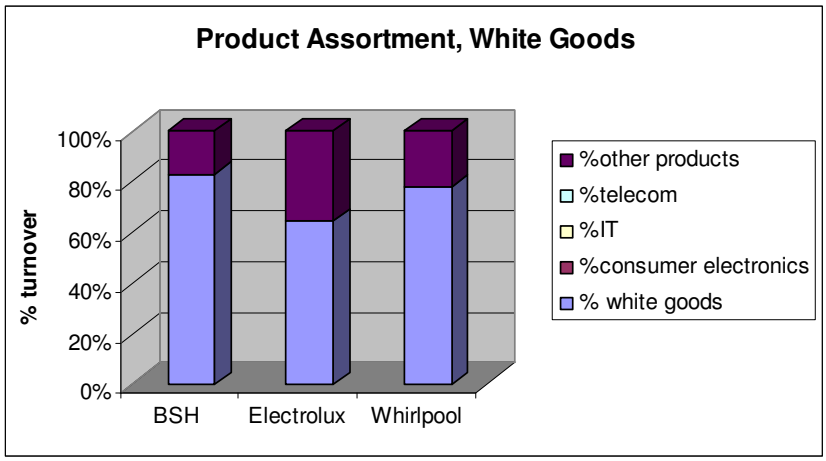

Figure 17 Product Assortment, White Goods

Electrolux is the only one amongst the companies to be active in the B2B market as well. This may partially explain Electrolux's attitude toward IPR and the fact that they were offering leasing services. Leasing and remanufacturing B2B products is easier because the company can control the flow of goods coming back. B2B customers generally do not use their appliance to the point of being worn out, unlike B2C customers. Electrolux was offering the services first to its B2B customers and then set up a trials for its B2C customers.

5.6. Key Findings from within-Sector Analysis

This chapter focused on within-sector differences between the companies studied. The main interesting finding is that there are considerable differences between different companies within any given sector. At least one company in each of the sectors at least had a history of in-house recovery capabilities.

Looking across the sectors, there are some characteristics that seem to be sector-specific. For example, the information technology sector is the most active in end-of-life management - especially for B2B products. For B2C products, the telecommunications sector is the most active. In the telecommunications sector, manufacturers have trouble getting handsets back because of an active secondary market and because consumers tend to not

return used products. In the white goods and consumer electronics cases, programs that target the company's own products are not common. Currently none of the companies studied are recovering more than material value from the products. One explanation for this could be the returns channels used. White goods and consumer electronics typically end up in the municipal waste stream when there is no value left in them. Besides Japan, they are not sorted by brand but rather treated as mixed waste.

This chapter also offered some suggestions as to which factors are behind the differences in how much companies are involved in different regions. The factors that arose from the within-case analysis are the target customer market (B2B vs. B2C), geographical sales distribution, the end-of-life management capabilities that the company has developed for other products, environmental awareness in country of origin, and location of R&D facilities.

A key factor that arose from many sectors was the customer market, whether the products are made for B2B or B2C market, and whether the company actually serves both. The information technology case showed that companies are more involved in their B2B end-of-life management than their B2C EOL management. One of the key drivers behind this is the manageability of returns flows and getting your own products back, as opposed to a share of mixed waste. Consumer products end up in mixed municipal waste streams more often than business products. Moreover, the total market that a company serves could also logically play a role. If a company serves both B2B and B2C markets it would be more likely to be more involved in end-of-life management of its B2C products too.

6. Potential Theoretical Frames of Reference

This study combines inductive and abductive elements in its approach. As explained in Sections 1.4. and 3.1 in abductive reasoning, the research process proceeds from observations in empirical data to "theory matching". The purpose of this chapter is to introduce the theories that the results of the analysis are matched with. The theories are applied to empirical findings in chapter 7. This chapter presents three theories that were deemed the most relevant to this study during the analysis. These theories are the resource-based view, stakeholder theory and institutional theory. After a brief description of the theory, the reasons for selecting it will be outlined.

6.1. Resource-Based View

Resource-based theory views the firm as a bundle of idiosyncratic resources (Wernerfelt, 1984). It explains company performance and strategy through these resources, which are slow to develop and difficult to trade (Barney, 1991). The resource-based view was created as a response to theories which assume that market forces determine company strategies. According to the resource-based view, and the closely related capabilities approach, the set of resources and capabilities that make the firm guide its strategy (Grant, 1991; Conner and Prahalad, 1996). Decisions about developing in-house capabilities for end-of-life management can be compared to other firm boundary or vertical integration decisions. Resource-based theory suggests that companies create capabilities in-house when:

- The company has capabilities that can be used in the new activity.
- The company possesses capabilities for performing the activity that are superior to those of potential suppliers.
- The activity is related to the core activity of the company.
- Assets needed in the activity are specific to the company.

The starting point in the resource-based view is an understanding of what capabilities the company has in-house (Espino-Rodriguez and Padron-Robaina, 2006). Outsourcing may provide the firm with access to complementary resources of a higher quality and at a

lower cost than those developed in-house (Connor, 1991). Outsourcing decisions depend on the extent to which the in-house activities permit the exploitation of different knowledge, capabilities, and routines within the organization (Bettis, Bradley and Hamel, 1992; Barney, 1999). Moreover, resource-based theory suggests that firms vertically integrate activities for which they possess capabilities that are superior to potential suppliers' (Argyres, 1996; Teece, 1988).

Another key aspect of resource-based theory is that it proposes that if the activity requires idiosyncratic resources, relying on external players is costly and the activities should be developed in-house (Poppo and Zenger, 1998; Espino-Rodriguez and Padron-Robaina, 2006). Outsourcing activities that are based on specific resources brings about a lower performance at the operational level (Poppo and Zenger, 1998). The in-house development of operations may be an efficient mechanism for the creation of new core skills and capabilities (Cohen and Levinthal, 1990). Firms thus risk eroding their potential for learning if they outsource key functions (Lei and Hitt, 1995).

Moreover, the more idiosyncratic the resources are, the more likely they would lead to a competitive advantage and therefore be valuable to keep in-house. In this context, the most important resources are the ones that contribute to the value perceived by the customer. Activities sustained by valuable resources should be kept in-house (Saunders et al., 1997). Resources that can be traded should be acquired from the market since it is improbable that the investment in their creation will result in any competitive advantage (Barney, 1999; Dyer and Singh, 1998).

The use of the resource-based view in explaining environmental management practices has grown more and more frequent (Clemens and Douglas, 2006; Sarkis, 2001). Olavarrieta and Ellinger (1997) argue for the use of RBV in supply chain management and logistics. RBV has been argued, to a limited extent, for examining product recovery strategies too (Toffel, 2004; Richey et al. 2005). The main reason for selecting the resource based view is its focus on differences between companies. The empirical study reveals that there are indeed considerable differences between the capabilities that manufacturers develop for end-of-life management. There was also some suggestion in a few cases that

the capabilities of the company motivate these decisions, which is why the resource-based view is examined.

6.2. Stakeholder Theory

Stakeholder theory focuses on identifying and understanding the role of stakeholder management on companies (Donaldson and Preston, 1995). From the environmental perspective, stakeholder theory is useful for understanding how companies manage environmental information and pressures (Henriques and Sadorsky, 1999). Broad definitions of stakeholders define them as any group or individual who can affect or is affected by the achievement of the organization's objectives (Freeman, 1984) others narrow it down to actors that are in an exchange relationship with the company (Cornell and Shapiro, 1987).

Mitchell et al. (1997) discuss perceived stakeholder salience as the major criterion as to whether a company reacts to certain stakeholder pressures. Stakeholder salience depends on the cumulative number of stakeholder attributes that the manager perceives to be present. Stakeholder attributes include power, legitimacy, and urgency. According to Mitchell et al. (1997) groups that do not possess any of these attributes are not stakeholders. Stakeholders can be divided into internal and external groups. Internal stakeholders can be employees, shareholders, customers and suppliers of a company (Henriques and Sadorsky, 1999) whereas external groups include governments, environmental non-governmental organizations (NGOs), industry associations and competitors (Carter and Ellram, 1998).

Regarding the company as dependent of its stakeholders, which is the crux of stakeholder theory (Donaldson and Preston, 1995) is often used at least implicitly in industrial ecology literature (Braglia and Petroni, 2000; Korhonen, 2004) as well as other literature that deals with end-of-life management (Meade et al., 2007; Geyer and Jackson, 2004; De Brito, 2004; Carter and Ellram, 1998). Stakeholder theory is used in this thesis because the business context of end-of-life management is highly legislated and multiple stakeholders have taken an interest in company practices. In this study the interviewees re-

ferred to their relationships with society for explaining decisions to invest recovery facilities.

6.3. Institutional Theory

Institutional theorists focus on the process by which items become institutionalized and the role of institutions in society (Scott, 1987). Institutional theory studies how companies are becoming more similar and is inherently focused on similarities (Powell and Dimaggio, 1983).

Institutional theory discusses three key forces, which are coercive, normative and mimicry (DiMaggio and Powell, 1983) that push towards isomorphism. Coercive force is typically used by governments in the form of regulations (Hoffman and Ventresca, 2004). Coercive force stems from political influence and the problem of legitimacy. Legitimacy can be defined as the generalized perception that the actions of an entity are desirable, proper or appropriate within some socially constructed system of norms, values, beliefs and definitions. Normative pressures come from industry associations in the form of standards. Normative pressure stems from professionalization. Members of an occupation have the same training and seek to define methods and conditions of their work. The more the field is reliant on a single source for resources, the more isomorphic the field. Finally, mimicry as a force pertains to pressure to imitate successful competitors to gain legitimacy. Mimicry as a homogenizing force is especially prevalent in situations where there is a lot of ambiguity. Companies seek to minimize risk by copying players that it perceives to be successful.

Whereas the more classical school of institutional theory focuses on how companies are becoming more similar (e.g. Dimaggio and Powell, 1983), neo-institutionalism views the way that companies manage institutional pressures as a source of differentiation (e.g. Oliver, 1991 and 1997; De La Luz Fernandez-Alles and Valle-Cabrera, 2006). According to neo-institutionalism companies also perceive changing institutional forces differently. Institutional scholars argue that instead institutional forces particularly coercive forces result in industry and firm level variations in strategies rather than isomorphism (Hoff-

man, 2001). Strategic choices may be constrained by institutional pressures, but the relationships between firms and institutions evolve over time resulting in differing strategies.

Institutional theory is the most common framework for analyzing environmental issues (Clemens and Douglas, 2006). Institutional theory has been used to understand how environmental practices diffuse amongst organizations and what can be done to encourage this diffusion (Jennings and Zandbergen, 1995). The main reasons for selecting this theory were issues that arose from the case analyses:

- Although there were considerable differences between companies in any given industry, homogeneity could be observed in Europe.
- The differences between innovation related to end-of-life management in Japan and the EU were rather striking.

Institutional theory has provided a useful lens for looking at how environmentalism develops within an industry over time (e.g. Hoffman, 1999) and the impacts of regulations on environmental practices. It has been applied to understanding innovation fostered by legislation.

7. Findings

This chapter discusses the results of the analysis related to the two research questions of this study:

1. How does extended producer responsibility legislation impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?
    - What other regional factors impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?
2. What company-specific factors impact levels of involvement of multinational manufacturers in end-of-life management in the EU, the USA, Japan, and China?

This chapter integrates the results of the analyses with literature. Section 7.1 discusses regional factors and Section 7.2 summarizes conclusions related to regional factors. Similarly, Section 7.3 discusses company-specific factors whereas Section 7.4 summarizes conclusions related to them.

7.1. Regional Factors

Regional factors are the same for all the players and they determine the basic set of opportunities regionally and the economics behind them. Section 7.1.1 discuses factors related to extended producer responsibility legislation, whereas Sections 7.1.2 and 7.1.3 discuss access to waste and existing recycling infrastructure. Section 7.2 will draw the conclusions related to regional factors.

7.1.1. Extended Producer Responsibility Legislation

The main factor within extended producer responsibility is the possibility that it provides for individual manufacturers to distinguish themselves. When manufacturers have the possibility to attain financial benefits from their efforts they will be more likely to develop sophisticated organizational capabilities. The main issue related to extended pro-

ducer responsibility in countries where it is only drafted is whether the companies believe that it will be passed. The country's track record of passing and enforcing such legislation determines whether the company invests in capabilities or manages the situation from another region

Extended producer responsibility legislations that affect the alternative levels of involvement are present in the EU and in Japan. Similar legislation has been drafted in China and the USA. When comparing impacts of existing EPR legislations, a clear difference could be observed in the manner in which manufacturers are involved in Japan and how they are involved in the EU. In Japan, manufacturers invest in tangible assets and recover materials from their own products. Japanese PC manufacturers even offer buy-back and refurbishment services for B2C PCs, something which is not prevalent elsewhere. In the EU, manufacturer involvement is more centered toward lobbying and having enough personnel in place to understand and keep up to date with what is required. In contrast to Japan, only one of the manufacturers included in the study owns a recovery facility in the EU and additionally two manufacturers are involved in individual recovery.

A clear difference in the legislations is that manufacturers are individually responsible for their products in Japan. In Japan, end-of-life products are sorted by brand. Whereas in the EU, manufacturers are responsible for a share of mixed waste not their own used products. In the EU, manufacturers are free to have individual systems to deal with their waste products. In most member states, a company cannot reduce the amounts that it collects through its individual systems from its B2C collection requirements. The legislation in the EU does not take into account any refurbishment or remanufacturing programs operated by the manufacturer. The legislation in the EU does therefore not provide incentives for investments into recovery capabilities or developing more sophisticated capabilities.

The possibilities that legislation provides to treat a company's own branded products also affect the level of sophistication of its organizational capabilities. The amounts of organizational resources dedicated to the WEEE Directive are very high in the EU. Most large companies have a team dedicated to WEEE compliance or end-of-life management. However, the employees are focused on legislative compliance due to the lack of options

and the complexity of member state differences. Most companies in the EU are not looking at ways to innovate to cut costs or generate revenues to cover costs. End-of-life management is not handled like a business process; many companies do not set financial and environmental performance measures.

Alarmingly, managing WEEE compliance is not linked to design improvements or product life extension in many companies. In contrast, Tojo (2004) found that the WEEE Directive motivated companies to improve the eco-design of their products. The difference could, however, be that her study was conducted in 2000-2001 when the WEEE Directive had not yet been passed. According to her study, companies were anticipating individual producer responsibility and had started making changes. In this study many companies were skeptical about individual producer responsibility becoming a reality. Some shared the view of Veerman (2004) that it would lead to duplications in infrastructure and thus higher costs. Others were also skeptical of the costs savings achieved by redesigning the products. The cost differences between treatment costs of products designed for recovery and those that are not are so small that they are outweighed by the losses in economies of scale in collection. However, most companies were supportive of the possibility of recovering products collectively and then treating them separately if needed.

Another way in which extended producer responsibility limits manufacturer involvement in end-of-life management is through administrative and financial requirements that are only imposed on individual systems. This is prevalent in the EU, where manufacturers are allowed to recover products with individual systems, but if they do so they face extra costs in the form of paperwork and financial guarantees. Manufacturers that use national collective schemes do not face these costs, thus making the collective schemes more attractive financially.

Overall the key point is that companies have sufficient flexibility in how they comply and that companies that are willing to invest in more have the possibility to benefit from their investments. This can be related to a higher level discussion on effective legislation. Traditionally, it is argued that increased environmental legislation leads to unproductive investments and the loss of competitive advantage (Walley and Whitehead, 1994). How-

ever, Porter and Van den Linde (1995) argue that the opposite may be true as well. According to their analysis, stringent environmental legislation provides firms with opportunities for improved efficiency and international competitive advantage. Further, Majumdar and Marcus (2001) found that proactiveness of environmental strategy depends on whether or not environmental regulations allow the company discretion in its technology investments.

Institutional theory also offers some suggestions for this. According to institutional theory, the governance framework includes command and control and market-based instruments or a mixture of them (Scott, 1994). Command and control instruments dictate how a company must comply whereas market-based instruments focus on aims rather than specifying means. According to institutional theory command and control legislation leads to a vertical hierarchical structure whereas market-based legislation leads to horizontal differentiation in the field with some specialization developing among organizations (Huestis, 1993). Moreover the elements diffused tend to lose their value if coercive rules and forces are used and legislation does not lead to the institutionalization of the principles that it was originally supposed to promote (Jennings and Zandbergen, 1995). Originally the EU WEEE Directive was supposed to represent a market based approach and it was supposed to promote closed-loop supply chains, but the way it has been implemented has taken these elements away. Compared to the impacts of the Japanese legislation, which incorporates market-based incentives there is a clear difference in the levels of innovation.

The observed similarity of operations within the EU can also be examined through the lens of institutional theory. Most companies consider the EU WEEE Directive to be ambiguous in its wording and they spend most of their managerial efforts on making sure that they are compliant. According to institutional theory in cases where legislation is ambiguous and managers perceive there to be risk, they copy each others practices (Dimaggio and Powell, 1983).

Finally the country's history in passing and enforcing EPR legislation affected the manufacturers' levels of involvement. The companies were mostly skeptical of legislation being passed in the USA and China. However in China, environmental legislation tends to

be enforced on multinational companies more rigorously than on local companies. Furthermore the USA has not been very successful in passing extended producer responsibility legislation that places responsibility on manufacturers. Many companies were therefore at least investing in monitoring capabilities in China whereas they were not doing so in the USA. This can be seen as a case of the institutional context being different in the USA and China leading to these differences in company actions. The impact of legislation does not depend solely on the content of the legislation. Firms' reactions to governmental regulation may vary depending on the society's view about the roles firms ought to assume in protecting the environment, the general effectiveness of environmental regulations and the degree to which the regulations have direct impacts on the firm (Branzei and Vertinsky, 2003).

7.1.2. Access to Waste

One of the issues mentioned by many companies was consumer awareness of the need to separate e-waste. In regions were consumer awareness was low, the companies had to opt for programs that were geared toward teaching the general public about the need for proper disposal rather than collecting the goods efficiently. The companies grouped China, and in some case the USA, into this category.

When consumer awareness is low, consumers do not return their used products to collection points. The impact of this on manufacturer involvement is that organizational capabilities are required to develop effective awareness-raising campaigns. Low consumer awareness also pushes companies toward more collaborative solutions because the costs of involvement are too high otherwise. Large-scale awareness campaigns are typically sponsored by more than one company. When awareness is low and companies are not getting end-of-life products back, it is even more difficult to get their own end-of-life products back, which would help counter the overall costs of collection and treatment. Companies are less likely to invest in tangible assets for product recovery in these cases. The exception to this would be companies that are based in the region, which are supported by local governments to invest. The impacts of low consumer awareness were reflected mostly in the cases that were active in China, i.e., Nokia and Motorola and to some extent BSH.

The handset cases presented another example of lack of access to waste. Consumers do not return handsets when they have finished using them. Investing in tangible assets does not make economic sense in these cases because the volumes are so low.

Previous literature describes consumer behavior as a key to recovering used products from consumers. If consumers do not sort waste for separate treatment, recycling becomes very expensive, if not impossible (Mayers, 2001). Access to waste has been cited as a constraint to supply chain loops (Geyer and Jackson, 2004).

7.1.3. Recycling Infrastructure

The existence of a working recycling infrastructure also came up in the cases in the EU and the USA as a factor for explaining why companies felt that they do not need to invest. If there are third parties that can make a business of it, why should manufacturers be involved? Turned around, if there is no working recycling infrastructure there is public pressure for companies to invest in infrastructure.

The impact of a recycling infrastructure is clear in the white goods sector in the USA. None of the white goods companies in the USA were active in end-of-life management. The recycling industry recovers materials from refrigerators without subsidies and the manufacturers felt that there is no reason for them to be involved in product recovery. A plausible explanation for this is that stakeholders in the USA are not providing much push for white goods manufacturers to be involved in EOL management, because the secondary market recycles these products efficiently. The question as to whether the system for recycling refrigerators is on the same level environmentally as the EU systems, where recycling white goods is a cost, was subject to doubt by European counterparts. The representatives from Whirlpool explained this difference with the higher steel content in their refrigerators. Another case where this provides some explanation is the EU, where manufacturers used to own recycling facilities but no longer do.

A plausible explanation for this is that stakeholders in the USA are not providing much push for white goods manufacturers to be involved in EOL management, because the

secondary market recycles these products efficiently. Stakeholder theory provides some insight for this finding. According to stakeholder theory, the salience of a stakeholder's demands depends on the attributes of power, urgency and legitimacy (Mitchell et al., 1997). In this case the sense of urgency is not there because the problem is taken care of by third parties.

7.2. Findings – Regional Factors

Regional factors determine the general framework of possibilities that a manufacturer has for managing end-of-life products in a given region. There are four main regional factors that emerged from the analysis as determining manufacturer levels of involvement in end-of-life management. Table 12 summarizes the regional factors and their proposed impacts on manufacturer involvement and compares the findings of this study with previous literature.

Table 12 Regional Factors – Study and Previous Literature

Regional Factors	Based on this Study	Theory	Previous Literature in End-of-Life Management
Possibility to benefit from voluntary efforts	Possibility to link voluntary schemes to compliance requirements increases interest in higher levels of recovery Possibility to benefit from design changes increases interest in higher levels of recovery	Institutional Theory: Legislation needs to contain market-based incentives and it needs to be flexible	
Social acceptance of environmental legislation and enforcement	Manufacturers invest in regional organizational capabilities if they perceive that EPR legislation will be passed and enforced	Institutional Theory: Institutional Context impacts how players view legislation	
Recycling infrastructure	Lack of recycling infrastructure, local manufacturers motivated to invest because of stakeholder pressures	Stakeholder theory: demands more salient when urgent	
Access to waste	Resources focused on marketing Low access limits necessary economies of scale		Access to waste can hinder closing the supply chain loop

The factors discussed in this section can be linked to the different levels of manufacturer involvement outlined in Section 4.1. Access to waste is a primary factor to determining whether a company is involved on levels three and four. If the access to waste is poor, manufacturers cannot achieve the economies of scale necessary to run such operations. Lack of a recycling infrastructure and legislation allows the possibility to benefit from own programs and/or design improvements increase the likelihood of manufacturers becoming involved. If manufacturers are unable to treat their own products, economic in-

centives are greatly reduced as they cannot benefit from learning opportunities or material recovery opportunities related to their products. Lack of recycling infrastructure serves as a motivator for investments into tangible assets. The actual levels of involvement depend on company-specific factors, which are the topic of the next section.

7.3. Company–Specific Factors

This Section discusses the results related to the second research question of the study. It combines the findings from the within-sector analysis of Chapter 5 with previous literature discussed in Chapter 2. More specifically this chapter seeks to explain the findings of the case analyses with theories discussed in Chapter 6. Based on the case analyses, functional capabilities located in region, geographical distribution of sales, environmental awareness in country of origin and target market determine levels of manufacturer involvement in end-of-life management. In addition to these product characteristics such as wear-out life, length of technology life-cycle and asset specificity play a role in determining to what extent companies are involved. Each of these factors and along with their theoretical background will be discussed in the following sections. Section 6.3.6 will discuss other factors that were identified as possible explanations.

7.3.1. Functions Located in Region

What is evident across all the companies included in the study is that they are active in EOL management in the region where they are based. In fact, companies are only vertically integrated in the regions where they are headquartered. There are many examples of this in the cases presented: Samsung in South Korea, Philips and Electrolux formerly in the EU, NEC and Hitachi in Japan, and Hewlett Packard in the USA. In the white goods sector in China, Haier, a domestic manufacturer, is the only company that owns a recycling facility there.

Investments in recovery facilities depend on the location of research and development because the facilities are often used to learn about the products. When asked about their investments, interviewees (Hewlett Packard, Hitachi and Philips) explained them to be for learning about the products and recycling. In such cases it is natural to locate the fa-

cility close to the research and development functions of the company. In many companies these are located in the region where they are headquartered. An interviewee from NEC USA stated that they are not involved because they are merely a sales subsidiary, they do not have the resources for such activities.

Christmann (2004) found in the case of chemical companies that voluntary investments in environmental capabilities depend on the presence of other capabilities such as research and development, production and marketing. The situation in end-of-life management appears to be somewhat similar, if a company does not have research and development activities in a given region, it will be unlikely to invest in recovery facilities.

7.3.2. Environmental Awareness in Country of Origin

Another way of explaining that companies are only vertically integrated in their region of origin is through pressures from salient stakeholders. The impact of stakeholder pressures is the most evident in the highest level of involvement, vertical integration. Companies had invested in recovery facilities although they were not making money from them. The reasons cited by companies were that it is their responsibility to own these facilities. In the cases of Korea and Japan, the government and industry associations are reported to have explicitly pushed companies to invest in these facilities.

In the lower levels of involvement the impact of stakeholder pressures is the most evident in the form of voluntary involvement in end-of-life management. Companies from countries where stakeholder pressures for environmental issues are limited were less active in end-of-life management elsewhere as well. Huawei, based in China, and Alpha Computers, based in Taiwan, are examples of this. Alpha Computers published its first environmental report this year and Huawei does not publish information about its environmental impacts at all. Alpha does not collect any measurements on the environmental impacts of its products and Huawei only does so to a limited extent. Compared with their European and North American counterparts, both companies were also clearly behind in their levels of involvement in end-of-life management.

Internal stakeholders, also referred to as organizational stakeholders, include groups that are directly related to the organization. They have the power to impact a company's bottom line directly. Rising public concerns about environmental degradation contribute to customers considering environmental factors in their purchasing decisions. Empirical studies have shown that customer pressures are an important explanatory factor of a firm's environmental conduct in domestic settings (Christmann and Taylor, 2001). Henriques and Sadorsky (1996) found that customer concerns were the second most cited source of pressure (after legislation) on a company to adopt environmental management systems. Internal stakeholders possess considerable power. The success of environmental activities depends on employees. The importance of individual managers leading efforts has been claimed in previous research on end-of-life management (Carter and Ellram, 1998; Tojo et al., 2004). Board members, for example, possess legitimate power. When they have claims that are urgent, they are naturally at the top of a manager's priority list (Mitchell et al., 1997).

Stakeholder theory proposes that managers perceive pressures from internal stakeholders to be the most salient (Mitchell et al., 1997). Internal stakeholders and the society where the company is based provide the company with important resources. Internal stakeholders employees tend to be from the country were the company is based. The pressure from these stakeholders depends on their levels of environmental awareness. In regions where such awareness is low the pressure for companies to be involved in end-of-life management are naturally reduced.

This observation is interesting from the perspective from previous research. Porter and van der Velde (1995) argue that companies from countries with tight environmental regulations will have a competitive advantage in other regions. The evidence from this study supports this partially. *Companies from regions that do not have tight environmental legislation have not developed capabilities in end of life management.* However, if we examine companies included in this study that are based in the EU or in Japan (which have the strictest end of life management regulations) there are no companies that would have transferred their knowledge in end of life management to create competitive advantage. There is increasing evidence from outside this study, however, that Japanese companies

such as Panasonic and Sony are attempting to transfer capabilities developed in Japan to the EU. Panasonic (Matsushita) founded Ecology Net Europe GmBH as a fully owned subsidiary in Germany. Ecology Net Europe offers compliance services in Germany.

7.3.3. Geographical Distribution of Sales

Geographical distribution of sales emerged from the analyses as a factor that explains some of the differences between companies. The most global companies were not, however, the most global in their end-of-life management activities. Significantly, two of the most global companies, Philips and Samsung, did not have global end-of-life management activities. What could be observed was that no home-market based companies had global end-of-life management activities. Companies such as NEC, Fujitsu, and Hitachi have all built considerable capabilities and invested considerable amounts in EOL management in Japan, but have not used this know-how on a global basis. Japan, their home market, dominates the sales of all three companies. The sales that they generate in other regions is relatively low. When asked why they are not active in other regions the responses from the Japanese companies were that they are only big in Japan. This factor clearly impacts the level of involvement that a manufacturer chooses, but it seems to be more related to B2C products than B2B products. Hitachi and Hewlett Packard for example offer B2B take back services globally.

Stakeholder theory provides some explanation as to why this is the case. Similarly to investing in facilities in the regions where they are from, companies invest in capabilities in regions where they have internal stakeholders. In regions that they generate little revenue from, companies typically do not have internal stakeholders.

7.3.4. Product Characteristics

In the cases included in this study, there are considerable within-sector differences. Nevertheless, the average levels of manufacturer involvement differ between product categories. Specifically, the information technology sector manufacturers are the most actively involved in terms of recovery capabilities. In the consumer electronics and white goods cases, the companies were not involved in end-of-life management in regions where it is

not required by law, based on the claim that recycling their products integrally is not profitable due to the long wear-out life of the products. Interviewees in the telecommunications network companies also stated that the long wear-out life compared to the short technology life cycles of their products made recovering products and/components challenging at best.

Overall the electronics companies interviewed had typically not invested into recovery facilities. Outside Japan, there are only two companies that still have investments in recovery facilities. Other companies have sold off their tangible assets. The emergence of third party recyclers and remanufacturers helps explain why this is the case. These third party players treat products from all manufacturers, suggesting that assets specific to one producer's products are not needed. The same facilities treat products from different manufacturers in all product categories. An explanation for why this is the case could be that most products are made of the same components in many industry sub-sectors. Handsets and information technology manufacturers use the same subassemblies in many of their products.

A key aspect of resource-based theory is that it proposes that if the activity requires idiosyncratic resources, relying on external players is costly and the activities should be developed in-house (Poppo and Zenger, 1998; Espino-Rodriguez and Padron-Robaina, 2006). Outsourcing activities that are based on specific resources brings about a lower performance at the operational level (Poppo and Zenger, 1998). Resources that can be traded should be acquired from the market since it is improbable that the investment in their creation will result in any competitive advantage (Barney, 1999; Dyer and Singh, 1998). In this sector the general tendency is to not invest in recovery facilities and this could be the reason.

7.3.5. Target Markets

An issue intertwined with product characteristics is the market that they are made for. The target market that the manufacturer serves is a key explanatory factor of the manufacturer's level of involvement in end-of-life management. Firstly, there are differences in how companies are involved for B2B and B2C products. Secondly there are differences based on what target markets the company serves.

B2B vs. B2C Products

On a regional level, there were clear differences in how companies managed their B2B and B2C products. Company programs for end-of-life management were much more developed for B2B products than for B2C products. The PC within-sector analysis demonstrates this and it is also evident in cases such as Hitachi and Philips that have proper programs in place for B2B customers, whereas on the B2C side their operations are less advanced.

The volume, quality, and timing of returns flows are key to profitable product recovery (Ferrer and Whybark, 2003; Guide and Van Wassenhove, 2001; Stock, 1998). Product recovery is more likely to be economically viable when flows of products are manageable in quantity and quality and sufficient in volume (Ferrer and Whybark, 2003). B2B customers use larger volumes of products for shorter times (Knemeyer et al., 2002). Impacting the quality and timing of returned products is also easier with B2B products. In many cases, manufacturers retain contact with B2B customers through their product's life, whereas retaining contact with B2C customers would be more complicated. Consumers tend to use products until the very end of their lives and dispose of them in municipal collection points. In contrast, business customers renew their equipment more frequently. B2B customers are also more eager to use manufacturer take-back services, because they typically dispose of big amounts of equipment. Finally, B2B products are typically bought for functionality and not "fashionability" like their B2C counterparts. Lebreton (2006) discussed the lack of second-hand markets for psycho-sociological products compared to functional products.

The Target Markets of the Company

Companies produce a variety of products with different characteristics that make them better or less suited to reuse. As discussed in the previous section, whether the products are made for a consumer market or for a business market plays a role in product recovery. In the cases where a company also sells products on both the B2B and B2C market, it may have organizational end-of-life management capabilities for its B2B products that can be used for B2C products as well. If a company has products destined for profes-

sional use and products destined for household use, it will be more likely to invest or at least have invested in EOL management capabilities for all product categories.

This idea emerged from the within-sector analyses of the telecommunications and white goods sectors. In the handset cases only Motorola was working with refurbishers to recover its used handsets. Out of the three companies it is also the only one that had developed capabilities to refurbish its B2B products (other than Network Equipment). In fact it even has a recovery facility in the USA to deal with other products. It could be that having developed these capabilities for other products helped it develop them for consumer products as well. White goods, especially in the EU, are characterized by high recycling costs. Consumers use them for over ten years and typically their reuse potential is low. This study included three companies from the white goods sector: BSH, Whirlpool, and Electrolux. Electrolux was the only one that had at some point invested in EOL management facilities. It was the only white goods company with a positive attitude towards individual producer responsibility. The main clear difference to both BSH and Whirlpool was in the area of product assortment, which, contrary to the other two, included about 20% of products for professional use that are leased to customers and remanufactured.

This is not mentioned in previous literature as a factor related to end of life management. However, resource-based theory offers some explanation as to why this is the case. Resource-based theory proposes that outsourcing decisions depend on the capabilities of a company; how well the capabilities of the company can be utilized in the new activity (Bettis, Bradley and Hamel, 1992; Barney, 1999), whether the activity requires idiosyncratic resources (Poppo and Zenger, 1998), and whether it is an activity that the company can perform better than its suppliers (Argyres, 1996). In this case companies that serve both markets have developed these capabilities for B2B customers and are able to use them for B2C customers too.

7.3.6. Other Factors

Manufacturing and Technology Capabilities

A factor for further consideration that surfaced from the cases was the capabilities that the company has in-house--specifically, whether a company has manufacturing and ser-

vice capabilities and to what extent it develops the technology for its products in-house. These factors may serve to explain why some companies are involved on levels 3&4 whereas others are not.

Examples of this include can be found in the information technology, consumer electronics, and telecommunications cases. Alpha Computers is the only company included in the study that has no manufacturing operations of its own. It is the only IT company that was not involved in reuse, even for its B2B products. LCD technology is used in telecommunications and consumer electronics and information technology. Out of the companies producing products with LCD screens, Samsung is the only one that designs them for recovery and has some plans at least to recover large LCD screens on a global basis. Samsung is also known as a forerunner company in LCD technology compared to the others and it sells LCD screens to many of the other companies. This is, however, rather tenuous as a finding, as it only relates to the plans of the company. The scope of the interviewees also limited deeper examination of the finding.

This finding is however supported by Toffel (2004) and more specifically the resource-based view, which proposes that outsourcing decisions depend on the capabilities of a company; how well the capabilities of the company can be utilized in the new activity (Bettis, Bradley and Hamel, 1992; Barney, 1999).

Market Positioning

Product positioning on the primary market may explain why some companies are involved in product life extension whereas others are not. If a company has an image for producing fashionable products as opposed to functional products on the market, it is less inclined to be involved in recovery operations. The reasoning behind this is that refurbished phones are perceived to be of inferior quality by consumers and manufacturers with high fashion brand images do not want to be associated with such products.

This seems to be apparent in the handset cases presented in this study. Nokia and Samsung both make phones that are more fashion items than functional products. They are not involved in partnerships with refurbishers. Motorola, on the other hand, partners with

refurbishers in the EU and the USA. Grouping manufacturers based on the "fashionability" of their products is problematic, because of the subjectivity involved. To explore this argument deeper, the case data would have needed to include more data from a marketing perspective to understand how the firms differentiate themselves in terms of fashionability or functionality.

In general, it is thought that remanufactured products may affect the sales of new products. Sales can either be increased, through a better environmental image (Rogers and Tibben-Lembke, 1998; Krikke et al., 2003) or decreased through cannibalization (Guide and Van Wassenhove, 2003). However, these findings suggest that the image of a remanufactured phone may hurt the brand image of a company that produces high-tech fashion-conscious phones. This finding is also linked to the discussion in Lebreton (2006) concerning markets for recovered products. According to him there are no markets for recovered fashion products, whereas there are markets for functional products. Lebreton, however, suggests that this depends on product type as opposed to the findings here that suggest that it may depend on the branding made by the manufacturer within a product category.

7.4. Findings – Company-Specific Factors

Table 13 summarizes the findings of this study on company-specific factors and how they compare to previous literature.

Table 13 Company-Specific Factors – Study and Previous Literature

Company-Specific Factors	Based on this Study	Theory	Previous Literature in End-of-Life Management
Location of other functional capabilities	Investments in recovery facilities depend on location of other functional capabilities	Resource-based theory: Companies outsource activities that do not rely on resources idiosyncratic to the company	
Geographical distribution of sales	Home-market based companies less involved in other regions On B2B side, level of involvement dependent on sales generated in region	Stakeholder Theory: Internal stakeholders most salient and typically mostly located in country of origin	
Level of environmental awareness in country of origin	Internal stakeholder pressure push towards investment in tangible assets in country where based. Impact depends on level of environmental awareness in country	Stakeholder Theory: Internal stakeholders most salient and typically mostly located in country of origin	
Product characteristics	Electronics manufacturers prefer to outsource end-of-life Management because it is not their core-competence	Resource-based theory: Companies outsource activities that do not rely on resources idiosyncratic to the company	
	If product has long wear-out life, EOL programs deal with mixed waste; if product has short wear-out life, programs may deal with branded products		The ratio between wear-out life and technology life cycle helps predict EOL strategy
Target market	Companies more likely to invest in tangible assets and organizational capabilities if product is made for B2B markets		Product recovery more profitable when returns flows manageable
	Companies that have previously developed EOL Capabilities for B2B products more likely to be involved than companies that have not or just sell B2C products	Resource-based theory: involvement in activities depends on how well in-house capabilities can be utilized	

If we look at the previous discussion and how it relates to the scaling of the cases discussed in Section 2.2, we can make some predictions as to which factors relate to decisions between the levels. Some factors are prerequisites whereas others increase the probability of involvement. Table 14 summarizes these factors and combines them with the discussion from Section 6.2 on regional factors as well as the framework for the different levels of involvement presented in Section 2.2.

Table 14 Factors and Levels of Involvement

Level of Involvement		Description	Regional prerequisites	Company-specific prerequisites	Other motivating factors
0	**Nothing**	No end-of-life Management operations			
1	**Collective contracting**	Few organizational capabilities			If voluntary, environmental awareness in country of origin
2	**Individual contracting**	Contracting capabilities, mixed waste			If B2C product, country relevant to sales B2B target market Manufacturer serves B2B and B2C markets If voluntary, environmental awareness in country of origin
3	**Individual Recovery**	Contracting and recovery management capabilities, own and mixed waste	Access to waste	Manufacturer serves B2B and B2C markets; Consumer environmental awareness in country of origin; Product wear-out life short, technology life short	B2B target market Legislation allows possibility to benefit
4	**Vertical integration**	In-house recovery capabilities	Access to waste	R&D capabilities in region, Manufacturer serves B2B and B2C markets; country relevant to sales; Consumer environmental awareness in country of origin	Lack of recycling infrastructure

A prerequisite for the highest level of involvement, i.e. investments in tangible assets appears to be the location of other R&D capabilities in the region. Whether manufacturers then actually invest in these assets depends on whether specific assets are needed to treat the companies' products and whether there is a regional recycling infrastructure. If no specific assets are needed and many players offer the services, manufacturers are unlikely to invest in tangible assets. This appears to be the case in the EU and the USA. Many electronics manufacturers used to own recycling facilities, but no longer do.

If we next look at the second highest level of involvement, individual recovery, a prerequisite for individual recovery is that the company serves the B2B market. Individual recovery activities were not found in companies that only serve the B2C market. A proposition that needs further testing is whether this depends on the capabilities that the company has developed for B2B products and how it makes use of these for B2C products. A regional prerequisite is access to waste. The likelihood of being involved on this level is increased when the target market of the product in question is professional customers and

when the wear-out life of the products is short. Furthermore the possibility to benefit from these types of activities in complying with EPR legislation increases the probability of adopting them. As for the lower levels of involvement, if they are voluntary in the sense that there is no legislation consumer environmental awareness in the region of origin is a prerequisite.

8. Concluding Discussion

This chapter concludes this dissertation and discusses the findings of the dissertation and their implications. This chapter consists of four sections. Sections 8.1 and 8.2 discuss the implications from a theoretical and a practical perspective. Section 8.3 explains the limitations of the study. Section 8.4 concludes the chapter by suggesting avenues for further research.

8.1. Theoretical Contribution

The main contribution of this thesis is an increased understanding of factors that explain manufacturer involvement in end-of-life management in the electronics industry. The topic of this study is related to two fields which are supply chain management and industrial ecology.

8.1.1. Theoretical Contribution to Industrial Ecology

Industrial ecology has discussed extended producer responsibility legislation and its environmental impacts. Previous studies in this field have focused on changes in product design and environmental impacts of EPR legislation in Sweden, the UK, Switzerland, the Netherlands and Japan. Apart from Mayers (2001) and Tojo (2004), it does not provide much empirical evidence of the effects of extended producer responsibility legislation on electronics manufacturers' operations. Mayers (2001) studied the environmental impacts of the legislation, whereas Tojo (2004) studied its impacts on design changes. Previous literature suggests that individual producer responsibility is needed to achieve design improvements (Lifset and Lindhqvist, 2003). Tojo (2004) finds that design changes were already being made in anticipation of individual producer responsibility legislation in the EU. Based on this study most companies did not see the EU WEEE Directive as providing them with incentives for improving design or changing business models. In fact in many companies, managers in charge of dealing with the WEEE Directive perceived that it had nothing to do with product design. The managers interviewed for this study also viewed that the WEEE Directive provides no incentives for higher levels of manufacturer involvement in end-of-life management. This study however found a contrast between how Japanese manufacturers were involved in end-of-life management. The Japanese

legislation differs from that in the EU in the sense that products are sorted by manufacturer. Moreover being in charge of their own recovery plants, manufacturers have incentives to develop their products and business models. This study finds that the possibility to benefit from higher levels of recovery increases manufacturer involvement. This study thus contributes to this line of literature by offering some insight into how extended producer responsibility legislation impacts the development of end-of-life management capabilities.

This can be linked to higher level discussion on when legislation provides incentives for proactive environmental management practices and more specifically institutional theory. According to institutional theory, command and control legislation does not lead to the institutionalization of the principles that it was originally supposed to promote. The elements that were supposed to be diffused, e.g. environmental practices, tend to lose their value if coercive rules and forces are used (Jennings and Zandbergen, 1995). Majumdar and Marcus (2001) provided empirical evidence that legislation needs to leave the companies sufficient room for determining how they reach environmental targets. In the context of the WEEE Directive, the national transpositions do not leave companies with many realistic options and they do not foster innovation related to closed-loop supply chains.

8.1.2. Theoretical Contribution to Supply Chain Management

Green supply chain management is a research area within the field of supply chain management that deals with issues like green product design and end-of-life management (Srivastava, 2007). Over the last decade work on network design, inventory management and other technical issues has been published. Many strategic aspects of engaging in product recovery have received limited attention (Guide and Van Wassenhove, 2003). Product recovery has been largely taken care of by independent third parties (Lund, 1998). With the proliferation of extended producer responsibility legislation, the role of the manufacturer in product recovery is expected to increase meriting further attention (Srivastava, 2007).

Previous literature identifies factors that impact the profitability for companies involved in recovery. Previous literature in this stream of literature identifies product characteristics (De Brito, 2004; Lund, 1998; Rose et al., 2002), markets for recovered products (Thierry et al., 1995; Guide and Van Wassenhove, 2003; Geyer and Jackson, 2004), characteristics of returns flows (Guide and Van Wassenhove, 2001; Ferrer and Whybark, 2003) and consumer behavior (Mayers, 2001; Geyer and Jackson, 2004). Previous literature tends to focus on industry and/ product characteristics as explanatory factors for different levels of product recovery (Rose et al. 2002; Guide and Van Wassenhove, 2003). Previous literature does not offer much explanation to questions such as why one manufacturer chooses to vertically integrate into end-of-life management whereas another manufacturer making the same product develops minimal organizational resources to deal with it. This issue is highly topical at the moment as manufacturers seek to find sources for competitive differentiation in their environmental practices.

This study found some support for the role of technology vs. life cycle (Rose et al. 2002) in predicting the levels of product recovery, but it also uncovered factors that had not been discussed before in previous literature on end-of-life management. Although product characteristics explain many differences, this study showed how manufacturer involvement in end-of-life management varies within industry sectors. Within each sector at least one company had developed in-house capabilities for end-of-life management. This study contributes to this field by uncovering some factors as to why this is the case. The dependence on other functional capabilities had been identified as a factor for environmental operations before (Christmann, 2004), this study showed that it has some explanatory power in end-of-life management practices too, particularly in higher levels of involvement like vertical integration. Relevance to sales, level of environmental awareness in country of origin, target markets of the company are factors that rose from this empirical study and have not been documented by previous research.

This study proposes that target markets are a company-specific factor that explains manufacturer involvement in end-of-life management. Many companies have developed B2B product recovery capabilities whereas fewer have developed B2C recovery capabilities.

All of the companies involved in the higher levels of recovery serve either B2B or both B2B and B2C markets. The differences of managing B2B and B2C product recovery has received limited previous attention. It does however link back to the discussion on factors that explain profitability of product recovery by manageability and volume of product flows (Guide and Van Wassenhove, 2001; Ferrer and Whybark, 2003). B2B and B2C products differ greatly in this sense. Interestingly this study found that companies have developed capabilities to deal with their B2B EOL products and use these capabilities to deal with their B2C end-of-life products. This is an interesting finding from the perspective of the resource-based view which proposes that company strategy depends on its possibilities to leverage existing capabilities (Bettis, Bradley and Hamel, 1992; Barney, 1999). Moreover, resource-based theory suggests that firms vertically integrate activities for which they possess capabilities that are superior to potential suppliers' (Argyres, 1996; Teece, 1988).

Another interesting empirical finding is that all companies are the most involved in their country of origin, it is typically the only place where they have invested in tangible assets. This study identified two factors that explain this, the power of internal stakeholders and the location of functional capabilities. Internal stakeholders, i.e., employees, board members and customers, are often considered to have the most salient demands (Mitchell et al., 1997). Companies are the most perceptive to requests from stakeholders that posses resources that they depend on. Internal stakeholders and governments in the countries where they are based typically possess the most of these resources. The levels of environmental awareness of internal stakeholders also clearly play a role. If internal stakeholders are not environmentally aware, the company is less likely to invest in recovery capabilities. The location and dependence on other functional capabilities also emerged as a factor. Similarly to what Christmann (2004) found for environmental practices in the chemical industry, the development of end-of-life management capabilities depends on location of research and development capabilities.

Furthermore, an important contribution of this study is identifying regional factors that explain the differences in producer involvement. Previous literature does not offer much explanation as to how regional factors impact end-of-life management (Meade et al.

2007). This study identified access to waste and existing recovery infrastructure as important regional factors underlying manufacturer involvement.

Institutional theory and stakeholder theory are not often used in supply chain management. The basic assumption in supply chain management is that supply chains are designed to fulfill customer demand. Institutional theory and stakeholder theory each look at how company practices are affected by stakeholders. Although they overlap somewhat in their scope, they provide many complementary insights. Stakeholder theory can be used to examine differences between companies within an industry, whereas institutional theory can be used to explain how similar practices diffuse within and across industries. Institutional theory can help provide normative results for policymakers whereas stakeholder theory can help companies understand how to manage their stakeholders more efficiently.

8.2. Practical Implications

The results of this study provide some interesting practical implications for both managers and policy makers. From a managerial perspective, normative results are generally the most interesting ones. However, a descriptive approach such as this one can help structure thoughts about the issue. This study, for example, contributes with a classification of different levels of producer involvement in end-of-life management, which can be used as a framework in different industries. The study also provides some insight into how industry leaders are tackling the issue of end-of-life management, which maybe interesting reading from a practical perspective.

The electronics industry is heavily regulated in terms of end-of-life management. It also contains some interesting voluntary end-of-life management operations. From a policymaker's perspective this study offers some insight into what the current situation is within this industry and what issues the corporate players are tackling. As the setup of the study was multi-regional, it provides some basis for analyzing the impacts of differing policy measures on companies. Perhaps the most interesting implications for policy makers can be derived from the analysis of manufacturer involvement in the EU compared to

manufacturer involvement in Japan. Legislation in the EU has developed to be rather prescriptive. Companies do not perceive there to be options for choosing how to comply with it and they do not see it as providing them with possibilities to benefit from their efforts. This lack of options has led companies to invest organizational capabilities to monitor the legislation, but it does not seem to provide them with incentives for higher levels of recovery or incorporating recovery considerations into their product designs. The issue in countries where there is an existing recovery infrastructure is not manufacturers investing in facilities, rather it is building incentives for higher levels of recovery; at least making sure that they are not being blocked.

8.3. Limitations of the Research

A number of characteristics can be seen as weaknesses of the case study method. Case studies examine a limited amount of companies and therefore resulting theory can be narrow or too complex. To mitigate the risks of this limitation, the multiple case study approach was used in this dissertation. However, using multiple cases has the drawback of limiting the amount of data that can be collected and analyzed. This was a considerable limitation in this study as the interviewees were all environmental managers in charge of end-of-life management. The understanding of the background information of the companies was limited by this and it may limit the factors that were identified.

Social desirability bias is always a risk when interviewing companies about environmental issues. Attempts to eliminate this risk completely represent a significant challenge. Wherever possible in this study, the approach was to use multiple informants, and to try to get figures on the operations. The author's involvement in organizing a seminar series about the topic also helped gain some additional insight into what different companies are doing.

Another limitation in the data collection was getting to interview sufficient amounts of people in each of the companies and the regions. In a few cases only one or two persons could be interviewed. The data of these cases is poorer than that of the cases that they are

compared to. A similar problem was faced with regional coverage. The data for the EU is much more extensive than the data for other regions.

The scope selected for the study also provides natural limitations for the applicability of the results. All of the companies included were from one industry and they were all large multinational companies. This limits the possibilities for drawing conclusions for other industries and smaller companies. Multinationals are commonly considered to be leaders in environmental issues, as they are faced with higher levels of public scrutiny than their more local counterparts. Care should be taken when drawing conclusions for the electronics industry in general.

8.4. Suggestions for Further Research

Previous research in the area of end-of-life management is mostly technical in nature and there is much room for examining strategic aspects of EOL management further. The findings of this study provide a good base for further empirical research. A survey could test the findings with a larger sample of companies.

Furthermore, the limitations of this study provide many openings for further research into this area. The focus of this study was on including four regions and multiple companies around similar products. This approach limited the scope of interviewees to managers in charge of end-of-life management. Interviewing marketing personnel and sales personnel could provide very interesting information on why companies are involved on specific levels in end-of-life management. Understanding the implications of market positioning would, for example, require their perspectives. The further exploration of capabilities as an explanatory factor would also require access to operations personnel. A study that goes deeper into a few cases by collecting data from different functions could provide more insight into the propositions of the different theories.

This study was explanatory and descriptive in nature. It did not aim at normative results. Normative results are naturally interesting from a practitioner perspective and from the perspective of policymakers. Future research could examine to what extent it is profitable

from a manufacturer's perspective to be involved in end-of-life management, more explicitly testing the resource-based theory.

Environmental effectiveness of extended producer responsibility legislation was beyond the scope of this dissertation. However, the empirical study analyzed how different companies are involved in end-of-life management in regions with different requirements and some interesting findings were made. The motivational issues related to the EU legislation would be worth looking into more deeply. The EU legislation provides limited room for innovation in how to comply with the Directive. Companies are not able to reduce amounts collected through their own programs from the quotas and if they set up individual systems they are faced with considerable financial implications in the form of guarantees. This seems to be contradictory with the aim of promoting reuse. If the companies are expected to innovate there should be sufficient room for different solutions that can help create competitive advantage. In the current systems, the playing field has been leveled. Interestingly, in Japan, manufacturers were active in reusing materials from products and offering take-back programs for B2C products. The Japanese system is not ideal, but creating a system with incentives for reuse could be interesting from an environmental perspective.

Finally, it would be interesting to examine whether manufacturer involvement in end-of-life management is the most effective way of achieving the environmental benefits that are sought. Virtually anything can be recycled, but the question is what to do with the recycled products? How do we develop markets for recycled products? The discussion goes quickly to a material level. How can you create a system where there is demand for recycled materials?

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Appendix 1: Terminology and Abbreviations

Back-end fee	Fee charged to consumers when they return their products when finished using them
Collective producer responsibility	Extended producer responsibility policy in which producers are responsible for mixed industry waste together.
Collective take-back system	System used to collect and treat end-of-life products shared by multiple companies.
Electronics waste (e-waste)	Used electronics products.
End-of-life (EOL)	Phase where the end-user has finished using the product
End-of-life product	A product that the end-user has finished using, used synonymously with the term "used product."
Extended Producer Responsibility (EPR)	An environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle. (Note: The focus in the dissertation is on take-back requirements.)
Front-end fee	Fee charged to consumers upon purchase of new equipment.
Individual Producer Responsibility (IPR)	Extended producer responsibility policy in which producers are financially and/or physically responsible for their own branded products.
Multinational Company (MNC)	A company that is headquartered in one country, but has operations in other countries
National Collective Take-Back System	An industry and country-wide scheme to manage end-of-life products

Product Recovery	Recovering value from used products, as opposed to landfilling them.
Product Life Extension	Refurbishing, remanufacturing used products
Recycling	Reclaiming material value of the product,
Refurbishment	Restoring the product to working order.
Remanufacturing	Restoring the product to as new condition.
WEEE	Waste Electrical Electronic Equipment, used synonymously with e-waste.
WEEE Directive	The EU Directive on Waste Electrical Electronic Equipment.

Appendix 2 Interviewees

Case	Job Title	Date	Mode
Alpha Computers	Key account manager, Europe	02.11.2005	phone
	Director Regulation Center, Taiwan	22.11.2005	phone
Bosch und Siemens	European affairs manager	24.11.2005	in person
	Technology manager, China	23.01.2006	phone
	Director of Product Safety, USA	30.01.2006	phone
Electrolux	Vice President Environmental and European Affairs, Electrolux Home products Europe	24.11.2005	in person
	Project manager Environmental and European Affairs	14.07.2005	phone
	WEEE Program Office Manager	30.07.2005	email
Fujitsu/ Fujitsu-Siemens	Vice President, Total Quality Management, Fujitsu Siemens Computers GmbH	23.11.2005	phone
	Consultant, Total Quality Management, Fujitsu Siemens Computers GmbH	23.11.2005	phone
	President of Corporate Environmental Affairs Unit, Fujitsu Ltd.	16.12.2005	email
Hitachi	Manager Corporate Environmental Policy Division	25.11.2005	in person
HP	Environmental Affairs Manager	1.09.2005	phone
	Director of Americas Take Back	6.03.2006	phone
Huawei	Quality and Environmental Manager, Europe	9.11.2005	email
Motorola	Director PRRCoE-Europe	10.1.2006	phone
	EMEA WEEE Coordinator	10.1.2006	phone
	Fellow of the Technical Staff & Director International and Environmental Research and Development PRR CoE-Asia PRR CoE-Europe	12.1.2006	phone
	Director of product business environmental health and safety (USA)	16.2.2006	phone
	Environmental health and safety Director for Asia-Pacific	15.3.2006	phone
	Head of environment, safety and health for the UK and Ireland	5.5.2006	phone
Nokia	Senior Environment Manager	10.5.2005	in person
	Service Product Manager (Nokia Networks)	2.12.2005	in person
	Regional Environment Manager, Americas	14.12.2005	in person
	Regional Environment Manager, Asia Pacific	7.12.2005	phone
	Quality and EHS Manager, China	14.02.2006	phone
NEC	Government affairs manager, Europe	19.12.2005	phone
	Chief Manager, Environmental Management Division, Japan	8.12.2005	in person
Philips	Senior Environmental Advisor, Europe	06.01.2006	phone
Samsung	Head of Sustainability, Europe	13.7.2005	phone
	Senior Manager Eco-planning, Korea	6.12.2005	phone
	Environmental Engineer, Korea	6.12.2005	phone
Whirlpool	Government affairs manager, USA	18.11.2005	phone
	Government affairs manager, Europe	16.11.2005	in person
	Government affairs manager, Europe	16.11.2005	in person

Appendix 3 Interview Guide

Section 1: Questions for global level manager

Company name	
Interviewed person	
Position in the company	
Contact information	
Web link	
Date of the interview	

Company level

1. Which of the following does your company have and when were they adopted?

   - A documented Environmental Management System?
   - ISO 14001 certification?
   - ISO 9001 certification?

2. How does your company measure and report the following items?

   - Energy consumption
   - Material consumption
   - Waste generation
   - Emissions generation

   2.1. Do you have specific targets for these items?

   2.2. When did your company start measuring these?

3. Please describe your company's organization for dealing with environmental issues and more specifically end-of-life products.

   3.1. How many people are involved?

   3.2. Which departments are involved?

3.3. In which regions are the people based?

4. Which issues in your company's environmental strategy are decided on a global versus a regional level?

4.1. What are the main differences, if any, in policies for the following issues in different regions?

Environmental criteria used in supplier selection
Use and reporting of toxic materials
Emissions measurement and reporting

4.1.1. If there are differences, what explains them?

5. Is environmental proactiveness a source of competitive differentiation for your company?

5.1. If yes, how does your environmental strategy differ from your main competitors'?

5.1.1. Please give examples.

6. What does your company consider to be the main opportunities for competitive differentiation related to managing end-of-life products?

6.1. Are these opportunities different in Asia, USA and Europe?

6.2. How do these opportunities differ for B2B and B2C products?

6.3. How are you exploiting them?

7. What does your company consider to be the main strategic opportunities related to the WEEE and RoHS Directives?

7.1. How are you exploiting them?

8. What are the main impacts of the EU Directives (RoHS and WEEE) on your supply chain?

9. What are the main financial impacts of the EU Directives on your company**?**

9.1. What if any have been the main investments made to comply with WEEE?

9.2. What if any have been the main investments made to comply with RoHS?

9.3. In which regions have these investments been made?

10. How do you expect EPR legislation to develop in the future?

10.1. What implications does this have on your company's environmental strategy?

Business Unit level

11. Please describe any initiatives that your business unit has been involved in related to end-of-life management. (who, when, where, why, which products,)

11.1. Did the initiatives involve reuse?

12. What are the main differences, if any, between the way that **your business unit currently manages** end-of-life products in Asia, USA and Europe?

12.1. Why are there differences?

12.2. How has it evolved over the last ten years?

12.3. What are the main changes that extended producer responsibility legislation has brought to the way end-of-life products are managed?

13. How do you measure the performance of your end-of-life management system?

13.1. Financial measures?

13.2. Environmental measures?

Section 2 - Questions for regional level manager

Company name	
Interviewed person	
Position in the company	
Contact information	

Web link	
Date of the interview	

1. Please describe your company's organization for dealing with environmental issues and more specifically end-of-life products.

   1.1. How many people are involved?

   1.2. Which departments are involved?

2. Please describe any initiatives your company has been involved in related to managing end-of-life products in your region.

   2.1. When and why were they started?

   2.2. Which products were they related to?

   2.3. What was the scale of these operations?

3. Please describe your strategy (s) for managing end-of-life products (reprocessing, players involved, outsourcing)

   3.1. Product focused on in interview.

   3.2. B2C products

   3.3. B2B products

   3.4. How has it evolved over the last ten years?

   3.5. What are the main changes that extended producer responsibility legislation has brought to the way end-of-life products are managed?

   3.6. How is your company planning to deal with individual producer responsibility for future waste?

4. What are the main financial impacts of the Directives on **your business unit?**

   4.1. What if any have been the main investments made to comply with WEEE?

   4.2. What if any have been the main investments made to comply with RoHS?

   4.3. Have you measured the financial impacts of the EU Directives?

5. What are the main investments that have been made for compliance to Japanese or USA extended producer responsibility legislation?

6. How do you measure the performance of your end-of-life management system?

   6.1. Financial measures?

   6.2. Environmental measures?

7. How does your company manage the different reporting requirements to the EU member states?

   7.1. Has your company developed any information systems to deal with WEEE and RoHS requirements?

      7.1.1. If yes, please describe.

8. How does your company plan to manage the reporting requirements of regional EPR legislation?

   8.1. Has your company developed any information systems to deal with regional EPR requirements?

9. What is your company's policy toward giving product information to recyclers?

   9.1. How and at what price will it be given?

10. What kind of an impact will the WEEE and RoHS Directives have on your relationships and contracts with:

   - Suppliers and subcontractors
   - Distribution channels

10.1. What kind of an impact, if any, will regional EPR requirements have on your relationships and contracts with them?

11. What does your company consider to be the main strategic opportunities related to managing end-of-life products?

12. What does your company consider to be the main strategic opportunities related to the WEEE Directive?

12.1. B2C products

12.2. B2B products

13. What are the major challenges posed by the WEEE and RoHS directives from **your company's perspective**?

13.1. How are you planning to overcome them?

14. What are the major challenges posed by regional EPR legislation from your company's perspective?

15. What does **your company** consider to be the benefits and shortcomings of the WEEE & RoHS Directives?

16. What does your company consider to be the benefits and shortcomings of the regional EPR legislation?

Appendix 4 Consumer Electronics Cases

This appendix includes three cases: Philips Consumer Electronics, Hitachi, and Samsung Electronics. Each case includes background information on the company, and a description of involvement in end-of-life management in the EU, USA, and Asia.

Case Philips Consumer Electronics

Background Information

Location of headquarters	Amsterdam, The Netherlands

	Total	Europe (includes Africa%	USA %	Japan %	China %	(Asia) %	Other
Company Turnover (billion USD, 2005)	35,853	42%	26%			26%	6% Latin America
Employees (2004)	161,586	43%	17%	-	-	31%	10%

Product category	**Global**
White Goods[21]	7%
Consumer Electronics[22]	33%
Information Technology	
Telecommunication	
Others[23]	60%

	% of company sales
B2B products	45%-60%
B2C products	40-55%

Philips' principal activity is the development and manufacture of electronic and electrical products. It has five product divisions: consumer electronics, lighting, semiconductors, medical systems, and domestic appliances and personal care (DAP). Philips does not publish any figures on the division between sales to consumer (B2C) and professional (B2B)

[21] The DAP business division which includes home and personal care products was placed under this heading.

[22] The Consumer Electronics division includes telecommunications products i.e. mobile phones.

[23] The others category in Philips' case includes medical equipment, lighting and semiconductors

markets. For the purposes of this study, it is estimated that up to 60% of its sales come from B2B products. Semiconductors, lighting, and medical systems were included in this figure whereas the other divisions were included under B2C products.

Philips manages corporate sustainability issues on a corporate and product division level. Decisions and targets for the sustainability strategy are made on a corporate level. Product divisions then translate the strategy to their level and implement it. Each product division has its own sustainability center that deals with environmental issues specific to their business environment. These centers include a few employees who serve as experts and auditors to the rest of the product division. Philips has however integrated environmental measures into all operating procedures and reporting formats. Each manager has performance measures related to sustainability, which contribute to their bonus.

Philips has global environmental standards for its products and processes. Standards have been made global mainly because its products move all over the world, but also for ethical reasons. Philips has sustainability officers in some of the national sales organizations. The amount of people depends on how important the area is from a sales perspective and how serious the local government is in sustainability issues. In principle, regional offices implement strategies that are developed in headquarters.

Philips has been working on environmental issues for three decades. Measurements related to the environmental effects of production began in the 1970s. Data still exists, but reliable statistics are a bit newer. Philips began a measurable, coordinated action to improve environmental development in the mid 1990s. Philips has developed a set of key performance indicators for major issues on their sustainable management agenda. For environmental issues, the focus is on energy use of products. The key performance indicator for this is the number of “Green Flagships” with energy consumption as a focal area.

Philips Consumer Electronics would like to see environmental performance as a source of competitive differentiation. However, they feel that the net result of legislation all over the world is a leveling of the playing field. Enforcement tends to focus on high profile companies for publicity value.

Involvement in End-of-Life Management of TVs

Global-Level Perspective

Philips Consumer Electronics' end-of-life management operations differ by region. However, everywhere in the world where there is work on extended producer responsibility, it is lobbying for the adoption of collective compliance schemes with visible fees.

The key differences between the regions are the sizes of the organizations dealing with the issues and the existence of activities. The differences in organizational size depend on the relative importance of the region in sales and the seriousness of the local government in developing take-back legislation. The existence of end-of-life management activities depends on whether local legislation has been passed. Philips Consumer Electronics has not developed any individual end-of-life management services anywhere. The reason why Philips Consumer Electronics has not been involved anywhere where it is not legally required is that there are no market forces to drive this behavior. Recycling TVs integrally is not profitable.

Philips Consumer Electronics has developed performance measures for end-of-life management in collaboration with Delft University. This collaboration resulted in a calculation mechanism through which Philips Consumer Electronics can calculate the positive recycling performance given the treatment alternatives. The performance measures for end-of-life management include the positive recycling performance and rate of toxic control.

The EU

Philips initiated a voluntary take-back project in the Netherlands in the mid 1990s called "Apparatur". The aim was to develop an understanding of the recycling possibilities of e-waste. The project included the investigation of costs, logistics, and the applicability of disassembly techniques. Disassembly was tested at a recycling company called Mirec, which was a Philips subsidiary at the time.

Based on its experiences from the pilot in the Netherlands and work with Delft University of Technology, Philips Consumer Electronics has decided to opt for collective compliance schemes everywhere in EU for WEEE compliance. Philips Consumer Electronics has not been involved in any initiatives for Consumer Electronics that would attempt reuse and remanufacturing. Philips Consumer Electronics has two employees specialized in end-of-life management in the EU. It does not current own any physical assets that are dedicated to end-of-life management.

Philips Consumer Electronics used to own a recycling facility in the Netherlands. The facility dealt with everything from factory reworks to office furniture refurbishment. At a later stage, it focused more on electronics and a lot was learned through it. Philips sold the facility because recycling is not a core competence. Philips Consumer Electronics does not own any recycling facilities. However, Philips Medical has its own refurbishment plant that has a turnover of about 15 million €.

The reason why Philips Consumer Electronics is a proponent of collective systems is financial necessity. Consumer Electronics products have a "structural recycling deficit". The products are made of glass and plastics, materials that have limited resales value. The revenues from recycling do not cover the costs of recovery. The recycling deficit cannot be reduced by designing the products differently as glass and plastics are necessary in TVs. TVs are not suitable for reuse; this is explained by their ratio of wear out vs. technology life. Consumer products come back in public systems. In public systems, everything that could be of value is taken out. Furthermore, there is a lot of second hand dealing of TVs. The dealers repair and recycle them and sell them to less developed countries.

Philips Consumer Electronics is not planning to opt for individual compliance, because of the need for economies of scale, which are essential for collection (collection accounts for 40% of the total costs). Recycling costs for its products are lower than those of its competitors' due to eco-design. In older products, the difference in treatment costs is 50%, in newer ones it is about 15%. The maximum differentiation is about one € per item in treatment costs. The amount is so small that from their perspective it does not make

sense to break up a collective system and lose the economies of scale related to it to benefit from ecodesign. If it were allowed, a mixed system would be possible. In such a system, goods would be collected collectively, but if an individual company wanted it could opt take its own products out for separate treatment.

The impact of extended producer responsibility legislation is being involved in collection and treatment systems everywhere in the EU. The financial impacts of the WEEE Directive would be tens of millions of euros if Philips were to pay for treatment. Philips Consumer Electronics is an advocate for visible fees to cover these costs. Apart from the direct costs, the WEEE Directive has also resulted in hiring consultants and lawyers and developing information systems to address the reporting requirements. Philips Consumer Electronics has a very clear picture of costs related to collection and treatment, but the organizational costs of compliance have not been measured.

USA

Philips has participated in joint industry collection events in the USA, but it is not systematically involved in end-of-life management activities where it is not legally required. Philips has an employee who dedicates a part of his time to monitoring the development of extended producer responsibility legislation in the USA. Philips does not have physical assets dedicated to end-of-life management in the USA. In states where legislation is under development Philips, Consumer Electronics is lobbying for a collective compliance schemes financed with visible fees.

Asia (Japan and China)

Philips has an employee based in Singapore who dedicates a part of his time to monitoring the development of extended producer responsibility legislation in Asia. Philips does not have physical assets dedicated to end-of-life management in Asia.

In countries where legislation is under development, Philips Consumer Electronics is pushing for a collective system. In China, the main challenge is collection, not actual treatment or outlets for recycled materials. No one would return used products to collec-

tion points. The reasons for this are that the secondary market is very active and that the level of income is very low compared to the price of electronics products.

Product Level

Philips Consumer Electronics products are made according to global standards. Environmental standards used are the same in products offered on all markets.

Five green focal areas for design for environment were introduced in Philips Consumer Electronics' 1998 EcoVision program that is focused on when developing new products:

- Weight
- Hazardous substances
- Energy consumption
- Recycling and disposal
- Packaging

There are some differences between business units so they reflect areas of particular need. However, the list of banned substances is corporate wide.
There are three categories of banned substances:
Category 1: restricted
Category 2 use must be avoided as much as possible
Category 3: use reduced within good housekeeping guidelines

Complying with the RoHS Directive has required a lot of work, but it is technically manageable from Philips Consumer Electronics' perspective. The costs are distributed within the organization so it is hard to evaluate how large they are. Philips Consumer Electronics started a program in 1993 called the chemical content program aiming at knowing what chemicals they have in products. Aside from lead, all the materials of the RoHS Directive were banned in 1995. Philips has been working on lead free soldering since 2000. The RoHS directive did not have an impact on supplier relationships because they were already used to Philips' restrictions.

Case Hitachi Limited

Background Information

Location of headquarters	Tokyo Japan

	Total	Europe %	USA %	Japan %	China %	(Asia) %	Other
Company Turnover ($ 2005)	84 billion	5%	9%	70%	-	15%	1%
Employees	355879						

Product category	**% Turnover in 2005**
White Goods	
Consumer Electronics (including home appliances)	12%
Information Technology (including telecommunication systems)	21%
Telecommunication	
Others	67%

	% sales
B2B	88%
B2C	12%

Hitachi, Ltd. and the Hitachi Group make up a corporate group of a total of 1,090 companies. Hitachi Limited's principal activity is to manufacture electronic and electrical equipment. It has seven product divisions: power and industrial systems; information and telecommunications systems; high functional materials & components: electronic devices; logistics services; financial services; and digital media & consumer products which manufactures the products included in this study including manufactures air conditioners, household appliances and audio/visual products. Hitachi does not publish figures on the division between B2B and B2C products, but, out of the product divisions, digital media is the only one that produces consumer products. Here B2C is therefore the digital media and consumer products sales and the rest is included in B2B.

Hitachi Ltd. has about 100 people working on environmental issues in Japan. All waste, energy, and environmental management policies are designed there and implemented globally. Hitachi aims on having as few differences as possible between the different regions. Hitachi established its environmental management center in 1971 and incorporated environmental measurements in its business practices in 1973. Hitachi has been highly commended for its CSR activities. Hitachi Ltd. does not see that environmental management is a source of competitive advantage amongst the Japanese companies.

Involvement in End-of-Life Management

Global-Level Perspective

Hitachi has end-of-life management operations for its B2C products in the EU and in Japan. For its B2B products, Hitachi has a global recovery service. It provides global recovery services through a network of service providers.

The EU

Before the WEEE Directive was passed, Hitachi did not have any end-of-life management operations in the EU for its B2C products. To comply with the Directive Hitachi has opted to join national collective take-back systems in all the countries that it operates. There is one person in the EU who deals with the environmental issues on a full-time basis at Hitachi regional headquarters and one person in each European Hitachi subsidiary (about 20 in total).

The main financial impact of the WEEE Directive has been employee time and the direct compliance costs. Hitachi has dealt with the WEEE requirements with existing information systems and employees.

In general, the WEEE Directive is not something that Hitachi sees as a potential source of competitive differentiation. There could, however, be some potential in getting lower costs than the competitors in, for example, registration costs. Hitachi could register only once instead of as several different business units.

USA

In the USA, Hitachi has not invested in any recycling capabilities and has no plans to do so. Where necessary, Hitachi will join collective compliance schemes. California is the furthest in developing legislation, but so far it has not had very big impacts on Hitachi. Hitachi has not developed organizational capabilities for dealing with environmental issues in the USA. These issues USA are coordinated from headquarters in Japan.

Asia

Hitachi is currently involved in end-of-life management in Japan in Asia. In Japan, manufacturers are responsible for their own waste in the white goods sector and they have to opt into one of two collective compliance schemes. Hitachi belongs to group B. The difference between group A and Group B, according to Hitachi, is that group B invests more in new technologies trying to bring recycling costs down.

Within Group B, Hitachi has its own recycling company, Tokyo Eco Recycle, in Japan. About 20 people work on issues related to end-of-life management in Japan. Hitachi and its subsidiaries have about 100 people working on environmental issues full or part time in Japan. Hitachi also has a manager in charge of environmental issues in China.

Hitachi established Tokyo Eco Recycle in 1999 as a response to the Japanese law recycling of specified kinds of home appliances. Hitachi owns 51% of Tokyo Eco Recycle. Tokyo Eco Recycle collects four kinds of machines and used plastics and develops secondary raw materials from them. Hitachi uses some of these recycled materials in its washing machines and refrigerators.

Hitachi offers take-back services for B2B products. In some cases, when it makes sense for commercial reasons, they offer the services for free. If there is demand for a certain type of used product, Hitachi tries to get them from the market proactively and it pays a refund to get them back. In Japan, Hitachi is unable to take-back products unless it plans to reuse them. Recycling B2B products requires a specific license that Hitachi does not have.

Design for Recovery

Apart from its white goods, Hitachi's consumer products are the same globally. Safety standards for washing machines are very different, for example, and Hitachi does not sell them in the EU. Environmental standards are the same globally for all Hitachi products. The standards are the same globally, because the products are distributed globally. If the products would have different environmental standards, there would be liability risks if a product entered the European market.

Lead causes the most challenges for Hitachi's products. As for the other materials banned by the RoHS Directive, Hitachi had phased them out in advance of the legislative requirements. Hitachi's own list of banned substances is stricter than the legislation. Hitachi did not have to make any investments to comply with RoHS and the Directive did not cause any changes in its supplier base. Hitachi worked together with its suppliers to implement the necessary changes, though the negotiations with them have required a lot of work. All of Hitachi's products within the RoHS scope have been designed to be RoHS compliant globally.

Case Samsung Electronics

Background Information

Location of headquarters	Seoul, Korea

	Total	**Europe %**	**USA %**	**Japan %**	**China %**	**(Asia) %**	**Other**
Company Turn-over (Billion USD, 2004)	79	21%	23%			54%	

Product category	**%turnover**		% of company sales
White Goods	3,1%	B2B products	31,6%
Consumer Electronics[24]	28,9%	B2C products	68,4%
Information Technology			
Telecommunication	32,7%		
Others	31,6% (semicon-ductors)		

Samsung Electronics manufactures and provides semiconductor, telecommunication and digital convergence technology products and services. It is part of the Samsung group and it consists of five main business units: digital media, telecommunication network, digital appliance, semiconductor, and LCD. Samsung does not report a ratio between B2B and B2C sales. For the purposes of this study, semiconductors were counted as B2B. The figure for B2B is higher in reality as digital media and entertainment and telecommunication both include B2B and B2C products.

[24] Here, 28.9% corresponds to digital media and entertainment which includes IT products such as PCs and printers.

Samsung has two environmental organizations: one focused around product-related issues and the other focused around production-related issues. A total of 30 people work on product-related environmental issues on corporate level. In addition to the corporate level staff Samsung has 3-4 employees in each of its ten product divisions focusing on product-related environmental issues.

Samsung has been measuring the environmental impacts of its production units since 1992 and reporting them since 2001. Samsung has the same environmental standards in use in all its factories and for all its products globally. All domestic factories obtained ISO 14001 certification by 1996. All overseas production units achieved it by the end of 2003. Gaining competitive differentiation by being environmentally proactive is a strategic aim of the company. Design for environment is one of the key ways of achieving this.

Involvement in End-of-Life Management of Handsets and TVs

Global-Level Perspective

Decisions related to end-of-life management strategies are made at corporate HQ based on information collected in the regions. Samsung has a different end-of-life management strategy in each of the regions. Key differences are in the level of investment. In Korea Samsung has its own recycling facility. The main reasons for this are the lack of market knowledge in other regions. As soon as regional knowledge is improved, Samsung might re-evaluate its strategies. For some products such as cartridges, Samsung is aiming for a global take-back process. High spec plasma screen TVs also offer some interesting opportunities for global take-back.

Samsung feels that end-of-life management will become an equal value proposition for customers, along with quality, value for money, function, and image. The main opportunities for competitive differentiation are getting lower costs than the competitors, improving corporate image and eco-design. Samsung sees that opportunities rise from its large volumes that will enable them to get better service at lower prices. Negotiation with the distribution channel on how they handle the returns can also be a source of competitive

differentiation. Taking back products when new ones are sold is a cost-effective way of taking care of some the amounts needed for compliance.

The EU

Before the WEEE Directive, Samsung's EOL management in the EU could best be characterized as providing ad hoc services. In some business units, key customers were offered take-back services while in others customers were directed to approved treatment providers.

Samsung has a company-wide policy for dealing with the WEEE Directive. The main differences in end-of-life management are between B2B and B2C products. These are due to the differences in legislative requirements. To comply with the WEEE Directive Samsung is negotiating membership of a consortium, which covers several of the territories in the EU. In countries where it does not operate, it has joined other collective compliance schemes. Samsung is not involved in refurbishment activities in the EU for handsets and it does not collaborate with third party refurbishers.

Samsung sees that there are many benefits to IPR, but there are a lot of technological barriers before it can even begin to become a reality. The key benefit would be complete cradle-to-grave control over financial and environmental costs of its products. IPR would help in achieving the financial benefits of eco-design. However, the current legislation does not provide that link between the investment in design and the reduced recycling costs, because all waste is collected on a collective brand and age basis. Samsung would certainly consider it with much more if it were technologically feasible. It has already been successfully operating its own collection and treatment services in Korea for years.

The WEEE Directive has caused major investments in staff resources, development costs of software, and legal advice for Samsung. Samsung has three employees that focus only on the WEEE Directive in The EU. Additionally, Samsung has someone in each member state monitoring the issues on a full or part time basis. In addition, about 200-300 people have been affected by the WEEE and RoHS Directives in logistics, product development, and system development.

To deal with the reporting requirements specified by the WEEE Directive, Samsung has developed a new database solution that tracks several different environmental criteria (net weight of unit, weight of all accessories, weight of packaging material by type, batteries, type, information for treatment providers on the location, and type of hazardous materials, if any) for each product that is developed. The required data needs to be in the system before a product is allocated a model number. The product cannot be sold before the data is fed into the system. The database is linked to SAP systems and sales volumes and will enable reporting of net weight volumes per region/customer account. These are significant investments, although they are small compared to actual annual compliance costs (registration, collection, recovery, and treatment) which are estimated at around 0, 5 % of their European turnover (2~3% for White Goods). There are many different sides to the argument on visible fees. Samsung feels that the only way visible fees will ever work in practice is when they are mandated by law and not optional. The fee that the manufacturer charges to the first buyer (distributor or retailer) needs to be protected by law. If it is not protected the buyer will try to push the price down to keep magic price markers. A visible fee is one way to make sure that the public does actually make a contribution to treatment costs. Another issue that needs to be dealt with is that the fee is not automatically given to any one organization.

In all contracts that Samsung has signed it has made sure that performance criteria and monitoring requirements have been included. Wherever local authorities have defined regulations for performance, they are used. Where they do not exist, Samsung has its own stringent requirements. Examples of measures used are mass balance figure in/out, residues lost in process, and % of materials not recovered or not recoverable and sent for incineration.

USA

Samsung is involved in many industry take-back pilots in the US at the moment. In the USA, the strategy has to go state by state because the legislative requirements differ. The company anticipates that most states will follow the European example. So far, US ex-

tended producer responsibility legislation has not had much of an impact on the manufacturers; in California, for example, the money is raised from consumers.

Samsung American QA Lab, located at Rancho Dominquez, CA, has two full-time environmental managers who are monitoring US and Canadian legislations, developing voluntary end-of-life management programs, and providing regulatory compliance activities to the state governments. End-of-life management is part of their focus area.

Asia (Japan, China, and Korea)

In Asia, Samsung is involved in product end-of-life management in Korea and Japan. Samsung set up its own recycling plant in 1998 in Korea that treats mixed consumer e-waste. The recycling plant was set up because there was no recycling infrastructure in Korea. The largest companies (e.g., LG and Samsung) all set up plants. More than 635,000 products (or 22,000 tons) were treated in Samsung's recycling facility in 2004. Samsung electronics also established the Metropolitan Recycling Center in 2003 as a joint initiative with four other Korean electronics companies. Samsung has four people at corporate headquarters dealing with EOL management on a full-time basis. Additionally, Samsung has five employees that manage the domestic end-of-life practice in Korea, with someone in each country's sales office monitoring local legislative developments.

In Japan, Samsung is a member of the consumer electronics recycling organization of Japan. Costs are covered through fees collected from consumers, so it does not really affect Samsung's business. Since October 2003, the corporation has a partnership with Mitsubishi Electrics & Electronics and others for the compliance with the recycling law for PC.

Product Level

Samsung has global standards for its products. There are no regional differences in environmental performance of the products. Many design improvements have been made with recovery in mind. There have been investments in R&D in finding better design approaches to improve structural rigidity of certain plastics moldings to reduce the amount of polymers per design and the variability of materials. Another particular design im-

provement involves handsets with LCD screens. LCD screens of handsets are buried in highly protective panels to increase possibilities for reuse.

Samsung sees eco-design as a potential source of competitive differentiation. Environmental technology related to LCD displays can become an important source of competitive differentiation. Samsung Electronics has been applying Life Cycle Assessment (LCA) and Design for Assembly/Disassembly/Recycle/Service (DfX) methods to all its products since 1995. In 2004, Samsung Electronics adopted the Eco-Design process to help determine and improve environmental quality at the product development process.

Product environmental performance is divided into three general groupings: Resource Efficiency, Environmental Hazardousness, and Energy Efficiency. Each of these groupings is classified into specific areas for assessment, and performance targets are established and applied in the process of developing new product. Eco-Design began as a pilot program for some printer and refrigerator models in 2004, and the Eco-Design process is expected to be applied strategically to all product lines in 2005. From 2006, it is expected to be in force for all new product development.

Samsung has also made large investments in phasing out of hazardous chemicals, which makes recycling easier. The RoHS Directive has lead to a considerable reduction in the number of suppliers at Samsung. Approximately three years ago Samsung had between 3000 and 5000 suppliers, each supplying up to 2000 components. There has been a considerable effort to rationalize the supply chain to fewer suppliers who have been able to demonstrate that their products comply with Samsung's internal demands on the phase-out of hazardous substances and energy efficiency, as well as the other demands we have for our suppliers. These efforts have involved 600 staff members auditing suppliers.

Appendix 5 Information Technology Cases

This appendix includes four cases: Alpha Computers, Hewlett Packard, Fujitsu (-Siemens) Computers, and NEC. Each case includes background information on the company, and a description of involvement in end-of-life management in the EU, USA, and Asia.

Case Alpha Computers

Background Information

Location of headquarters	Taiwan

	Total	**Europe %**	**USA %**	**Japan %**	**China %**	**(Total Asia) %**	**Other**
Company Turnover ($ 2005)	9,68 billion	53%	11%			20% Taiwan	15%

Product category	**Global**
White Goods	
Consumer Electronics	
Information Technology	100%
Telecommunication	
Others	

Alpha Computers' principal activity is marketing its own brand name information technology products. Other activities include repair and maintenance services of their own brand name products. Alpha is best known for its notebook computers and it generates most of its sales from the B2C market.

Alpha Computers has five full-time employees working on environmental issues in its corporate headquarters in Taiwan. Alpha Computers also has one employee working on the issues part-time in the EU.

Alpha Computers has global standards for all environmental issues related to products and production except end-of-life management. End-of-life processes are designed regionally because of the differences in legislation. Alpha Computers does not measure any production- related environmental measures because it does not have its own production facilities. Alpha Computers published its first environmental report in 2005. The organization does not see environmental proactiveness as an opportunity for competitive differentiation.

Involvement in End-of-Life Management of PCs

Global-level perspective

Alpha Computers does not have any employees focused solely on product end-of-life management. It has not been involved in any voluntary EOL management initiatives and it does not have experience from components reuse. Further, Alpha Computers does not view end-of-life management or complying with the EU Directives as a strategic opportunity. For Alpha Computers, the RoHS and WEEE Directives are environmental issues. As they see it, the main issue is to get the old products off the market and replace them with new more environmentally friendly products that contain less hazardous substances.

The EU

Before the WEEE Directive, Alpha Computers EOL management in the EU was limited to participating in the existing collective recycling schemes in Norway, Sweden, the Netherlands, Belgium, and Switzerland.

Alpha Computers' strategy to deal with the WEEE Directive varies by member state. In some countries (such as Belgium, Switzerland, Austria, Finland, and Sweden) joining the collective scheme is the only possibility. In countries where it is feasible, Alpha Computers is planning to use the services of a third party service provider that offers a Pan

European compliance service. The main reasons for this include higher efficiency, better control, lower costs, less need for owning manpower in each country, and dealing with the WEEE Directive. This service will take care of compliance requirements for both B2B and B2C customers. Alpha Computers does not own any tangible assets dedicated to product recovery in the EU.

In addition to the environmental efficiency measures specified by the WEEE Directive, Alpha Computers measures the economic efficiency of its collection and recycling operations by cost per ton. The main investment made to comply with WEEE is employee time. However, Alpha Computers has not hired any new employees to focus solely on WEEE. Environmental policy and strategy are handled by headquarter support to local operations in The EU. One key account manager is using about 20% of his time to manage the issue on a higher level and employees in Alpha Computers country sales offices are using some of their time to deal with issues such as registration and keeping up to date with local legislative requirements. As for RoHS, there are eight people working on compliance issues in Alpha Computers' business units. The cost impact of the WEEE Directive has been measured in terms of annual collection and recycling costs.

USA

The main involvement in end-of-life management at the moment is compliance with the California legislation, which targets monitors. More recycling services will be started in the USA as this legislation develops. End-of-life management policy and strategy are handled by headquarter support to the local operation in the USA. Alpha Computers does not have dedicated personnel resources managing EOL products.

Asia

Alpha Computers participates in the national compliance schemes in Japan and Taiwan. In Taiwan, the product take-back programs for batteries, printer toners, and personal computer equipment from business and consumer customers is handled through the government- created EPA (Environmental Protection Administration) Recycling Management Fund. The fund consists of recycling fees paid by computer manufacturers. Private entities are authorized to carry out other computer equipment waste disposition and recy-

cling processes, in accordance with the prerequisite EPA licenses, depending on waste category and handler's expertise.

Alpha Computers does not have any employees focused solely on end-of-life management in Asia. At its headquarters, product end-of-life management is managed through the environmental department. In other Asian countries, the activity is managed with headquarter support to local operations.

Product Level

Alpha Computers' products have global design. There are no regional differences in products. Alpha Computers has been active in eco-design for a longer time. In 1991, for example, Alpha Computers developed the first screwless PC design.

For an organization considering recovery options, the main considerations involve:

- Avoiding bonding and soldering different materials
- Avoiding using surface adhesive technologies on plastic components
- Labeling plastic materials and recyclables.

To provide environmental information about its products, Alpha Computers applies the IT Eco standard. Alpha Computers also provides this information on a selection of its products on its website. The environmental information it provides is the same globally. Alpha Computers has recently undergone a thorough environmental audit. The two areas requiring the most attention were use of toxic materials and insufficient use of recycled materials.

About 30-40% of the metal parts used are recycled materials. Alpha Computers would like to use more recycled materials if availability was better. As for hazardous materials, Alpha Computers uses the OSPAR list for checking material content. Alpha Computers prohibited use of BP, HG, and non-regulated halogenated flame-retardants in its IT products in advance of the regulatory requirements.

With RoHS, a major challenge is ensuring that product performance is not compromised due to changes made for compliance. This is an important issue, especially for servers. Rigorous performance testing of the products will be made to ensure quality. The process of checking that all suppliers are RoHS-compliant has also posed some challenges.

Company A set an internal deadline for RoHS compliance for Q2 2006. All but one of Company A's suppliers will be able to meet the deadline. The challenge is phasing out lead. Removing brominated flame retardants (except for PBBs and PBDEs) and PVC will be the challenges. Company A hopes to make these changes within the next three years.

Apart from employee time in business units, Alpha Computers' suppliers have made the investments to comply with RoHS. Alpha Computers has been working with its suppliers in Taiwan to comply with RoHS. The RoHS Directive has not lead to a reduction in the number of suppliers.

Case Fujitsu Limited/ Fujitsu Siemens Computers

Background Information (Fujitsu Limited)

Location of headquarters	Tokyo, Japan

	Total	**Europe %**	**USA % (Americas)**	**Japan %**	**China %**	**(Total Asia) %**	**Other**
Company Turn-over ($ 2005)	44,528 billion	12 %	6%	75%			7%

Product category	**Global**
White Goods	
Consumer Electronics	
Information Technology (platforms includes some telecommunication too)	36%
Telecommunication	
Others (software and services, electronic devices, others)	64%

	Global
% of company sales B2B products	64%
% of company sales to B2C products	36%

Fujitsu Limited's principal activities involve manufacturing computers and information processing systems, communications systems, electric components and equipment, audio navigation systems, mobile telecommunication equipment, and electronic devices. Operations are carried out through the following sectors: Service and Software, Platforms, Electronic Device, and Others.

Fujitsu Limited does not formally announce the division between sales to B2B and B2C customers. The figures here have been calculated based on sales reports from product divisions. B2B includes Software and Services, Electronic devices, and other operations.

B2C includes platforms. However, in reality, the figure for B2C is lower because the platform's unit includes B2B products such as servers, mobile/IP networks, and transmissions systems, in addition to PCs and handsets.

Background Information (Fujitsu Siemens Computers)

Fujitsu Siemens Computers was established in 1999 through the merger of Fujitsu Computers The EU and Siemens Computer Systems. It is a 50:50 joint venture between Siemens AG and Fujitsu.

Location of headquarters	Maarssen, The Netherlands

	Total	**Europe, Middle East and Africa %**	**USA %**	**Japan %**	**China %**	**(Total Asia) %**	**Other**
Company Turnover (€ 2005)	6,7 billion	100%					
Employees (in 2005)	7000						

Product category	**Global**
White Goods	
Consumer Electronics	
Information Technology	100%
Telecommunication	
Others	

	Global
% of company sales B2B products	74%
% of company sales to B2C products	26%

The top decision-making organ in Fujitsu's environmental management system is the management council, which is headed by the president. The Corporate Environmental Affairs Unit at Fujitsu Headquarters oversees environmental management. There are also committees for different environmental activities, such as green products, product recycling which transcends business group and divisional frameworks. Additionally, there is

an environmental committee, which oversees the work of these groups and reports back to the Corporate Environmental Affairs Unit.

Fujitsu has had a documented environmental management system since 1995 and it started environmental accounting in 1998, which allows it to track costs and benefits related to environmental investments. Fujitsu started environmental production-related measurements in 1991, and has been reporting them since 1996.

Fujitsu has established a worldwide integrated ISO 14001-based framework for environmental management in March 2006, covering Fujitsu group in Japan, and now 11 group companies outside Japan, for a total of 102 companies that are primarily involved in manufacturing. Establishing an environmental management system geared toward Fujitsu's global supply chain enables the company to strengthen the governance of, and increase the efficiency and effectiveness of, its environmental activities. Fujitsu has 34 non-manufacturing group companies overseas whose environmental impact is relatively insignificant, and these companies are not covered by Fujitsu's worldwide integrated certification. However, these companies are promoting environmental initiatives by establishing their own environmental management system based on corporate environmental policies.

Fujitsu considers environmental proactiveness to be a source of competitive differentiation. The main way that their strategy differs from their main competitors' is the level to which it is implemented throughout the organization. Environmental consciousness is fostered in all employees, which leads to the development of new environmentally conscious products and services.

Involvement in End-of-Life Management Of Pcs

Global-level perspective

Fujitsu has a different end-of-life management strategy in each region. The reasons for this are the differences in national legislations, treatment infrastructures, cultural, and social requirements.

The main strategic opportunity related to end-of-life management is providing recycling as one of the Product Lifecycle Solution services. It is an opportunity for Fujitsu to work together with the customer in a partnership to reduce the environmental burden of the products.

The differentiating factor related to competitors is that Fujitsu will offer these services earlier. Fujitsu considers the compliance to WEEE and RoHS directives as one of their main strategic opportunities to promote further with applicable environmental protection policy.

Opportunities do not differ regionally, but there are differences in legislative backgrounds, treatment infrastructures, cultural, and social requirements. Implementation has to take all these aspects into consideration. There are some cases in which regulations differ for B2B and B2C products. It may be comparatively easier to cooperate with the customer in B2B cases.

The EU

Fujitsu Siemens Computers' remarketing and recycling operation was started in Germany in 1988. Fujitsu Siemens Computers collects used products from mainly business customers and brings them to the Remarketing and Recycling Center in Paderborn. Complete systems are refurbished and sold for reuse if possible. If this arrangement is not feasible, individual components are removed, refurbished, and used for maintenance and repair purposes. The remaining parts are dismantled and recycled.

The volumes of recyclables collected fluctuate greatly over years, but about 5000 tons of used products are collected in an average year (compared to about 25 000 tons of new equipment sold per year in Germany). 15-20% of what is collected can be resold as a complete product. The rest is dismantled into 50 different materials, i.e., capacitors, batteries, aluminum and steel. Only 2 % of the collected amount has to be disposed. Take-back services are often a spot business. Customers ask Fujitsu Siemens Computers for specific old equipment. Then, Fujitsu Siemens Computers tries to find it in the market,

purchase it, and refurbish it for the customer. Banks and insurance companies are typical examples of customers that have special types of computers and want to have the same computers when they expand so that they can run the same software on all machines. Fujitsu Siemens Computers' recycling center was just a cost in the beginning but now it is a profit center. Besides the direct income derived from the reuse activities, value is added from a marketing perspective through the take-back of old equipment. Experience from the recycling center has also improved the design qualities of the products. Moreover, there is a learning loop between the recycling center and the engineers developing new products.

The main change that the WEEE Directive has brought to Fujitsu Siemens Computers' operations is that it now has to deal with B2C products, too. The recycling center works as Fujitsu Siemens Computers compliance scheme for B2B products. For B2C products, Fujitsu Siemens has contracts with service providers that take care of collecting the products from municipal points and delivering them to their treatment facilities. The electronic waste that is collected by the communities from private households is not refurbished and resold. It is transported to the nearest possible recycling center, dismantled, and recycled for material content. The aim is to recycle and sell valuable substances as secondary raw materials. Fujitsu Siemens Computers has an individual compliance scheme for the WEEE Directive in Germany with two logistics and recycling partners. In other EU countries, Fujitsu Siemens Computers participates in the national schemes. If there is no national scheme available the operation works in a similar way, as in Germany.

Fujitsu Siemens Computers did not have to make many investments to comply with the WEEE Directive, as it already had a system in place in Germany. No additional employees were hired and no additional facilities were set up. The main issue was incorporating what had to be done into the company's internal processes. Information and reporting requirements will be handled by expanding existing systems. One person dedicates most of his time to support end-of-life management at Fujitsu Siemens Computers in The EU. Additionally there are people involved in every department, including legal, who devote a

couple of hours a week to the issue. Finally, there is one person in each of the sales countries who is responsible for monitoring local recycling concepts and contacts.

Fujitsu Siemens Computers has estimated that it will cost them 8-9 million € to get everything ready for the WEEE and RoHS Directives. This figure includes all investment in machinery, people working on the issues, and the process costs. As financial performance measurements, Fujitsu Siemens Computers tracks the costs and income related to collection and treatment. On the environmental side, Fujitsu Siemens Computers measures what happens to the material content and how much of it gets recycled.

There is no actual visible change so far in contracts with distribution channels. However, there is much ongoing discussion with large distributors on how to handle registration so you don't "put the products on the market" twice. This is a challenge. Fujitsu Siemens Computers does not support visible fees. For now they are watching how the competition is reacting. A motivation for them would be if their customer would need it. The dealers in many countries are used to meeting certain price points. They don't care what is included or not included as long as you meet the expected price point of, e.g., 399, 599 or 799 Euro.

Fujitsu Siemens Computers and their recycling companies do not see any specific need to give information on how to recycle computers to recyclers. Recycling companies know how to do it. Fujitsu Siemens Computers will be prepared if questions arise, but at the moment this does not seem likely. Fujitsu Siemens Computers supports individual producer responsibility. They have already implemented it in the EU and Norway and Switzerland.

USA

Fujitsu is not involved in end-of-life management operations in the USA. Its target is to establish recycling systems in North America by the end of March 2007. Fujitsu Computer Systems Corporation has an employee in the quality organization that monitors legislative developments in the USA.

Asia

In Asia, the Fujitsu Group has been involved in take-back initiatives in the Republic of Korea, Taiwan, and Japan. Fujitsu Group companies in the Republic of Korea and Taiwan have already begun recycling PCs. Fujitsu's target is to establish recycling systems in Asia by the end of March 2007. In China, Fujitsu is still looking at developing appropriate recycling systems.

In 1995 Fujitsu established a service that recovers used equipment from corporate customers in Japan. At that time, the company established a recycling center , and further established the first nationwide Fujitsu Recycling System (FRS) in the industry in 1998. Fujitsu currently has seven recycling centers in Japan. It collected 14070 tons in 2004 and its recycling rate was 88.3%. Its target is to improve this to 90% by the end of March 2007. Fujitsu also recovers and refurbishes computers and components.

The main change that EPR legislation brought in Japan in 2003 was the need to treat consumer products too. The main investments that have been made to comply with Japanese EPR legislation have been the establishment of recycling centers and systems to link with logistics partners for both private and corporate customers. Fujitsu handles its product end-of-life management operations from its Corporate Environmental Affairs unit in Japan. One person in the Corporate Environmental Affairs Unit has been assigned to promote establishing recycle system in Asia on a full-time basis in Japan.

Fujitsu in Japan also has a web-based system that provides Fujitsu recycling centers with information about procedures for dismantling and disposing of Fujitsu products in an appropriate manner. This includes information pertaining to the chemical substances included in the product, the materials used in plastic parts, and units that still retain customer data. Japanese EPR legislation has not had any impacts on contracts and relationships with the supply chain and distribution channels.

Design for Recovery -- PCs

There is no regional environmental customization. Customizing is done on customer request, and there is no regional customizing in Europe. Eco-design is considered to be a source of product differentiation for PCs. The main ways in which recovery is taken into

consideration are the promotion of materials that require fewer natural resources, like plant-based plastics, and recycled plastics. Recycled plastics have been used in notebook PCs since 1998, and in desktop PCs since 1999. The aim is to increase the use of recycled plastics to 20% by the end of 2006. Fujitsu has used recyclable paints on its plastics since 1999.

Environmental information about products is provided in accordance with ISO standards for environmental labels definition. Type-I, Type-II, and Type-III labels have been certified or clarified and applied to products.

Use of toxic materials has been measured since 1995. Hazardous materials have been phased out in the regions, based on each country's regulations. The main challenge related to RoHS has been communication with the supply chain. Fujitsu has tackled this by organizing explanatory meetings with its suppliers to get cooperation. The task of bringing all of the players in line for every component is a challenging one, as Fujitsu Siemens Computers has thousands of components in its warehouses. Further, the RoHS Directive has thus far not led to a reduction in the number of suppliers.

Lead-free soldering has required roughly half a million € investment into each of Fujitsu Siemens Computers' eleven production lines. These investments were already started in 2002, and the target will be met earlier than legally required, so lead-free soldering does not pose problems--as long as the product comes from Fujitsu Siemens Computers' own production lines.

Case Hewlett Packard

Background Information

Location of headquarters	USA

	Total	Europe %	USA %	Japan %	China %	(Total Asia) %	Other
Company Turn-over (billion $, 2005)	86,696	42%	35%			16%	7% Other Americas

Product category	**Global**
White Goods	
Consumer Electronics	
Information Technology	88%
Telecommunication	
Others (services and software)	12%

	% of company sales
B2B products	40
B2C products	60

Hewlett Packard is a technology solutions provider. Its operations are organized into seven business segments (% of turnover): Enterprise storage and servers (19%), HP Services (18%), the personal systems group (31%), the imaging and printing group (29%), HP financial services (2%), and software and corporate investments (1%).

HP does not report the ratio between B2B and B2C sales. B2C here contains the printing and imaging group and the personal computing group, both of which contain significant B2B sales as well.

HP has a dedicated environmental organization in The EU, the Americas, and Asia. It also has a forum that meets every three to six months to share direction on legislative developments and treaties in each of the continents. The organizations in each region are coordinated from a higher level.

In principle, the environmental strategy is the same in all regions of the world and the tendency is toward everything becoming even more similar. There are some differences that mainly come from there being a specific regulatory requirement to take specific action in a specific location. Hewlett Packard considers environmental proactiveness to be a source of competitive differentiation.

Involvement in End-of-Life Management

Global Perspective

HP offers its customers five follow-on services when they are finished using a product:

- *Recycling Service*
- *Donation*

  Working hardware can be donated to charitable organizations through the National Cristina Foundation in the USA.
- *Trade in*

  Customers in The EU, USA, and Australia have the opportunity to trade in their used hardware and upgrade to new HP products, while receiving credit for the value of used equipment. Used equipment is sold on the secondary market or recycled.
- *Asset recovery*

  HP provides enterprise, public sector, and large commercial customers the option of receiving cash or credit for qualifying used equipment. This service is offered worldwide. Under the arrangement, proprietary data and company identification is removed and products are transported for reuse or recycling.
- *Leasing*

  HP offers financial solutions to acquire and retire IT products. This service is also offered worldwide.

Out of the four options, leasing, recycling, and asset recovery are offered worldwide. End-of-life management (recycling) is managed in its own organization hosted by the printing and imaging group. EOL management is loosely linked to the corporate envi-

ronmental function as well. The end-of-life management unit deals with products that no longer have a useful life. Warranty returns are handled in the returns organization and trade-ins and asset recovery are handled in the financial services organization.

Although the recycling service is offered globally and Hewlett Packard has contracts with treatment providers in all regions, the implementation details are locally customized. Customers have different sensitivities for paying and different sensitivities with respect to long they are willing to drive somewhere. In some countries, customers are willing to make a little effort to receive something for free or close to free. Customer awareness is also different in areas like Latin America, and in parts of Asia efforts are geared toward raising awareness.

HP has organizations dedicated to managing end-of-life products in all regions of the world. HP also has a worldwide management team that helps coordinate efforts if necessary. This team helps if the organizations want to share resources on something like IT systems.

HP is heavily involved in lobbying in regions where extended producer responsibility legislation is under development. HP believes that the best way to deal with end-of-life products is to place the responsibility on the manufacturer. HP believes that in systems where the money goes directly to the government there is no incentive to reduce the costs of the system or make the system customer friendly.

“This is our customer, we do not ask the government to design our products or to take care of a warranty, so it seems bizarre, when the products come to end-of-life and they are still with our customer, that we would suddenly ask another organization to come in.”

HP sees end-of-life management as a source of competitive differentiation. It has been actively involved in this activity since 1987 and has thus had the opportunity to learn how to do it. Through its programs, HP has learned much about customer needs and the actual recycling process itself. The learning curve effect and managing the customer interface themselves are the key differentiators related to competitors. HP measures the perform-

ance of its EOL management processes through the cost per ton and weight of products collected. HP also measures the awareness of consumers. Periodically, when HP does market research, its EOL team adds questions pertaining to consumer awareness of the company's activities in this area.

The EU

HP has been involved in end-of-life management since the early 1990s by offering ad hoc services to its business customers. HP first launched its Planet Partners Program, which started consumer take-back, in the US and brought it to the European market in 2003. The main reason for starting the program was corporate concern for the environment.

In the Planet Partners Program the final end user of the IT piece of equipment can order a pick-up service on the HP website against a fee. The products are collected and sent to a network of 10 contracted vendors that recycle the products according to HP's standards, which are tighter than standards mandated by the WEEE Directive.

Where feasible, components are retrieved from the collected products. For example, used products from business customers are often not even waste and there are brokers that salvage parts for after-sales support. In some cases, HP sells the used products to the brokers, whereas in others, the B2B customers sell their used products directly to them. With consumer products, e.g., ten-year-old PCs, the likelihood of salvaging anything useful is very low. The program is mostly used by business customers. However, the demand for this service has been low. In The EU, HP recycled 22 000 tons of IT equipment in 2004.

The main change that the WEEE Directive brought to HP was making take-back mandatory. HP is one of the founding members of the Electronics Recycling Platform (ERP). In all eight countries where ERP is operational, HP takes care of its obligations through this mechanism. In other countries, HP is directly involved in the collective systems.

HP takes care of recycling B2B products when a replacement is bought. Recycling services can be provided at an extra cost when this is not the case. For B2B products, the WEEE Directive has not brought about any major changes. The only change is the opti-

mization of the B2B take-back network. Today, HP is offering a Pan European solution for business customers, including a call center for each country.

The main investment that HP has made for WEEE compliance has been the use of employee time for lobbying. Among other environmental topics, the environmental business organization handles the EOL and WEEE issues in the EU. It is hosted by one of HP's largest businesses, the printer business. In the EU, about 25 people work for this division and most of them are somehow involved in WEEE. Data management is another major HP investment. Providing data to each and every country in a different prescribed format is a very complicated matter. At the moment, data at HP is managed semi-manually. The organization is working on building an information system to handle this major process. In connection with this initiative, HP is opposed to the use of visible fees as they only add to complexity.

The WEEE Directive has no impact on suppliers. The impact on distribution channels depends on the way manufacturer is defined (importer on National Territory, as defined by National Legislation, which radically differs from the EU interpretation of the manufacturer who is the importer on the Community Market). Where possible, HP will take over the responsibility of the channel.

The main strategic opportunity related to EOL is to do it right for the environment, the customers, and the stakeholders. The system has to be easy for the customer and low-cost for the stakeholders. That is why HP launched the ERP, which is a pan European scheme and that can leverage economies of scale for waste transportation and treatment. A key strategic opportunity is to use the company's resources to influence the way policies are designed on a European and member state level. One of the general objectives for lobbying is to have as much freedom as possible for a company to reach its goal and to avoid some of the means inherent with reaching the goals.

USA

HP's computer hardware recycling program began in 1987 in the USA. At that time, the focus of the program dealt with equipment from business customers and internal returns.

As described earlier, HP has a number of possibilities that it offers its customers in the USA, ranging from leasing and trade-ins to recycling. In Canada and the USA, consumers can go to the HP website and for a small fee they can have old equipment picked up at their house. The fee ranges from 9 to 30$, and customers also receive an electronic coupon that they can use on HP.com shopping for the same amount or more. Furthermore, consumers can use that coupon to purchase anything they want--so in essence it is free. The collected equipment is transported to one of HP's three recycling facilities in the States that are operated as a strategic alliance with Noranda Inc. HP has chosen to own these facilities in partnerships because recycling is not one of its core competencies. HP remanufactures some of its B2B products, but all the B2C products it collects are recycled. The company has an organization dedicated to end-of-life management take-back in the USA.

Asia (Japan, China, and other Asia)

The Planet Partners Program was extended to Asia in 2003. HP has LaserJet cartridges and hardware recycling programs in place in China, Hong Kong, Japan, Korea, and Singapore for corporate customers. For consumers, HPs take-back service for computer and printing hardware is offered in Japan only. HP operates these programs with contracted service providers. It does not own any recycling facilities in Asia, but it has teams dedicated to end-of-life management in Singapore and China.

Product Level

HP established its design for environment program in 1992 and initiative has three principles: Energy efficiency, materials innovation, and design for Recyclability. HP operates several recycling facilities that are used to develop better DfR techniques. The main ways in which recyclability is taken into consideration in the product design process are:

- Eliminating glues and adhesives
- Marking plastic parts
- Reducing materials used
- Modular design.

Product designers use checklists to evaluate the recyclability of products. HP has one product design globally, so all products adhere to the same environmental standards everywhere.All plastics parts must be labeled according to HP specifications. HP sees DfE as a source of competitive differentiation. The company has been putting a lot of work into this effort, because it wants to be involved in the actual recycling itself.

Streamlining the supply chain in preparation for the RoHS due date has required major efforts from the factories and suppliers. The biggest investments have, however, been made upstream in the supply chain. Moreover, the process of phasing out lead in solders in PCAs has proven to be a very difficult practice.

Case NEC Corporation

Background Information

Location of headquarters	Tokyo, Japan

	Total	Europe %	USA %	Japan %	China %	(Total Asia) %	Other
Company Turnover ($ 2005)	45,392 billion			77,8 %			

Product category	Global
White Goods	
Consumer Electronics	
Information Technology	43%
Telecommunication	39%
Others (electronic devices)	19%

	Global
% of company sales B2B products	NA
% of company sales to B2C products	NA

NEC's principal activities are to provide systems, components, services, and integrated solutions for computing and communications applications to corporations and public sectors. NEC does not measure the ratio of B2B vs. B2C products, but most of its IT and Network solutions products are sold to government agencies, enterprises, and communications service providers.

Environmental issues are managed from NEC headquarters in Japan. In Japan, the corporation has 16 full-time people involved in environmental issues. Additionally, on some levelall departments manage environmental issues. NEC does not have employees focusing on environmental issues outside Japan.

NEC established its first company regulations for Pollution Prevention and Environmental Management in 1971 and it initiated eco-audits in 1973. Its first "Environmental Accounting" results were released in 1999.

NEC considers its environmental strategy to be mostly reactive. Environmental proactiveness is not seen as a source of competitive advantage. NEC is included on a number of sustainability indexes: Dow Jones Sustainability Index DJSI World 2005/2006; FTSEGood Global Index and Morningstar Socially responsible Investment Index

Involvement in End-of-Life Management

Global-Level Perspective

NEC has regional strategies for dealing with end-of-life management. The company is deeply involved in EOL operations in Japan only. The reason for this is that Japan is the only market where NEC has a strong position. NEC is still in the process of collecting information in China and The EU. Another reason why NEC is only active in EOL in Japan is because of the differences in secondary markets. In Japan there is a market for refurbished goods. Computers are much more expensive there. Companies can sell their products with a profit related to the brand name image. Furthermore, refurbishment costs are lower because all recycling costs are born by the consumer.

There are differences in EOL management strategies for different product types. Carriers typically take care of end-of-life cell phones, whereas network equipment and PCs are handled by NEC.

NEC obtained a license for disposal of industrial end-of-life products in 2000. It was a competitive advantage for the organization at that time, because NEC was the first company to obtain the license in Japan. However, now almost all its competitors obtained the same license. Hence, it is no a longer competitive advantage for the organization. NEC does not see end-of-life management or compliance with extended producer responsibility legislation as a strategic opportunity. There are no opportunities related to B2C products. With respect to B2B products, the company sees an opportunity in offering “cradle-to-cradle” services. To measure performance NEC uses environmental accounting.

“In Japan we do sell products from a recycling point of view and also a chemical content point of view. We really do better than average from an environmental point of view.

This environmental approach for Japanese companies is much less used in The EU than in Japan. There is a lot less focus on marketing environmentally friendly products. I think NEC has so far failed to see the existence of strong EU legislation as an opportunity. Managers in Japan are so focused on the Japanese market that they don't need to look for anything but traditional sales opportunities in EU. So the environmental and WEEE angle is non existent from an opportunities perspective."

The EU

NEC has been involved in very little voluntary end-of-life management in The EU. Some of NEC's five individual sales companies had ad hoc services for B2B products. These were mainly used for expensive products like telecommunications equipment and mobile terminals. Customers had the chance to send computers back, but that option was rarely exercised, because it was not promoted.

NEC launched a system for computer recycling in 2004. In this system, electronic parts and printed circuit boards in products returned by customers due to product failure, etc., and in used equipment collected from business users are checked for performance and reused as maintenance parts. So far, the number of products returned by, or collected from, customers has been low, averaging 10-20 units a month, but these numbers are expected to rise as product reuse is further promoted.

NEC sells predominantly B2B products, whereas WEEE was initially more focused on consumer products. As they are typically set up, the schemes do not work for B2B products. As a result, a major challenge is finding a scheme that accepts B2B products and preferably one that accepts all the products that NEC sells. Most sales companies are very small and not familiar with environmental issues. NEC is not actively looking into individual schemes at the moment. They investigated the possibilities of individual compliance for a few product groups like PCs and monitors in some countries to have the possibility of recovering some of the costs related to recovery. However, individual schemes turned out to be much more complicated and time-intensive than the organization anticipated. NEC found that all the additional work would not be worth it for them. Now, NEC's focus is on finding solutions that allow them to outsource as much as possible to service providers. IPR is the right approach according to NEC. IPR is the way forward.

There is no final opinion on the financial impacts of the WEEE Directive, because of the company's lack of experience in EOL management. NEC relies on information from the recycling industry. The biggest cost issue is with compliance costs. Financial impacts in terms of work hours have also been considerable because of the company's general lack of experience. This is something they have tried to mitigate by working together within NEC to realize economies of scale. Thinking beyond country borders does not make sense within The EU because of the differences in national implementations and problems in shipping e-waste across borders.

Six people work on WEEE compliance in The EU as a part of their job. NEC's European headquarters has a project team for WEEE and RoHS. This team includes two corporate compliance and quality managers, two environmental people, and some people from legal affairs. Additionally, there are representatives from each of the sales companies in the team. In addition to this team, there are two people working on the issues alongside other tasks in government affairs. These individuals deal with analysis of political and environmental policy developments, and are responsible for assessing and communicating the impacts of the WEEE Directive are. The company's headquarters in Japan also participates in the analysis and gives feed back in terms of where and how to apply mark and design impacts of the WEEE Directive.

NEC has not put a lot of work into information systems to deal with the WEEE Directive. The requirements are mainly taken care of with SAP data, which is collected internally anyway.

Moreover, NEC has not measured the total costs related to compliance with WEEE. So far, only recycling costs have been measured. The main investment in WEEE has been the development of a database. NEC does not have an opinion on visible fees. This topic is not a political and ideological issue for them. Their opinion depends on the individual markets and how NEC is positioned in them vis-à-vis competitors.

So far, NEC has not seen compliance to the EU Directives as much of an opportunity. The WEEE Directive has, however, triggered a lot of thinking within NEC The EU about how to be prepared for environmental legislation.

USA

NEC is not involved in end-of-life management on the US market and it does not have any employees in the US that manage EOL activities.

Asia

NEC is deeply involved in end-of-life management in Japan. In China and other Asian countries, it is still gathering information. NEC has 16 people working full-time on environmental issues in Japan. Two of these employees work on end-of-life management. NEC also owns recycling and refurbishment facilities in Japan that treat its products.

NEC offers “cradle-to-cradle” solutions for its B2B products in Japan. They have been offering these solutions since 1969. NEC's "Refreshed PC" business was launched in July 2003. In addition to reducing environmental impact, it aims to raise customer satisfaction and improve the brand image of NEC-made PCs. The “Refreshed PC” business service was launched ahead of the PC Recycling Law that went into effect in November of the same year. Its purpose was to establish a reuse method with a lower environmental impact than recycling.

NEC buys back used PCs and sells them upgraded. The company repurchases, refurbishes, and resells secondhand computers that it manufactured in the first place. Japanese consumers can ask NEC to repurchase their used PCs on a site on the Internet. At present, most models released from 2000 onward are eligible for repurchase. Following the request for repurchase to NEC, a parcel company designated by NEC comes to pick up the PC at the date specified by the customer and delivers it to the Gunma Plant of NEC Personal Products. After a product appraisal, the appraised value is submitted to the customer. If the quoted value is acceptable to the customer, NEC repurchases the used PC for the appraised value. The appraised value varies according to the model, condition, etc., but it usually ranges from ¥20,000 to ¥150,000. Once a PC has been repurchased,

data stored on it is deleted using NEC's proprietary software. After the PC has been cleaned, an OS has been installed, etc., the now like-new PC undergoes a battery of product tests on the same level as those for new products and is then sold to a mass retailer that sells secondhand computers.

Though used, NEC guarantees the quality of each PC (warranty six months). While the warranty term is shorter than that of a new product, no other secondhand products carry a manufacturer's warranty. In addition to the OS (basic software) and word-processing, spreadsheet, and other applications, the latest anti-virus software comes installed on the machine. The price of these secondhand computers is about ¥100,000 on average, which is somewhat higher than other similar secondhand products.

In 2005, about 16,000 PCs were collected and refurbished (compared to 83,000 tons of new products being sold). NEC also had to obtain a license for dealing in secondhand articles. While the company is experienced in sales, repurchasing was an altogether new experience for them, so the company had to establish an assessment method for determining what price to pay for products in various conditions while closely watching the going market rates. NEC does not see that "Refreshed PCs" would have resulted in a drop in new PC sales. On the contrary, according to their estimates their user base expanded. New PC buyers and secondhand PC buyers are two distinct groups of users. Demand for secondhand PCs comes mostly from people who already have a PC and are looking for a second one. Although the business was launched with an expectation of initial losses, it produced profits in its very first year.

In 2005, the amount of used information equipment (computers, PCs, printers, and other products) collected was about 98,000 tons. The recycling rate was 98% (including incineration, reuse, and recycling) and the resource-reuse rate was 89% (including reused or recycled products).

Design for Recovery

Eco-design is considered to be a source of competitive advantage. The use of eco labels is an example of how products are different from those ofkey competitors’. NEC's own en-

vironmental label, "Eco Symbol," was established in 1998, and the company's product assessment guidelines were issued in 1994.NEC actively promotes the use of easily recyclable materials as well as the use of recycled materials. 62% of plastics used in casings and frames were recycled plastics in 2005.NEC has Eco Product Standards that are used for design for environment, which include items related to the 3Rs. Considerations practiced by the company that arerelated to recovery include the following:

- Must use reusable parts and units
- Must display material names on plastic products, packaging materials, and accessories
- Target products and accessories: 25g or more
- Target plastic foam packaging: 15g or more
- Must display rechargeable battery material and have an easily separable structure
- Parts containing mercury (Hg) must be easily separable
- It must be possible to easily disassemble products into individual materials (up to the unit level) with a screwdriver or other general tool

The main way of taking recovery into consideration is material choices. NEC attempts to choose materials that are good for the environment and that can be easily recovered. The main impacts of RoHS have been asking the suppliers to comply with material regulations. NEC has not reduced the amount of suppliers. NEC made the restrictions required for RoHS globally in 2002, because there is so much regulation on the issue. NEC has been working on lead free initiatives before any legislation was enacted. It launched a lead-free PC in 1999.

The main challenge with RoHS is not the bottom-line requirements. RoHS lacks definitions and clarifications. And there is still no method for testing RoHS compliance. Moreover, the "put on the market" definition can also cause problems with RoHS compliance. Products like mobile terminals cannot be shipped that quickly from one country to another.

Appendix 6 Telecommunications Cases

This appendix includes three cases: Motorola, Nokia, and Huawei. Motorola and Nokia are discussed for both handsets and network equipment, whereas Huawei is discussed in relation to network equipment only. Samsung Electronics, which is also discussed in the analysis for handsets, can be found in Appendix 2. Each case includes background information on the company, and a description of involvement in end-of-life management in the EU, USA, and Asia.

Case Motorola Inc.

Background Information

Location of headquarters	Schaumburg, Illinois USA

	Total	Europe %	USA %	Japan %	China %	Asia %	Other
Company Turnover (billions USD, 2005)	36,843	19%	47%	7%	9%	19%	15%

Product category	% of turnover		% of turnover
White Goods		B2B products	42%*
Consumer Electronics		B2C products	58%*
Information Technology			
Telecommunication	75%		
Others	25%		

Motorola's principal business activities are to provide integrated communication and embedded electronic solutions. Products and services include subscriber equipment with related software and accessory products, embedded processing, and connectivity products. Motorola's product offering also includes wireless infrastructure communication systems,

including hardware and software, mission-critical integrated communications, and information systems.

*Personal communication business segment counted as B2C, others B2B.

Global Environmental Organization

On a corporate level, Motorola has cross-functional teams to drive environmental issues through the business segments. Usually each business segment will have someone (typically from environmental, health and safety) in the teams, who will matrix down as required. These people are distributed all over the world. The ratio is about 50:20:30 in Asia, USA, and The EU respectively. Motorola sees that integrating environmental issues, like end-of-life management, into other business issues is very important. For them, environmental issues should be considered as just another aspect of the product.

For the majority of environmental issues, Motorola tries to have one set of requirements globally. However, in products made for specific markets, the restrictions on material content differ.

Environmental proactiveness is something that Motorola considers to be a source of competitive differentiation. According to Motorola, it is especially good at product assessment, and its globally tough environmental standards have been recognized around the world. Motorola considers itself to be in a leadership position in the industry when it comes to environmental standards and WEEE and RoHS compliance of products. Motorola set up material and reporting databases before its competitors, about five years ago.

Involvement in End-of-Life Management - Handsets

Global Level Perspective

Motorola has cross-functional global teams in place for both WEEE and RoHS compliance. Jobs at Motorola are typically organized so that all employees have numerous areas of concentration. No employees focus solely on end-of-life management.

Motorola is involved in take-back activities in the EU, USA and Asia. It has different projects in each of the regions, largely due to considerable regional differences in attitudes and is continuously expanding programs with market expansion. The company is expanding its take-back program geographically. The different regions also differ with respect to internal coherence. For example, in the US and China you can have one system. In other Asian countries, you would have to do it separately.

From Motorola's perspective, end-of-life management offers possibilities for competitive differentiation. Designing products so that they are easy to recycle and refurbish could be seen as a competitive advantage. Moreover, having a relationship extending to the customer where you take-back their old product and sell them a new one could be a competitive advantage. Finally, designing a system where the costs are minimized or covered by revenues could lead to competitive differentiation. There are considerable regional differences in how far Motorola is in gaining competitive advantage. In The EU, Motorola is still working on establishing a formula that would allow them to break even for take-back. In the USA, its handset take-back operation is already profitable. "Asia is a question mark." The organization's environmental, health, and safety department has performance measures for evaluating end-of-life management processes.

The EU

Organization dealing with end-of-life management

In The EU, three people focus on the WEEE Directive full-time. They are part of a global WEEE implementation team, which includes people from all departments. One person is in charge of the coordination for WEEE, and two are working on reverse logistics, including reselling and remarketing. Numerous people work on the issues part-time, including a person in each of the 25 member states. In addition to this, Motorola owns a research facility that has five people who work on environmental issues full-time. This research facility, launched in 2000, analyses all of Motorola's products in terms of compliance with RoHS and WEEE and other environmental regulations.

The returns management organization is responsible for WEEE compliance in the network equipment business in The EU. This group takes back used components and fixes

them when the products are still in use. The same group of people manages end-of-life management because they have the knowledge and the experience of managing the process of bringing back equipment to service centers.

Regional End-of-Life Management Operations

Motorola started preparation regarding WEEE and RoHS compliance 10 years ago. In 1997, it started to cooperate and coordinate with competitors like Nokia, Siemens, Samsung, and Panasonic. This collaboration resulted in a one-year pilot project in Sweden and the UK. A second initiative took place four years ago with a German association called Bitkom. The conclusion was that there is no industrial solution.

Motorola has a scheme in place on the web where customers can print envelopes and return handsets for free. All the products collected through this scheme end up at a facility where they are checked for reuse and remarketing possibilities. This facility is owned and operated by a service provider. Motorola uses the same facility for commercial returns. Currently, the scheme is working in eleven countries now and it will be extended to include all the European countries in the future. Motorola is also working with Recellular, Foneback, operators, and some charity organizations. These refurbished phones are sold in developing markets. About 100,000 units per year are sent to the facility, and about 1-2% of these are end-of-life products.

For the near-term, Motorola has opted to join collective compliance schemes to fulfill its B2C WEEE Directive requirements. The company will continue to comply collectively to future waste requirements as well, due to the technical difficulties of individual systems. Motorola sees that from a practical perspective the distinction between future waste and individual responsibility is very artificial. As the interviewee noted: “We are responsible as a manufacturer for the waste--there is no differentiation between old and future waste because we cannot sort it out.” In the future Motorola could support a mixed system (collective collection and sorting with individual treatment). This way they could reuse where it makes sense. These kinds of operations could be the source of competitive differentiation, but Motorola considers them as its environmental responsibility. In time, they feel

that they may be able to save money and generate extra business through creating new markets. Motorola's goal is to exceed WEEE and RoHS requirements.

Motorola has made the main investments required to comply with the WEEE Directive over many years. For example, the laboratory was built about ten years ago. Motorola has looked at the total operational costs related to compliance, i.e., one-off costs to register and the running costs. Expenses consist mainly of equipment and labor costs and they are confidential. In any case, end-of-life management is cost avoidance to Motorola because the product has already been sold. As process measurements, the organization looks at costs and revenues from these activities. Motorola has scorecards for all processes however the measures included in the scorecard for end-of-life management are confidential.

Company information related to opportunities for competitive differentiation is also considered confidential. Motorola is currently focusing considerable time and attention on future aspects. That is a point for competitive differentiation. There are some areas related to design where they feel there is room for competitive differentiation.

Regional End-of-Life Management Operations--Network Equipment

Before the WEEE Directive, Motorola offered take-back services to its customers on an ad hoc basis in The EU. If the customer asked for it, Motorola organized the service as part of the deal. This service was not something that they offered proactively. After the WEEE Directive, Motorola takes back used equipment as specified in the national laws. Take-back is typically a bilateral agreement between the customer and Motorola, but in some cases, collective compliance schemes can be used too.

There is currently no refurbishment or parts retrieval for base stations. Motorola leaves this activity to the operators who own the equipment. Motorola's returns management center keeps a stock of field-replaceable units. Before the process of collecting the used equipment from a customer starts, the returns management center reviews the type of equipment that is being taken down. If they see a need to increase their stock holding of certain parts, they take out components.Reuse is challenging, because the technology life cycle of base stations is short.

Challenges

The main challenges related to the WEEE Directive are convincing people to bring back their used products and the addressing the complexity of the Directive. The administrative burden, including labeling and reporting requirements, is huge. There are many requirements made by the member states, and simply understanding how these requirements should be interpreted adds to the administrative burden. As the interviewee noted: "It is not the Directive; it is the 25 different member state laws." Moreover, the WEEE Directive is very complex. It defines artificial barriers and limits. In the future, it will be less complex. The Directive will have to be simplified and made more realistic. The main challenge in The EU is getting a system in place that actually breaks even.

On the network side, the main challenge is changing peoples' attitudes toward the reuse of components. Another challenge is setting up some sort of organizational processes that can identify components that are sufficiently reliable for reuse and sale in new equipment.

USA

Regional Organization Dealing with End-of-Life Management

Motorola manages end-of-life management through cross-functional global teams. End-of-life management is a part of many people's jobs across the organization.

R*egional End-of-Life Management Operations*

Motorola has been involved in several voluntary take-back initiatives in the USA.

The earlier initiatives were community recycling efforts. Local schools were used as collection points for waste electronics such as scrap TVs, computers, and handsets. Motorola is currently running an initiative called "Race to recycle" which offers schools 3 per intact phone returned. A particular school can earn up to $21,000 through this program. The goal is to collect one million phones per year. The initiative has been very successful so far. Motorola includes a prepaid envelope with new phones to allow consumers to return used phones of all brands easily. Consumers can obtain a US postage prepaid label

on Motorola's web pages. It has also placed prepaid envelopes in 5 million boxes since the program was started two years ago.

Collected phones are refurbished and resold, given to appropriate organizations, or safely recycled and disposed of. The phones that are returned through those programs tend to be older and from different companies. Motorola will not resell a competitor's phone with their name on it. Motorola used to own refurbishment facilities; however, it has sold most of them to service providers. In addition, Motorola refurbishes its products for some particular customers like the automotive industry.

Motorola's end-of-life management activities are a profit center in the USA, and their level of profitability is confidential. According to them, taking back products makes sense economically and environmentally. On interviewee noted: "In The EU for take-back a lot of times you end up writing lots checks to governments and what not or national collection schemes and it is just a net cost. In the USA, it has been set up so it actually pays for itself. It is good you get to do the right thing and you don't have to write huge checks."

Regional End-of-Life Management Operations Network Equipment

Motorola has been offering the take-back of network equipment to customers for four years as a service.

Challenges

The main challenge is the complexity brought on by 50 states making their own requirements. "There are 50 different initiatives swimming around out there. I think each state has its own waste restriction and some have tax ideas, payer ideas. It is not a unified set of requirements that you are trying to meet. The US is behind when it comes to WEEE and RoHS. They do have some restrictions but highly geographical but very inconsistent."

Asia

Organization Dealing with End-of-Life Management

The Environmental Health and Safety Organization is in charge of end-of-life management of handsets in the Asia-Pacific region and China, operating from their regional headquarters in Singapore. About 30 people deal from different functional backgrounds deal with end-of-life management as a part of their job.

Regional End-of-Life Management Operations--Handsets

There is currently no extended producer responsibility legislation in place that covers handsets in the Asia-Pacific region. Motorola has, however, been involved in joint industry voluntary initiatives for take-back in Malaysia and Australia since the late 1990s.

China, which is Motorola's biggest Asian market, is still in the process of developing a solution for WEEE. Motorola started the Green China project in 2004. It placed collection bins at service centers and made contracts with treatment providers. The volumes collected so far have been low; take-back in Asia tends to focus around customer education initiatives. The Green Box initiative that Motorola launched together with China mobile and Nokia is a good example. A green van goes around to schools providing education about recycling and places boxes in a thousand shops to collect phones. Nokia and Motorola both had collection infrastructures that they streamlined into the Green Box initiative.

Motorola is not involved in refurbishment in the Asia Pacific region, because the refurbishment markets are too small to merit proper attention. Compared to the volume of new products sold, the volumes are very low. Besides, most consumers in the region use their phones until the very end, and if they buy a new phone, they hand the old one down to friends or relatives instead of returning it. Additionally, there are plenty of secondhand vendors in the market that offer to buy the phones from them.

Motorola is also active in the development groups for WEEE legislation in the region. It is too early to say what would be the best system in the different countries. A system where all cell phone manufacturers come together to deal with the issues would most likely be the best alternative. However, with such a system the problem would be how to differentiate the company from its competitors. From Motorola's perspective there might

be opportunities for competitive differentiation in green marketing. The systems have only been put into place recently, so it is difficult to see what kind of an impact they will have.

Regional End-of-Life Management Operations-- Network Equipment

The end-of-life management of network equipment is handled on a contract-to-contract basis in the Asia Pacific region. If the customer requests take-back, Motorola requests a selected treatment provider to collect the products. If there are no authorized recyclers in the country where the network is located, the products are shipped to a point for consolidation. The main challenge in China is lobbying toward a set of requirements that are consistent with The EU. GSM is a big standard in both The EU and China. Motorola would like the phones that are sold in those markets to be as consistent and comparable as possible.

Design for Recovery

In some cases, handsets are designed for recovery--in many cases they are not. The main change that Motorola has made is reducing the number and type of fasteners. This makes sense from a manufacturing standpoint as well. Additionally, there are some finishes that designers should avoid and recommended materials they should use. Motorola has some options for using recycled materials. Much research has been done on using recycled plastics. Motorola aims at increasing the use of recycled materials in their products. Labeling is also used to improve recyclability. Plastic parts weighing over four grams are labeled to aid recycling.Furthermore, Motorola is currently looking at using materials such as bio- or nano-based materials. There are subsequent opportunities in the design of B2C products due to the sheer volumes involved. There is a difference if you have recycled materials only or just bio-based materials. The results of the research on this are not yet available.

Motorola tries to make all of its products comply with the same standards. There are, however, some exceptions. For example, two-way radios, which are a big product in the States, but their frequencies would not be applicable elsewhere or with other products that would never be sold outside the USA. As the interviewee noted: “It does not make

sense to do a lead-free conversion on it, right?" With mobile handsets like GSM, Motorola's products will be compliant across the board. Motorola does not want to take the risk of having non-compliant products end up in the wrong markets. CDMA is not a predominant technology in Europe, so it does not have to comply with European standards. Japan has its own wireless standards so anything Motorola produces for NTT DoCoMo is produced just for that market according to local standards.

"It costs a lot of money to take a product that has already been developed and performing fine to redesign it so it meets WEEE and RoHS. That is the only benefit and you will never sell it in the market where the directives apply. You would be spending 100s of thousands of dollars fixing problems that are not problems. For products that will never get shipped to Asia or Europe it does not make sense to make WEEE and RoHS compliance design changes."

The main financial impacts of the RoHS Directive were going through the entire material list part by part and making sure that that there is test data on everything. There are significant costs involved in this, but the investments are made gladly because they want to make sure that their products comply with the regional requirements. Motorola set up a laboratory in Germany ten years ago to work on these issues.

Motorola has been consolidating its supply base over the years but these decisions have not been driven by RoHS. Most of their vendors have put forth the effort required to certify the part composition, to provide the information to Motorola, and address issues if there are any. Late in a design cycle, there might have been a part that is clearly not RoHS compliant that the vendor cannot fix it in time. In those cases, they would have had to switch vendors, but these are exceptional cases.

The challenges with RoHS are similar. There is a lot of discussion about exemptions. Understanding the requirements is difficult. The major design challenge at the moment is how to reduce energy consumption for both handsets and base stations.Another challenge is the effort it requires to check to see that suppliers are compliant.

Case Nokia

Background Information

Location of headquarters	Finland

	Total	**Europe**	**USA**	**China**	**Japan**	**Asia total**	**Other**
Turnover (Billion USD, 2005)	40,330	42%	8% %	11%	-	26%	Other Americas 8%; middle east and Africa 13%

Product category	**Global**	**Product type**	**%of sales**
White Goods		B2B products*	39%
Consumer Electronics		B2C products*	61%
Information Technology			
Telecommunication	100%		
Others			

Nokia's principal activity is to provide mobile phones, broadband, IP network infrastructure, and related services. It also develops mobile Internet applications and solutions for operators and Internet Service Providers. The group operates through the following segments: Mobile Phones, Network, Multimedia, and Enterprise Solutions. *The ratio between B2B and B2C products was calculated based on business unit turnovers. B2B includes everything except mobile phones.

Nokia has an environmental organization on all levels: Head Office (Strategic directions), Business Units (Mobile Phones, Multimedia, Enterprise Solutions, Networks) and Horizontal Groups (Customer and Market Operations (CMO) and Technology Platform).

Worldwide a total of 30 people work on environmental issues full-time and about 70 work on environmental issues as a part of their job.

Environmental policies are consolidated and directed from the global level. Regional lines implement them. There are no regional differences in environmental standards or policies. The reason for this is that Nokia is a global supplier and its intent is global. The policy level is also the same for all products.

Nokia published its first environmental policy in 1994. In 1997 it included a page in its annual report on the environment. Nokia has been publishing environmental reports since 1999. The company started production-related environmental measurements in some plants in 1990 and companywide environmental measurements in 2000.

Environmental proactiveness is something that Nokia would like to see as a source of competitive differentiation. Speed to market, activities, and global coverage in implementation differentiate Nokia from its key competitors. Moreover, the company's activities in the area of local take-back initiatives and WWF cooperation have enhanced its perception with the public. Nokia has been awarded a number of certifications and third party mentions related to environmental issues. It has been a member of the World Business Council for Sustainable Development since 2000. It is also included on numerous sustainability indexes, such as the Dow Jones Sustainability Index and FTSE4.

Involvement in End-of-Life Management - Handsets

Global-Level Perspective

There is no manager with global level responsibility for end-of-life management of mobile phones at Nokia. Responsibility lies within the horizontal organization of Customer and Market Operations (CMO). The CMO organization covers all business units except Nokia Networks.

Nokia has a global end-of-life management strategy for mobile phones, which has been put into place locally in all regions of the world. The principle is the same globally, but there is some customization in the regions. The basic components of this service were

introduced five years ago. Consumers can dispose of their phones free of charge at Nokia's worldwide network of service points. The used phones go through the same sorting process as other returns. If the product is in good enough condition it is sent to component recovery or repair. If not the phones are sent to regionally appointed recycling companies for materials recovery.

Preliminary visual inspection already determines that the phones returned to these collection points are only worth their material value. The amounts of phones that are returned to the collection points are marginal. Nokia is not currently involved in refurbishing its phones. According to a study by Accenture, only 10% of mobile phones are currently returned to service providers for recycling. The secondary market is very active for mobile phones.

Nokia has considered all options for managing used products (materials recycling, component or module reuse and repair, and reuse of whole products). The organization has gained considerable experience from repairing phones and component reuse in warranty cases. Returning post-consumer collected phones back to the market as secondhand products would require a stable flow of high-quality used products.

One of the challenges Nokia faces is that it does not have direct contact to its consumers, as mobile phones are generally sold through operators. Products could be bought directly from consumers, but in the present situation Nokia is not willing to enter into a price competition with third party refurbishers to buy products from the market. Based on some experiments, the prices refurbishers are willing to pay vary from 2€ to 20 € per handset depending on what they are allowed to do with the product. The third party refurbishers can offer the refurbishment process and the secondhand product at substantially lower costs, often because they have lower quality requirements. Nokia competes on the primary market with the quality of its phones.

The main strategic opportunities in end-of-life management from Nokia's perspective are risk minimization, brand support, and market opportunities. The opportunities do not differ regionally or by customer type. Nokia is exploiting the opportunities by being legally

compliant, offering additional take-back services for customers, and by organizing market and attention campaigns. End-of-life management also adds value by enabling a customer interface. Furthermore, it can be used to avoid higher costs and to gain positive perception.

The EU

Regional Organization Dealing with End-of-Life Management

In CMO Europe, there is one person that dedicates the majority of her time to end-of-life management issues. In addition, depending on need and available resources, Nokia has some employees in local organizations that dedicate part of their time to EOL management issues.

Regional End-of-Life Management Operations

Nokia has been involved in numerous voluntary take-back initiatives in different regions of the world. The earliest was a joint initiative with Motorola and other manufacturers in Sweden and the UK in 1997. Also, Nokia set up a Europe-wide collection and treatment network in 2000. As described above, Nokia collects some used phones through its service point network.

The main change that the WEEE Directive brought to Nokia's operations is that it has to participate in the collective financing of the historical e-waste. Although Nokia has opted to join collective schemes where they exist, it is still looking into how it can use its own take-back system in parallel with the collective systems. Individual take-back systems could be a solution if national transpositions supported them and practical barriers were overcome.

Besides the direct compliance costs, the main financial impact of the WEEE Directive has been developing internal tools and reporting procedures. The work required, i.e., internal resources devoted to the issue, are also an important cost. The performance of end-of-life management operations is measured as the collection costs for the units and fate of the collected units (re-use, recycle, recovery).

Regional End-of-Life Management Challenges

The main challenge of complying with the EU Directives is orchestrating supply chains both upstream and downstream. Combining the global scope of these issues with the local ways of implementation adds extra layers to the process. Dealing with this challenge requires new processes and resources in the organization.

USA

Regional Organization Dealing with End-of-Life Management

Nokia's organization that deals with product end-of-life management in the USA consists of two employees who dedicate the rest of their time to other environmental issues. These employees are part of the Customer and Market Operations Organization.

Regional End-of-Life Management Operations

Nokia has taken part in a number of forays and take-back events in the USA. It also has some recycling bins in place to collect used phones. The phones collected through these channels are sent to contracted recyclers for material recovery. So far, the collected volumes have been low. The reason for this is that operators are between Nokia and the end users in the distribution channel and they usually have their own processes in place for end-of-life management. However, some operators that work on a prepaid basis have requested that Nokia take care of the whole issue. Nokia's current end-of-life management operations in the US are mostly geared toward raising awareness.

Collecting mobile phones for recycling is not directly profitable in the USA. If refurbishment and parts reuse are not used as options, breaking even is difficult. The costs of collection are somewhere between $1.50 and $2.40 per handset. The scrap value of the phone sent for precious metals recovery is $1.

To develop cheaper systems for collection Nokia has set up partnerships with operators and logistics service providers. Unlike some of its competitors, Nokia's policy has been to avoid the reuse of its products and it does not have contracts with third party refurbishers. Some of the reasons for this are that there are no assurance processes controlling the quality of the refurbishment and there is no visibility into the distribution of products.

Phones may be sold in countries with limited recycling infrastructure or may be poorly refurbished and perceived as dumping of poor quality product on developing economies.This can have a negative brand and publicity impact. Another problem with refurbishing phones is the privacy issues. People are concerned about the personal information that is left in the phones after they are used.

The financial impacts of extended producer responsibility legislation in the US have been small so far. Performance measures are materials disposition weight and value of collected materials. Nokia always sets performance measures when it makes contracts with recyclers. Targets related to EOL management are not financial. The targets are set around the number of qualified vendors and objectives to complete due diligence in contracts. Overall performance measurement in this area is more qualitative than quantitative.

Asia-Pacific

Regional Organization Dealing with End-of-Life Management

Nokia has one environmental manager in Singapore who is in charge of end-of-life management in the Asia Pacific region. Strategies are formulated in headquarters, but put into place locally.

Regional End-of-Life Management Operations

Nokia has had recycling bins in its service centers in most of the countries in the Asia Pacific region since 2001. The collected phones with these recycling bins are sent to authorized recycling companies. Nokia is not involved in reuse. This system allows the company to comply with extended producer responsibility legislation in the region. At the moment hardly anything is returned to the recycling bins. Many secondary market players offer the consumers money for their used handsets. Consumers also often give them away to relatives.

According to Nokia, none of its competitors are involved in take-back activities in the Asia Pacific region. The operations were started because of a desire to be a leading player in environmental activities, but now they have become a source of competitive differen-

tiation. As extended producer responsibility legislation becomes more common in the region, there will be clear benefits to already having implemented some kind of a system. Nokia has also been consulted in the development of extended producer responsibility legislation in various countries in the region.

Advertising has been the main investment made into these activities so far, apart from employee time. Nokia advertises the concept of recycling in the area. At the moment the weight of returned products per country is tracked as a performance measure. Mostly Nokia is just collecting the data for information purposes.

China

Regional Organization Dealing with End-of-Life Management

The care organization manages EOL mobile phones in China. There are no full-time employees for environmental issues there. Two people spend most of their time on environmental issues (50-60%) and end-of-life management is part of their tasks. Environmental strategies are formulated at headquarters, especially for EOL. These are followed to the extent possible. There are of course some differences as WEEE legislation has not yet been published in China.

Regional End-of-Life Management Operations

Nokia launched a mobile phone and accessory take-back scheme in 2002. It was the first company to do this in China. Nokia has service centers in 100 cities all over China, equipped with a total of 200 recycling bins. The reason for setting up a collection system was that there was nothing like it in place in China previously, and people had nowhere to put their used batteries. Nokia also wanted to promote environmental awareness.

The volumes of handsets that have been collected to date have been very low, about 1 ton or 10,000 units since the program was started in 2002. The market for used products is very active in China and normally people do not put their old products in bins free of charge. The bins are, however, good for batteries which people typically cannot get any money for.

The products that are collected through the bins are sent to one city in China and from there they are sent to a contracted recycler. Nokia is not involved in refurbishment in China, as it is illegal mainly for product safety reasons. Large corporations like Nokia must follow all the requirements. Used phones are refurbished by very small companies in China. None of the big refurbishers operate there. In December 2005, together with China mobile and Motorola, Nokia launched the Green Box mobile phones and accessories scheme. The scheme works in the 40 biggest cities and includes about 1300 recycling bins placed in China's mobile retail shops and Nokia and Motorola service centers. In the next stage more operators and manufacturers will be included and it might develop into a producer responsibility organization for mobile phones.

At the moment, Chinese legislation does not affect mobile phones. In the future, Nokia estimates that it probably will, and the company has been involved in much lobbying to impact the content of the legislation. In the current draft regulation, companies are requested to pay money into a special fund based on production volumes. The government collects this money and gives it to the recycling business. Nokia does not support this fund, because the companies are not encouraged to improve their design from an environmental perspective. Furthermore, there is no control on how the recyclers spend the money. Nokia is also lobbying for collective systems to comply with legislation in China. The biggest challenge in China is the lack of collection infrastructure.

Nokia has been working on building a green image in China. It is perceived by some to be greener than the others and it feels that proactiveness might impact the purchasing decisions of some consumers. Environmental issues are a very hot topic in China and public environmental awareness is growing.

Nokia has not yet set performance measures for end-of-life management. The volume of sales is huge, but it is very difficult to get end-of-life products back.

Involvement in End-of-Life Management -- Network Equipment

Responsibility for end-of-life management of network equipment lies with Nokia headquarters in Finland, in the network business unit. One person, based in Europe, manages

the global recycling service on a full-time basis. Local Care Business Lines in the regional organizations provide assistance when needed.

Nokia Networks has a globally standardized EOL service, which was first implemented in 1999. Currently, the EOL service package consists of four independent, fee-based services: removal, collection, recycling, and project management. Prices are calculated on a case-by-case basis, because the revenues from material recovery vary greatly, depending on collected volumes and products. In recycling, the disassembly is typically the largest cost component, as removal and collection drive most of the costs in the whole service package. However, EOL management is rarely charged for separately, because it is usually performed in connection with the delivery of new equipment.

Collected products are sent to appointed recyclers. Nokia Networks does not refurbish nor reuse the parts or components originated from customers. Contracts with customers specify what Nokia is allowed to do with the used products. Usually the only recourse left to the company to scrap the product. In general, recovering the parts or components for reuse is not feasible due to the long use life of the products compared to its technology life cycle, and recovered components could not be used in new products due to reliability issues. All in all, there is a small market for used network equipment. For example some used network equipments are installed in the rural areas by operators. The feasible, unused parts and components from equipment manufacturing are checked by the contracted recyclers and resold.

There are many reasons for having the same service concept in place globally. Nokia expects that other regions, especially China, will follow its lead in passing extended producer responsibility legislation. From their perspective, making different service concepts regionally would not make any sense. Information systems issues and service descriptions need to be the same. While customer-specific details can be in provided, the service concept essentials need to be the same. Plus, the service concept has to be designed centrally for it to be manageable. Having one concept also helps in selecting recycling vendors as prices can be compared more easily.

Offering asset recovery services is seen as a possible source of competitive differentiation if it can be implemented well and cost effectively. The motivation for the service has come from the customers, typically from the USA. Asset recovery service entails that Nokia takes responsibility for the customer's hardware during its entire life cycle. That way Nokia will know what components the customer has in different locations when the customer decides to get rid of them. The concept is under investigation.

There are some tools under development to calculate the optimality of end-of-life management solutions.

The EU

Regional Organization Dealing with End-of-Life Management

A total of 4-5 people at Nokia Networks in Europe are working on the WEEE Directive part-time. In addition, there are people in the local country offices following the legislative developments. The RoHS Directive is managed in a separate Nokia-wide project.

Regional End-of-Life Management Operations

Nokia Networks has had an EU-wide recycling service in place since 1999 (see above). It was redesigned in 2003 so that it would be WEEE-compliant before the deadline. Nokia has a large customer base in Europe, which is technologically the most advanced in the world. European operators renew their equipment the most frequently. However, the volumes collected through the service are still low. Relative to volumes of products sold, the collected volumes are about 3-5%.

The main financial impacts of the WEEE Directive in Europe are work hours. Some investments have been made in information systems. Recyclers frequently ask Nokia to provide information on its products. Nokia has subsequently built an extranet application to deal with these requirements, and pertinent information will be provided there for free. This capability did not require large investments because it was built on top of an existing system. Total costs for complying with the WEEE Directive have not been calculated. Such a calculation was, however, made for the RoHS Directive.

Regional End-of-life Management Challenges

The differences in national transpositions of the WEEE Directive cause a lot of challenges. Registration is a major issue. A lot of resources are required to understand what the definitions and requirements are in different member states.

USA

Regional Organization Dealing with End-of-Life Management

Nokia's organization that deals with product end-of-life management in the USA consists of two employees who dedicate the rest of their time to other environmental issues. These employees are part of the Customer and Market Operations Organization, which does not include networks. However, they help with issues related to network products when needed.

Regional End-of-Life Management Operations

Nokia currently offers a take-back service for its network customers and has contracted recyclers to treat them. The recyclers used for network equipment are different than the ones used for handsets. This service has high demand. Virtually every time something is sold, something is taken back.

Asia Pacific and China

Regional Organization Dealing with End-of-Life Management

Nokia has one environmental manager in Singapore who is in charge of end-of-life management in the Asia Pacific region as part of his responsibilities. In China, this is taken care of as a part-time job through the logistics organization.

Regional End-of-Life Management Operations

The first case of take-back for network equipment in China was in 1999. Nokia currently offers a take-back service for its network customers and has contracted recyclers to do the treatment in China and the Asia Pacific region. Nokia does not reuse its network components. In China reuse is against the law. A lot of questions are asked about end-of-life management as operators are pressured about environmental issues by the governments. Network equipment is taken back regularly, in connection to about half of the deliveries.

Design for Recovery -- Mobile Phones and Network Equipment

Mobile Phones

Product design for mobile phones varies according to customer preferences, i.e., color and size, in different markets. However, Nokia has global environmental standards for its products. Eco-design is a concept that is built into the design of all mobile phones and highlighted by corporate communications. The recyclability of mobile phones ranges from 65 to 80% of a product's mass. The recycling rate of metals is high, however plastics (which account for about half of the mass), cause problems in recycling as they are typically contaminated or mixed. In addition, recycled materials are currently being used in the packages of the phones. There has also been some work on using recycled plastics in the covers; however, there were substantial difficulties in attaining stable quality needed for production. Upgrading is in principle possible for mobile phones, but the nature of mobile phones as personal possessions expressive of the owner's taste and preferences sets limits to this.

All new mobile phones come with an Eco Declaration that covers energy consumption, material use, packaging, batteries and chargers, and recycling. These have been provided since 2002. The eco declarations have also been available on Nokia's web pages since 2003. There are no regional differences in what information is provided.

The main impact of the RoHS directive on suppliers is the elimination of hazardous substances as implied in the Directive. Renewing and additional tracking, checking, and reporting required by the RoHS Directive also result in additional work. Nokia has worked diligently with suppliers to overcome technical challenges and it has not reduced the number of suppliers that it uses because of the directive.

Network Equipment

On the network equipment side, more and more pressure toward eco design is coming from customers. The major environmental impact of network equipment comes from the use phase, from energy consumption. That is why Nokia puts in the effort to develop new

ways to reduce energy consumption in its products. In the product design phase, Nokia Networks sometimes collaborates with the recyclers to determine how long it takes to disassemble the products and what materials can be recovered.

The recyclability of network equipment is 80-85% (figure excludes energy recovery). Networks products contain a large proportion of metals. Metals can more readily be recovered for reuse and recycling than plastics. Moreover, network products are at the moment not purposely designed to include recycled materials. Modularity is an important design criterion for Nokia's network equipment, providing for upgrades and repairs that can extend the service life. Software dispatching rather than equipment replacement can further increase material efficiency.

Lead is the most challenging RoHS material to phase out. The other materials were mainly phased out in Nokia Networks products before the RoHS Directive. Producing and repairing without lead is by far the most challenging issue. Most of the competitors are on the same schedule when it comes to phasing out materials. Non-RoHS-compliant spare parts will still be needed for years. A big challenge is how RoHS-compliant and non-RoHS-compliant parts work together. A lot of testing is being done to verify this currently.

Nokia published its first substance list in 2001. It provides a comprehensive list on its website of materials that have been banned or limited, or are being monitored. Monitored substances will be reduced or phased out in the future. The materials implied in the RoHS Directive have been phased out during the last five years.

Case Huawei Technologies Co., Ltd.

Background Information

Location of headquarters	Shenzen, China

	Total	Europe %	USA %	Japan %	China %	(Total Asia) %	Other
Company Turnover (Billion USD, 2005)	8.3				59%		
Employees (2005)	36,000						

Product category	**Global**
White Goods	
Consumer Electronics	
Information Technology	2%
Telecommunication	98%
Others	

Huawei Technologies specializes in R&D, production, and marketing of communications equipment. Huawei's products can be divided into fixed network, mobile network, data communications, optical network, software and services, and terminals. Huawei's products are based on its own independently designed chips. Huawei has over 50 branch offices, including research centers worldwide.

Environmental management is part of the quality department at Huawei, and there are about 30 people currently working on environmental issues full time in China. Environmental proactiveness is not a source of competitive differentiation for Huawei. Huawei has local environmental standards for each region that it operates in, which are based on the local legislation. Huawei measures waste generated and energy consumption as production-related environmental measurements, but it does not report them and it does not

publish an environmental report. Huawei achieved corporation-wide ISO 14001 certification in 2003

Involvement in End-of-Life Management

Global-Level Perspective

Huawei HQ has set up an end-of-life management team in 2004 to deal with the EU WEEE Directive, which was moved to European Headquarters. Huawei has one person coordinating on end-of-life management globally and that person is situated in Europe. Logistics, operational management, and legal department are also involved in EOL issues.

Huawei only has an EOL management strategy in regions where extended producer responsibility legislation has been passed. In regions where no such legislation is in force, Huawei does not have any EOL operations. The company expects extended producer responsibility legislation in China and the US to spread globally and in anticipation it has recently set up a team in China to deal with the issues.

Huawei does not perceive there to be any strategic opportunities related to end-of-life management. Its competitors have set up global product take-back and recycling systems long before them. Huawei has not done any take-back and recycling activities so it has not set performance measures.

Europe

Regional Organization Dealing with End-of-life management

Huawei has one person working on a part-time basis on end-of-life management in Europe. This person is affiliated to the quality department.

Regional End-of-Life Management Operations

Huawei is a new telecommunications equipment vendor in Europe, and was therefore not involved in end-of-life management before the WEEE Directive.

To comply with the WEEE Directive Huawei has different solutions for B2B and B2C products.

For B2C products, Huawei is negotiating membership with the European Recycling Platform and some national collective schemes. The organization has selected four recycling partners in EU for B2B products. Through them, collection can be arranged all over Europe and local recyclers will collect and treat all of Huawei's end-of-life products. Huawei chose to use these services for B2B products because, from its perspective, this is the most cost- effective solution. Huawei will only have to pay take-back and recycling fees when end-of-life products are collected. Huawei is not involved in refurbishment. Huawei support individual producer responsibility for future waste. Thus far, it has not made any investments for WEEE compliance so far. Huawei supports visible fees.

Regional Challenges

A big challenge for Huawei is its lack of experience in complying with this kind of environmental legislation. Cross-functional cooperation is needed, but it is difficult to draw enough attention from top management. Producer registration is another challenge, along with the task of setting up a take-back and recycling system for B2B products.

USA

Organization Dealing with End-of-life management

There are no people working on end-of-life management in the USA.

Regional End-of-Life Management Operations

Huawei is not involved in end-of-life management in the USA.

Asia

Organization Dealing with End-of-life management

Huawei has set up a reverse logistics team to deal with take-back issues in China.

Regional End-of-Life Management Operations

Huawei is not involved in EOL management in Asia.

Design for Recovery

Huawei has not made any design changes to improve recovery properties and it does not use recycled materials in its products. However, changes have been made for products on the EU market to comply with RoHS. This is a big investment in the areas of supply chain, design, and RoHS testing. These investments and changes were made in the EU. Huawei does not publish a list of controlled substances.

Appendix 7 White Goods Cases

This appendix includes three cases: Bosch und Siemens Hausgerate, Whirlpool, and Electrolux Home Appliances. Each case includes background information on the company, and a description of its involvement in end-of-life management in the EU, USA, and Asia.

Case Bosch und Siemens Hausgeräte (BSH)

Background Information

Location of headquarters							
	Total	**Europe %**	**USA %**	**Japan %**	**China %**	**(Total Asia) %**	**Other**
Company Turnover (billion USD, 2005)	8,6	86,2%	6,6%	NA	NA	5,8%	1,6%

Product category	**Global**
White Goods	83%
Consumer Electronics	
Information Technology	
Telecommunication	
Others	17%

	Total
% of company sales B2B products	0%
% of company sales to B2C products	100%

The business activities of the BSH Group are arranged into two segments: white goods and other. The "other" segment encompasses customer service, consumer products and electronics, and drives and systems.

BSH has a central unit called Zentral Technik that manages everything related to technology. Within this unit there are two departments which deal with the environment, Zentral Technik Umwelt (ZTU) and Zentral Technik Recycling (ZTR). The ZTU department

deals with all environmental and safety issues for BSH factories and products. Their role in EOL management is looking over all the legislation related to hazardous substances. There are four people in this team in Europe and six in China. Each factory worldwide also has an employee dedicated to environmental and safety issues.

Environmental issues are decided on a global level at ZTU in Germany. However, input is taken from people who work in the different regions. Environmental standards are the same everywhere--there are no regional differences in environmental strategy. Environmental issues are not a source of competitive differentiation in the white goods sector. The industry sector is mature. The production processes are subsequently very similar, as are the ways in which large companies deal with environmental issues. BSH has been measuring production-related environmental impacts and publishing annual environmental reports since 1992.

Involvement in End-of-Life Management

Global-Level Perspective

BSH has different ways of managing end-of-life products in each of the regions, because local legislation is different. At the moment, BSH is only involved in recycling operations in Europe, but it is monitoring the situation in China and USA. BSH is a strong proponent of collective systems. It supports them where they are in place and is actively working toward setting them up in other areas.

The biggest strategic opportunity from BSH's perspective is dealing with the e-waste issue collectively. Collective systems provide the opportunity to share the costs and opportunities. From BSH's perspective, the business is mature and there is no room for competitive differentiation in EOL management.

Europe

Regional Organization Dealing with End-of-life management

Four people within the ZTR department work on the WEEE Directive full time. ZTR was set up in 2002, when lobbying started for the WEEE Directive. Additionally, someone in

each local sales office dedicates a large proportion of time to the WEEE Directive. Regular updates ensure that everyone involved is current on the situation across Europe.

Regional End-of-Life Management Operations

BSH has some experiences with voluntary take-back in Germany, dating from the mid 1990s. The company's logistics department organized a take-back service against a fee from dealers and staff stores. BSH strongly supports collective systems for WEEE Directive compliance. The organization is not against individual systems, but it sees loopholes in the concept.

Electronic waste streams are anonymous. Waste belongs to the recycler regardless of whose mark it is. Sorting e-waste into categories of new and historical, and by brand, requires considerable work, which is not required in collective systems.

According to studies by CECED, electronic tagging is not feasible for household appliances because their life-time is so long, about 15-20 years. The simplest system is a collective system where manufacturers pay according to their market share on a "pay as you go" basis. BSH does not see that there is a difference in the level of competitiveness of individual and collective systems. The tendering process is exactly the same within collective and individual systems. You cannot have a tendering process more often than every two years. Authorities are charged with checking that monopolies are not created. BSH does not see that there is a difference in the level of competitiveness of individual and collective systems.

BSH estimates the yearly running costs of complying with WEEE to be 60 million €.The main financial impacts come from administration (20%) and transportation (50%), while recycling only accounts for 25%. BSH fully supports the idea of fully using visible f up until the end consumer. Visible fees are good for making consumers aware of how much money is going into recycling. Therefore, fees need to be visible throughout the supply chain. If the fees are internalized, people do not know how much money is going to recycling and the consumer will pay more because everyone in the distribution chain will take

their benefit out of the fee. BSH is against this. The visible fee should be fixed for the period of the environmental agreement.

USA

Regional Organization Dealing with End-of-life management

There is one employee working on end-of-life management on a part-time basis in the USA. EOL is handled in the product safety department and the work mainly consists of communication to the outside and keeping track of legislative developments. In total, 12-15 people are working on environmental issues as a part of what they do. A few people in each product area are looking at the issues.

Regional End-of-Life Management Operations

BSH is not involved in product end-of-life management in the USA. However, it has been actively involved in industry association studies on where used products end up. Most used products in the US are sold on a secondary market, mostly within the States--primarily because US appliances are larger and less efficient, which makes them less desirable overseas. When there is no more use for them most of them are recycled, because there is some value in recycling them.

There is no company opinion on what type of legislation BSH is pushing for in the USA. Primarily it is hoping that legislation turns out to be consistent across the region. EOL is a very recent issue in the USA, having been a topic for discussion for only the last 5-10 years.

BSH estimates that legislation on this issue will come at some point, but not within the next few years. This is partly due to the fact that a large portion is recycled already so disposing of them is not a large problem.

There are not many opportunities for competitive differentiation in this area, most of which are related to the environmentally friendly image of the products.

Asia

Regional Organization Dealing with End-of-life management

There are six full-time employees working on environmental issues within the corporate technology unit in China. Two people dedicate about 70% of their time on the Chinese WEEE project. The rest of the time, they work on other standards such as RoHS and EuP. Everything is done based on instructions given from HQ in Germany.

Regional End-of-Life Management Operations

BSH has had employees dedicated to the e-waste topic in China for one year. The company is part of the adoption team for WEEE in China, where it is allowed to give input on draft legislation. BSH collaborates with different government parties by giving information about European WEEE Technology or directives at conferences. BSH aims at making the Chinese system like the European and having collective compliance as opposed to copying US and Japanese systems.

The draft WEEE legislation is already finished. However, it is not yet published. There are four different levels to the legislation:

- Policy and legislation
- Standards
- Labeling
- Market supervision.

Details of the legislation will be published in the beginning of 2007. After that, there will be a two-year transitional period. BSH feels that the situation in China with extended producer responsibility legislation will similar to Europe in the future.

BSH has not been involved in any pilot recycling programs nor has it made investments into recycling plants. There is only one manufacturer with such a plant in China, Haier. Haier got financial support from local and Chinese governments to build the plant. The profits of recycling depend on the recycling fees. At the moment the level of fees is so high that the manufacturer that owns the factory will make money. BSH is lobbying against this, as it wants the fees to reflect the actual costs. The main challenge (especially

for big international companies) will be how the system is controlled and how to handle free riders. Local governments will be in charge of collecting the funds. There is a danger that they will choose to support local manufacturers and punish the manufacturers from other provinces.

Product Level

Refrigerators are customized for regional markets through the use of different refrigeration gases. In Europe and China, refrigerators use HC, whereas HFCs are used in other markets. The reason for this difference is that there is no legislation restricting the use of HFCs in other markets and refrigerators that use HFCs are more energy efficient. Factories in Germany produce refrigerators with both refrigerants. For other components, the refrigerators are the same regionally.

BSH started analyzing the environmental impacts of its products in 1996. BSH estimates that 90-95% of the environmental impact of its products comes from the use phase. The recycling rate for their appliances is already very high. BSH has been involved in some initiatives in the past related to design for recycle. At the moment, BSH is collaborating with other companies in finding more cost-efficient technologies that can recycle all refrigerants. Examples of product development changes that have been made with recycling in mind include ending the use of CFCs and HFCs in insulation foam and switching from stainless steel cavities to plastics.

BSH has been working on moving from HFCs and CFCs to HCs since 1993. Since 1999 BSH only manufactures refrigerators with HC foams and refrigerants in China. It is the first and only company doing so in China. The only problem with HCs is that they are flammable--there have already been two explosions in a recycling plant in Belgium.

The quantities of hazardous materials included in BSH products are very low. BSH was not actively looking to eliminate them before the discussions on the RoHS Directive. BSH has been working on RoHS compliance for a year now. There global company guidelines for the use of hazardous materials, but BSH does not publish them. There are some issues that cause major investments for BSH as well as its suppliers. The RoHS Di-

rective has not lead to a reduction in the number of suppliers for BSH. Lead-free soldering is one of the main challenges--products will not be lead free in the States if they are just sold on the American market.

Alternatives for RoHS materials are available but not for everything. A problem with complying with RoHS is that many suppliers are also supplying the car industry which was exempted for one year. The white goods industry is not as big a customer so suppliers are not ready to change just for it.

Environmental labeling differs according to regional legislation. If there is no requirement to provide information, BSH does not do it. In principle, giving environmental information, such as energy use and efficiency, about products is good. However sometimes giving environmental information results in more questions than answers.

Case Electrolux Home Products

Background Information

Location of headquarters	Stockholm, Sweden

	Total	**Europe %**	**USA %**	**Japan %**	**China %**	**(Asia) %**	**Other**
Company Turn-over ($ 2005)	16, 267 billion	45,9 %	40%	NA	NA	3,5%	10,6%

Product category	**% Turn-over**
White Goods	64,3%
Consumer Electronics	
Information Technology	
Telecommunication	
Others	35,8%

	Total
% of company sales to B2B products	15,3%
% of company sales to B2C products	84,7%

Electrolux is the world's largest manufacturer of appliances and equipment for kitchen, cleaning, and outdoor use. The company has two main business areas: consumer durables and professional products. The consumer durables business consists of white goods, floor care products, and consumer outdoor equipment. Electrolux is a white goods provider in Europe, Australia, USA, Brazil, India, and China. The professional outdoor products of Electrolux include chainsaws, clearing saws, and lawn and garden equipment. The professional indoor products business area consists of foodservices equipment and laundry equipment. Electrolux has manufacturing facilities in 97 locations, and its manufacturing operations consist of the assembly of components and the processing of raw materials.

Electrolux' environmental organization is based mainly in Europe. It includes eight full-time employees, two in Stockholm (global headquarters Electrolux group) and six in Brussels (the headquarters of Electrolux Home Products Europe). It also has representa-

tives dealing with environmental issues at production sites, one employee in China, and one in the USA, who monitor environmental issues in addition to carrying out other responsibilities. Strategic decisions are in principle made in Europe and the target is to have global environmental standards. Some regional differences exist because of local legislation.

Electrolux started measuring and reporting production-related environmental measures in 1987. It published its first environmental report in 1994. Electrolux is proactive in environmental issues; for example, its list of restricted materials is tighter than legislation. However, it does not see this leading to any competitive advantage at the moment. Electrolux has been included on the Dow Jones pan- European sustainability benchmark (DJSI STOXX) since 2000.

Involvement in End-of-Life Management

Global-Level Perspective

Electrolux' end-of-life management strategy varies according to regional legislation. Where there is no regional extended producer responsibility legislation, Electrolux is not involved in any EOL activities. The reason for this is that recycling household appliances implies a cost to the company and without the legal requirements there is currently no incentive for Electrolux to manage recycling. End-of-life management of white goods is a significant cost. The main opportunities for competitive differentiation lie in how these costs are managed.

Europe

Regional Organization Dealing with End-of-life management

Electrolux Home Appliances currently has four people focused on WEEE on a full-time basis in Europe. These people are based in Brussels.

Regional End-of-Life Management Operations

Electrolux has been involved in developing systems for product take-back since 1995. Initially, these efforts consisted of collecting used products when new products were sold.

In 1998, Electrolux was involved in a pilot program in Sweden that involved selling function rather than products. From 1999 to 2003, Electrolux took back and refurbished used white goods in Sweden and the UK. It had similar operations with chainsaws in the USA. Before it sold off its professional cleaning equipment business unit, Euroclean, in the late 1990s, it had a business model for leasing and service contracts for cleaning equipment. Products were returned to Electrolux at the end of the leasing contracts, refurbished, and then offered to new customers. Reconditioned products were also used in the event a product failed. However, Electrolux is currently not involved in voluntary take-back programs.

The main change that EPR legislation has brought to end-of-life management is that there will now be a system in place everywhere in Europe.

Electrolux is a founding member of the ERP, which is a scheme developed for WEEE compliance in nine EU countries. In line with WEEE legislation, ERP is allocated a share of mixed e-waste according to its members' market share. This e-waste is then collected and recycled by selected service providers. In member states where ERP is not operational, Electrolux is using national collective take-back systems. In eight out of nine non-ERP countries, Electrolux opted to join the national scheme. However, even in Finland, where Electrolux did not join the national collective scheme, the organization works in tight collaboration with it. The main challenge in a national collective scheme is the lack of control and influence when working with too many others. Through ERP, Electrolux aims at getting lower costs through economies of scale and reinforcing competition in the recycling industry. Future plans and further investigations into IPR are on hold at the moment as energy is focused on getting the system that will manage historical waste for the starting years up and running. Electrolux sees IPR as a key to future improvement of products to facilitate recycling.

USA

Organization Dealing with End-of-Life Management

Electrolux has one person in the United States involved in environmental issues as a part of his job. This person is in charge of following legislative developments in the area of end-of-life management.

Regional End-of-Life Management Operations

Electrolux is not involved in EOL management of home appliances in the USA, as there is no legal requirement to do so currently. For B2B products like chainsaws, Electrolux has offered leasing services in the USA.

Asia

Organization Dealing with End-of-life management

Electrolux has one person in China involved in environmental issues, in addition to performing other responsibilities.

Regional End-of-Life Management Operations

Electrolux is not involved in end-of-life management in Asia as there is no legal requirement there to do so currently.

Product Level

The basic assortment of refrigerators that is offered in the different regional markets is the same, but there are some differences in their construction. For example, HFC is used as a cooling gas in the USA, whereas it has been phased out in Europe. Electrolux has been a leader in the phase-out of CFC and HCFC in new markets such as China and Brazil. The overall trend is toward more global designs and fewer product platforms.

Electrolux has performed life cycle environmental impact analyses on its products. The greatest impact of a group's products occurs during use, about 90%. End of life management only accounts for a marginal percentage. Because of this, Electrolux's design for environment initiatives are focused on reducing the environmental impacts during use phase. Design for recycling is not a priority, and the recycling percentage of a product is not presently focused on. Anything can be recycled with an appropriate technology. Recycled steel is used in home appliances, but increasing the use of recycled materials as

such is not something that Electrolux is focusing on at the moment. Electrolux has been investigating the increased use of recycled materials for the last five years. So far, the quality of recycled materials that is available would cause technical problems if used.

Environmental information on product labels differs by region. US and European regulation requires that every product bears a label indicating the products energy consumption. Similar labeling regulations are applied in Mexico, Japan, China, India, and Australia. In Hong Kong and Brazil Electrolux applies these voluntarily.

Most of Electrolux' products were touched by the RoHS Directive. Electrolux has a separate group dealing with RoHS issues. Much of the testing for RoHS compliance is still ongoing. The RoHS Directive has had a heavy financial impact through the need to find substitutes for banned materials.

Electrolux implemented its restricted materials list in 2004. The list is available on the web. Products on the list are classified into the following three categories:

- Substances of concern: Substances that are listed because they generate concern now or may do so in the future.
- Restricted: Shall not be present in any products put on the market by the Electrolux group, but exemptions can exist.
- Banned: Shall not be present in any products put on the market by the Electrolux group.

Although the list itself is used globally, there are geographical exemptions on the use of certain substances.

Case Whirlpool

Background Information

Location of headquarters	Benton Harbor, Michigan, USA

	Total	**Europe %**	**USA %**	**Japan %**	**China %**	**(Asia) %**	**Other**
Company Turn-over ($, 2005)	13,2 billion	23%	63%	NA	NA	2,9% Asia,	13%% Latin America
Employees	68125	20,5%	41%	NA	NA	7,3%	31% Latin America

Product category	**Global**
White Goods	100%
Consumer Electronics	
Information Technology	
Telecommunication	
Others	

	Total
% of company sales B2B products	0%
% of company sales B2C products	100%

The Whirlpool Corporation's principal activity is to manufacture and market home appliances and related products. The products include home laundry appliances, home refrigerators and freezers, home cooking appliances, home dishwashers, air-conditioning equipment, mixers, and other small household appliances. The Group also produces hermetic compressors for refrigeration systems.

There are two environmental organizations at Whirlpool: the level that deals with production related issues and the level that deals with product related issues. Both organizations have employees in all regions of the world. There are also global groups for environ-

mental strategy and reporting. Whirlpool has a global strategy for all environmental issues except materials use in products.

Whirlpool considers itself to be an environmentally proactive company. It was the first and only corporation to undertake a global greenhouse emissions reduction target. Its target also includes emissions during the use phase of a product. According to one of their studies, 95% of the environmental impact of their products is related to emissions from the power plant producing energy to run the appliances.

Whirlpool does not publish an environmental report and it does not publish information on its environmental impacts. Whirlpool has its own proprietary environmental management system, which is a version of Six Sigma. It does not have ISO 14001 certification, because it does not feel that this path would be the optimal way of introducing conformity and quality. Whirlpool started developing its environmental management system, "global standards" in the early 1990s as its business started to grow in Asia. Whirlpool is included in the Dow Jones Sustainability Index World. It has been elected Energy Star Partner of the Year six times.

Involvement in End-of-Life Management of Refrigerators

Global-Level Perspective

Whirlpool's operations related to end-of-life management depend on regional legislation. The company feels that while extended producer responsibility legislation is necessary for some product categories, it is unnecessary for white goods. Whirlpool is lobbying against extended Producer responsibility for white goods in countries that are considering it. The main reason for this is that steel content is so high, especially in refrigerators, that it is economically attractive to recycle them. For example, in the USA the recycling rates are 90% related to products sold without any legal requirements or extra fees to the consumers. Whirlpool sees that adding regulatory obligations that jeopardize the current market-based systems which achieve very high rates of recycling (e.g. in the USA) would be counterproductive.

Whirlpool is still undecided as to whether there is any business model where the manufacturer could be involved in recycling. Most likely this is not the case. Whirlpool thinks that it is hard to view the WEEE Directive as a strategic opportunity because it is a significant cost burden that will be unlikely to be recoverable from the consumer. As the industry is very competitive, the odds of fees, either visible or not, being bargained away in trade negotiations is very high. Whirlpool fears that these costs will be especially high as there is no incentive to be profitable because the government is the process owner and they know that they have the authority to pass the costs on. The recycling industry, on the other hand, is profit oriented and has to organize its operations collection and treatment and comply with regulations while maintaining profitability. Competitive opportunities for a company would be around making it less of a cost burden than its competitor, but there are currently no opportunities that would make end-of-life management a net benefit.

Europe

Regional Organization Dealing with End-of-life management

Many people at Whirlpool deal with the WEEE directive, none of them however full-time. Whirlpool is organized in product groups and WEEE and RoHS compliance are dealt with in product category meetings where there are representatives from different functional areas. One person, typically a quality manager, is responsible for issues related to the WEEE and RoHS Directives in each group. Moreover the government affairs function looks over the WEEE issue on a European level. Whirlpool also has people in all the member states following the legislative developments and participating in the work of national collective schemes.

Regional End-of-Life Management Operations

Whirlpool has not been involved in managing end-of-life products prior to legislation. It was involved in managing end-of-life products prior to the WEEE Directive in the Member States that already had national WEEE legislation (Belgium, The Netherlands etc.). For WEEE Directive compliance, Whirlpool joined collective schemes everywhere in EU because it sees them as the most efficient way to dispose of WEEE from both the environmental and cost perspectives. All companies within the industry share the same issues

and costs. Most issues related to WEEE are managed through the national compliance schemes. According to Whirlpool the national schemes are working well and there is no incentive for setting up an individual system. Moreover, according to Whirlpool individual producer responsibility is not technically feasible and it is better to share the burden with other companies.

The main financial impact of the WEEE Directive is the cost per ton (logistics and treatment). Internal development costs have not been an issue so far as they are typically passed on to the national compliance schemes. The national implementation phase is still ongoing and it is very unclear what the requirements and costs will be. Whirlpool supports the use of visible fees. Visible fee negotiations among stakeholders are still ongoing in several Member States

USA

Organization Dealing with End-of-life management

End-of-life management is dealt with through the Government affairs unit in the USA, as the main task there at the moment is lobbying.

Regional end-of-life management practices

Whirpool is not involved in end-of-life management in the USA. Recycling refrigerators is a profitable business. Two states (New Jersey and Rhode Island) have included white goods in their draft EPR legislation, but Whirlpool feels that the legislation is unlikely to pass.

The main contact that Whirlpool has with the recycling industry is the feedback that it receives from recyclers. Recyclers, for example, suggest using more steel instead of plastics. However, as steel prices are very high at the moment, they are not asking these questions anymore. Thus far, the tipping point has not been reached as to when it would not be economical to recycle white goods.

Asia

Regional End-of-Life Management Operations

Whirlpool is not involved in end-of-life management in Asia.

Design for Recovery

Whirlpool's products are customized for different regional markets. The refrigerants and defrosting technologies differ. In the US HFCs are used as refrigerants, whereas HCs are used in Europe. Legislation on their use differs in Europe and the USA. In Europe there is a cost penalty for HFC containing refrigerators, because the foam that includes HFCs is stripped out and incinerated. HCs cannot be used in the US for environmental reasons. HCs cannot be vented in the USA, because they contain VOCs which are restricted in some areas. In Europe, HC gases are vented out from refrigerators. As for defrosting technologies, in the USA Whirlpool makes non-frost refrigerators that defrost themselves. Non-frost refrigerators are not common in Europe.

HCs are not used in the US due to product liability risks. Using HCs in refrigerators that automatically defrost themselves would be risky. There could be a leak and the refrigerant could leak into the compartment and have an electrical short. HCs are explosive, so if they are used in these refrigerators the door could be blown off. Apart from the liability risks, Whirlpool prefers to work with HFCs instead of HCs for environmental reasons. According to their studies, HFC foam has superior insulation qualities of about 10%. This has an important environmental impact as 95% emissions impact comes from the power plant that supplies energy during the use phase. 10% improvement in energy efficiency results in a net environmental benefit.

Whirlpool sees environmental proactiveness related to product design is a source of competitive differentiation. According to an internal study, the recyclability of Whirlpools products is very high, over the target of 75%. Whirlpool considers itself to be one of the pioneers in refrigerant recovery. The company has included energy and water efficiency measures in its research and development practices since the 1970s. One of the things that Whirlpool is currently looking into is using recycled plastics that don't produce exactly the same perfect finish in low end markets such as China and Latin America. This could provide a way of offering more affordable products.

Whirlpool has one person solely working on their list of restricted materials, but this list is not published. There are variations in the materials that are used in different regions and in the environmental labeling. Environmental labeling is only done in regions where it is required.